Handbooks in Health, Work, and Disability

Robert J. Gatchel
Izabela Z. Schultz *Editors*

Handbook of Musculoskeletal Pain and Disability Disorders in the Workplace

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In loving memory of Nancy Penson (1924–2012).

Preface

In 2011, the Institute of Medicine (IOM) released a very important and influential report, *Relieving Pain in America* (Institute of Medicine of the National Academy of Science, 2011). This report highlighted the urgent need for the development of better methods for pain management because the ever-increasing costs associated with current treatment approaches cannot be sustained. This report emphasized the fact that musculoskeletal pain is the most common single type of chronic pain. As a result, this *book* was developed to address some of the most important issues related to this significant epidemic of musculoskeletal pain and disability disorders. The *book* was designed to integrate the growing clinical research evidence related to the causes, assessment, treatment, and prevention of these disorders, especially those occurring in the workplace. This is especially important because of the growing costs, including social and economic, and those associated with human suffering.

The *book* will be of great interest to physicians, psychologists, occupational therapists, vocational rehabilitators, labor relations and human-resource professionals, employee and family assistance counselors, disability case managers, supervisors/employers, as well as researchers and academicians alike. As delineated in the *Table of Contents*, there is a wide array of important topics that are covered. It consists of three major parts. *Part I*, “The Most Common Occupational Musculoskeletal Pain and Disability Disorders,” will provide an overview and discussion of these major disorders, ranging from back and cervical pain to chronic widespread pain. *Part II*, “Conceptual and Methodological Issues,” will expose the reader to critical terminology and important topics in the occupational musculoskeletal disorders’ arena. In *Part III*, “Intervention Approaches and Techniques,” a comprehensive evaluation of most recent evidence-based therapeutic approaches will be reviewed.

As in the first book of this series, all contributors to this *book* were asked to provide a balance between current best-practice guidelines and evidence-based documentation of such guidelines and assessment/treatment approaches. The contributors were carefully selected for their unique knowledge, as well as their ability to meaningfully present this information in a comprehensive manner. We made it our mission to provide the most comprehensive coverage of this important area to date in the scientific literature. Each chapter added a unique thread to the overall fabric of this *book*, making it a comprehensive overview of the area.

We would like to acknowledge all of the authors for their valuable state-of-the-art contributions and for making this *book* come to fruition in a timely manner. We also especially thank Janice Stern of Springer, who has supported the vision of this *book* series and encouraged us during our journey. In addition, we are indebted to Pedro Cortes at the University of Texas at Arlington for his technical contributions to the development of the *book*.

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Part I

The Most Common Occupational Musculoskeletal Pain and Disability Disorders

Occupational Musculoskeletal Pain and Disability Disorders: An Overview

1

Robert J. Gatchel, Nancy D. Kishino, and Alan M. Strizak

Overview

The very important and influential Institute of Medicine (IOM) report, *Relieving Pain in America* (Institute of Medicine of the National Academy of Science, 2011), has highlighted the urgent need for the development of better methods for pain management because of the ever-increasing costs associated with current treatment approaches cannot be sustained. This report highlights the fact that musculoskeletal pain is the most common single type of chronic pain. It is therefore fitting to have this initial chapter of the current handbook focus on musculoskeletal pain and disability and what they consist of:

> Musculoskeletal disorders involve the musculoskeletal system, the 90 % of the human body devoted to interacting with the external environment. Although linked to all other systems, the musculoskeletal system is less concerned with issues of homeostasis, sensory input and problem solving. The bones and joints provide the frame, with ligament connectors and muscle/tendon pulleys providing the motor power. The peripheral nerves and nerve roots, providing the communication links from the central nervous system, may be included in the paradigm, especially in the upper extremity. Occupational injuries represent an important cost to industry and therefore to the productive capacity of every developing nation. An occupational musculoskeletal disorder provides the most significant component of occupational injury in frequency, disability, loss of productivity, and cost. (Gatchel & Mayer, 2000, p. 3)

As further reviewed by Punnet and Wegman (2004), these musculoskeletal disorders include a wide array of degenerative and inflammatory conditions that affect this system (i.e., muscles, joints, tendons, ligaments, as well as peripheral nerves and the supporting blood vessels). A partial listing of these associated conditions include tendon inflammations, such as bursitis; nerve compression disorders, such as carpal tunnel syndrome; osteoarthritis; and low back pain. As Punnet and Wegman (2004) also highlight, these musculoskeletal disorders are the single largest category of work-related illness in industrialized countries today. Indeed, occupational musculoskeletal pain and disability disorders, especially when they become chronic in nature, are highly prevalent and costly in industrialized countries. Actual statistics on the prevalence of such disorders may vary from one reference source to another, usually due to vagaries in the diagnostic

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criteria used for these disorders, as well as variations among different jurisdictions in the United States and in other countries. Nevertheless, according to the Bureau of Labor Statistics (2007), the overall rate of nonfatal occupational musculoskeletal disorders in the United States that required time away from work was reported to be 35 per 10,000 full-time employees. Moreover, the median days of work absence was 9, and 27.9 % of these injured workers were absent from work for more than 30 days. In terms of the specific body region affected by musculoskeletal disorders, 48 % were back injuries, 1.6 % were cervical injuries, 14.5 % were upper-extremity injuries, 8.1 % were lower-extremity injuries, and 4.7 % affected multiple body regions (Bureau of Labor Statistics, 2007).

Hult (1954) conducted one of the earliest studies that examined the rates of a very prevalent musculoskeletal disorder (low back pain) in the work environment by comparing its rates among different subsets of workers. He found that 60 % of forest workers reported having low back pain at some time during the study or had a history of low back pain. Pain symptoms generally began after the age of 30. Although the prevalence of low back pain was comparable for both heavy labor and lighter jobs, heavy labor workers were more at risk to develop disability as a result of low back pain. Hult (1954) also found that the rates of occupationally related low back pain were much higher than in the general population. Since that time, there have been numerous other studies evaluating different work environments in order to better understand the various contributing factors for different musculoskeletal disorders among different occupational subsets (Garofalo & Polatin, 1999).

Such studies are important because, in terms of costs, in the United States alone, it is estimated that approximately $100 billion are spent annually on healthcare utilization and concomitant work productivity losses due to patients with the most commonly cited occupational musculoskeletal disorders—back and neck pain conditions (Research and Markets, 2009). It should also be noted that, traditionally, because these are the most prevalent of such disorders, the vast majority of research conducted has focused on the lumbar regions. However, in recent years, there has been increased attention paid to the rising prevalence of non-lumbar occupational musculoskeletal disorders, such as neck, upper-extremity, and lower-extremity disorders. Because of the great prevalence of these various occupational musculoskeletal disorders, there has been a growing need to develop the most effective intervention methods for them. As a result, objective criteria (based on evidence-based research) are being established in order to identify successful treatment outcomes. For example, the Official Disability Guidelines (ODG) provide up-to-date, evidence-based research focused on the benchmarking of duration and treatment of occupational injuries (Official Disability Guidelines, 2012). Objectives of the ODG include the following: a reduction of delayed recovery time from injury onset to return to work, a reduction of medical costs associated with the injury, and helping the injured worker to safely return to work in a reasonable amount of time. These are ambitious goals that will, hopefully, be realized with additional clinical research on the most effective assessment and intervention strategies.

The current chapter will present four important areas related to occupational musculoskeletal pain and disability disorders: (1) a brief description/discussion of the most prevalent of these disorders, (2) a review of some causal theories/models of these disorders, (3) workers' compensation issues related to an occupational injury, and (4) an overview of the most common and effective treatment methods for these disorders.

The Most Prevalent Occupational Pain and Disability Disorders: A Brief Description

Most recently, Hernandez and Peterson (2013) have provided a comprehensive review of the most prevalent work-related musculoskeletal disorders and pain. Such disorders can range from well-defined ones, such as disc herniation, tendonitis, and carpel tunnel syndrome, to those less well defined, such as facet syndrome, to nonspecific disorders such as cumulative trauma disorders or fibromyalgia syndrome. The reader is referred to that chapter for a more thorough understanding of these disorders. Also, at the outset, it should be noted that diagnostic imaging tests (such as magnetic resonance imaging or MRI) are often used as confirmation evidence that a "true" pathological underpinning is involved in a musculoskeletal injury (after a thorough history and physical examination is administered). However, one must keep in mind that such tests are not necessarily 100 % reliable to serve as a "gold standard" for the presence or absence of an injury. Results of such tests that need to be interpreted by a radiologist have to be combined with other parts of the physical examination and patient self-report in order to make most comprehensive evaluation. Indeed, there have been numerous studies that have demonstrated the "fallibility" of diagnostic imaging tests, as listed below:

- In the lumbar spine, 22 % of subjects younger than 60 years of age with *no symptoms* (i.e., asymptomatic) of back pain, and 57 % of those older than 60, had significantly *abnormal* MRIs that suggested spinal disc herniations and stenosis (Goldsmith & Wiesel, 2000).
- In the cervical spine, 19 % of *asymptomatic* patients have positive MRI evidence of bulging or herniated intervertebral discs (Goldberg, Singh, Van, Garretson, & An, 2002).
- For *asymptomatic* subjects over the age of 60, MRI scans will show positive evidence of rotator cuff tears in 50 % of them (Wiesel, Sankar, Delahay, & Wiesel, 2010).
- Likewise, 24 % of subjects *without* knee symptoms will yield MRI findings to suggest a torn meniscus (LaPrade, Burnett, Veenstra, & Hodgman, 1994).

Obviously, these above false-positive rates (i.e., identifying an injury when it is not present) are a persistent medical problem that makes precise and reliable diagnoses difficult. Indeed, inherent in the process of any diagnostic testing such as MRI is the concept of *validity*. Validity is the ability of a diagnostic test to correctly identify those individuals who have some pathology (e.g., a rotator cuff tear) and those who do not. The more valid the test is, then the better that test is at differentiating: *test-positive* results (often call *sensitivity*, defined as the probability of a test being positive when the pathology is present) and *test-negative* results (often called *specificity*, defined as the probability of a test being negative when the pathology is not present). Conversely, when a test suggests the presence of pathology when it is not there, it is called a *false positive*; or when a test suggests the absence of pathology when it actually is present, it is called a *false negative*.

The Lumbar Spine

It should be noted that the spine, as a whole, consists of four major zones: the craniocervical spine, the subaxial spine, the cervicothoracic junction, and the thoracolumbar spine. It is beyond the scope of this chapter to review all of the anatomic and muscular landmarks of these zones (this can be found in Rao & Smuck, 2012). Also, for the thoracolumbar spine, we will focus primarily on the lumbar section because this area is associated with the most costly and prevalent occupational problems of all musculoskeletal disorders (accounting for 48 % of all occupational musculoskeletal injuries; Bureau of Labor Statistics, 2007). Indeed, low back pain is a common condition, with a lifetime prevalence of over 80 % and a 1-month prevalence of 23 % (Hoy et al., 2012). Moreover, annually, low back (lumbar) pain is primarily responsible for over 20 million ambulatory medical care visits (Licciardone, 2008), and $100 billion in costs (Katz, 2006) in the United States. Although most of low back pain is of nonspecific etiology in terms of what our current available technology/laboratory skills can determine (Deyo & Weinstein, 2001), it is considered chronic when it lasts more than 3 months, at which time it may cause progressively more disabling physical and psychosocial deficits (e.g., Manek & MacGregor, 2005). It has been estimated, though, that approximately 95 % of low back pain cases are the result of muscle, tendon, and ligament sprains or strains (e.g., Agency for Health Care Policy and Research, 1994). Patients will present with limitations in range of motion, localized tenderness, and spasm along the paravertebral muscles (Wiesel et al., 2010). Indeed, most of the episodes of back and neck pain will be uncomplicated cases of muscle

Table 1.1 Specific diagnoses for lumbar spine injuries

Degenerative disc
Dislocation
Fracture
Nonspecific lumbar pain
Radiculopathy
Spondylolysis/spondylolisthesis
Stenosis

Table 1.2 Specific diagnoses for cervical spine injuries

Degenerative disc
Dislocation
Fracture
Nonspecific neck pain
Radiculopathy
Stenosis

sprain or strain that resolve in a few weeks. In fact, uncomplicated acute low back pain (without any pathological signs such as nerve root involvement on spinal cord compression) should be treated conservatively. Indeed, clinical practice guidelines recommend the use of nonsteroidal anti-inflammatory drugs or acetaminophen, instructions to remain active, and reassurance that the prognosis for recovery is good. Moreover, any extended bed rest is to be avoided (Koes et al., 2010). Such a general conservative approach is usually also initially recommended for other acute musculoskeletal disorders.

Only a small number of patients will develop more serious spinal conditions that require surgical intervention (Wiesel et al., 2010). As a result, multiple biopsychosocial risks factors have been identified, as will be discussed later in this chapter. Table 1.1 presents a summary of many specific diagnoses that relate to lumbar spine injuries. It should be noted that, for nonspecific low back pain, 80–90 % of the cases will resolve within 6 months, although patients who have poorer general health, psychiatric disorders, and/or prior episodes of neck pain are at higher risk for developing chronic low back pain (Chou & Shekelle, 2010).

The Cervical Spine

Many of the same painful conditions that affect the lumbar spine may also affect the cervical spine, and the symptoms and treatments may be similar (e.g., Stauffer, 1991). However, the symptoms of cervical spinal disorders tend to be more widespread and vague, relative to those of lumbar spinal disorders (that tend to be more localized and discrete). Also, as a consequence, the physical findings of cervical disorders are more difficult to isolate and to precisely document the actual anatomic location based on objective physical examination (Kang, Sowa, & Woods, 2012). As noted by Wiesel et al. (2010), cervical pain resulting from structural pathology is more persistent and may require more intensive intervention. For example, cervical *radiculopathy* (i.e., related to the nerve root) results from the compression or irritation of a cervical spine nerve root and usually produces symptoms of pain and *paresthesia* (i.e., an abnormal sensation, such as burning, prickling) along the nerve root distribution. In 25 % of these patients, persistent and/or recurrent neck pain occurs, and surgery may be needed. Cervical *myelopathy* (i.e., functional disturbance of the cervical spine) results from compression of the entire spinal cord, rather than from an isolated nerve root, and is a much more serious condition. Symptoms include numbness and impaired fine motor function of the fingers and hands, as well as weakness in the lower extremities, gout, and balance difficulties, and often urinary systems dysfunction. If there are no signs of nerve root compression or other neurological symptoms, then there is no firm evidence that surgery is beneficial for cervical pain (Carragee et al., 2009).

Often, symptoms of neck pain, shoulder pain and headache can co-occur, so that it may be difficult to isolate the specific anatomic, nerve root and sensory areas that are involved. Thus, there is a wide array of symptoms that can be reported, including pain, tenderness, stiffness, muscle spasms, and headache. With the above caveats in minds, it has been estimated that 1.6 % of all occupational musculoskeletal injuries are in the cervical region (Bureau of Labor Statistics, 2007). It should also be noted that, with the growth in occupations that involve more repetitive movement types of work (such as keyboard operations, small assembly lines), there has been an increase in cervical, as well as upper extremity, injuries that result in workers' compensation claims. Table 1.2

Table 1.3 Specific diagnoses for upper-extremity injuries

Shoulder diagnoses	Wrist diagnoses	Hand diagnoses
AC joint dislocation/arthritis	Amputation	Amputation
Amputation	Arthritis	Arthritis/degenerative joint disease
Brachial plexus injury	Carpal tunnel syndrome and other nerve compression	Dislocation
Fracture	De Quervain's (tendinitis)	Fracture
Glenohumeral dislocation	Dislocation	Nerve laceration/entrapment
Glenohumeral joint arthritis	Fracture	Nonspecific
Impingement syndrome/tendinitis	Ligament sprain/other	Tendinitis
Nonspecific	Nonspecific	Tendon laceration/dysfunction
Other nerve injury/entrapment	Tendinitis	Trigger joint
Rotator cuff tear	Other nerve injury/entrapment	Other
Other		
Elbow diagnoses	*Other upper-extremity diagnoses*	
Amputation	Long bone fracture	
Arthritis	Nonspecific	
Cubital tunnel syndrome	Peripheral vascular disease	
Dislocation	RDS/causalgia/CRPS	
Fracture	Thoracic outlet syndrome	
Lateral epicondylitis/tendinitis		
Medial epicondylitis/tendinitis		
Nonspecific		
Pos. interosseous nerve entrapment		
Other		

presents a summary of many specific diagnoses related to cervical spine injuries.

Finally, one specific type of cervical/neck disorder that is receiving increased attention today is whiplash and neck pain-related disability (Schofferman & Koestler, 2005). Although many such injuries are caused by motor vehicle accidents, other occupationally related causes may produce it, such as falls and head-related collisions/accidents. Such injuries are of great concern because approximately 4–8 % of neck whiplash patients become partially or totally disabled over time (Schofferman & Koestler, 2005). Thus, they need to be appropriately treated at the acute stage before they become more chronic and disabling.

Upper Extremities

As can be seen in Table 1.3, there are a great number of upper-extremity injury diagnoses, ranging downwards from the shoulder, elbow, wrist, and hand. As a result, there are physicians who specialize in only specific injury area. Many of these injuries are caused by repetitive work or recreational activities (such as continuous neck, arm and/or hand movements that can negatively affect the muscles/nerves of these areas). Again, as we discussed earlier for the other musculoskeletal injuries, there is still some lack of consensus as to what precise criteria to use in diagnosing many upper-extremity injuries. On a global level, the general approach to diagnosis involves the following: a clinician's physical examination of the injured area; the assessment of the range of motion, strength, and palpation of muscle tendons/ligaments of the area; and the evaluation of self-reported pain while performing these evaluations. Quite often, imaging tests may be ordered if the patient experienced a blunt trauma, or if there are other signs of serious pathophysiology.

Two well-known upper-extremity disorders are rotator cuff injury and carpal tunnel syndrome.

Table 1.4 Specific diagnoses for lower-extremity injuries

Hip diagnoses	Ankle diagnoses	Knee diagnoses
Amputation	Amputation	Amputation
Degenerative joint disorder	Degenerative joint disorder	Degenerative joint disorder
Dislocation	Dislocation	Dislocation
Femoral neuritis	Fracture w/ or w/out pseudoarthritis	Fracture w/ or w/out pseudoarthritis
Fracture w/ or w/out pseudoarthritis	Ligament injury (sprain)	Ligament injury (sprain)
Nonspecific hip pain	Nerve injury/entrapment	Meniscal injury/tear
Piriformis	Nonspecific ankle pain	Nerve injury/entrapment
Tendinitis/bursitis	Tarsal tunnel/nerve compression	Nonspecific knee pain
Other nerve injury/entrapment	Tendinitis	Patellofemoral dys./chondromalacia
		Tendinitis/bursitis (other)
Foot diagnoses	*Other lower-extremity diagnoses*	
Amputation	Long bone fracture	
Crush injury	Peripheral vascular disease	
Degenerative joint disorder	Long bone fracture	
Dislocation		
Fracture w/ or w/out pseudoarthritis		
Nerve injury/entrapment		
Nonspecific foot pain		
Plantar fasciitis		
Tendinitis/tenosynovitis		

In terms of the former, the rotator cuff is a set of four muscles that are responsible for the rotation and elevation of the shoulder while providing stability to the *humerus* (i.e., the bone that extends from the shoulder to the elbow). Damage to the rotator cuff may be the result of a traumatic injury, or due to a more cumulative trauma due to repetitive overuse. One or more of the four tendons connecting the rotator cuff muscles to the bone may be torn, and patients will report pain over the anterior lateral shoulder. This pain may awaken the patient from sleep and may be exacerbated by overhead activities. Complete tears of the tendons may require surgery, especially if patients start to develop atrophy and weakness of the shoulder muscles. It has been reported that patients who were receiving workers' compensation, and those with prior surgical procedures, are more likely to need revision surgery (Piasecki et al., 2010). Also, they are less likely to return to work or display improvement in self-reported pain, disability, and strength (Holtby & Razmjou, 2010).

The most frequent cause of occupational wrist pain (with carpal tunnel syndrome being the most commonly diagnosed disorder) is cumulative trauma or overuse. Carpal tunnel syndrome occurs when the transverse carpal ligament compresses the median nerve as it passes though the wrist, resulting in symptoms such as decreased sensation and paresthesia (i.e., an abnormal sensation, such as burning and prickling, to the three radial fingers). As symptoms progress, atrophy to the thenar muscles of the thumb may develop (Wiesel et al., 2010). It should be noted that the incidence of the diagnosis and resultant surgery for this syndrome has been significantly increasing during the past decade, both in the United States and other industrialized countries (Atroshi, Englund, Turkiewicz, Tägil, & Petersson, 2011).

Lower Extremities

Table 1.4 presents various lower-extremity disorders. Again, as can be seen, there are a great number of them, ranging downwards from the hip to the feet. Of these, knee disorders are extremely prevalent in adults, accounting for approximately three million healthcare visits per year. In fact, knee trauma is the second most common occupational injury (second only to low back strain). Acute knee injuries include damage to the ligaments (especially the anterior collateral ligament) or damage to the cartilage (especially the meniscus). As noted by Wiesel et al. (2010), the rates of knee surgeries have dramatically increased over the past few decades, particularly in younger patients. They now make up a patient population who undergo some of the most frequently performed orthopedic procedures.

Similar to the upper-extremity disorders, because there are so many types of lower-extremity disorders, there are different physicians who specialize in assessing and treating specific injury sites. Likewise, the general approach to diagnosis is similar to that discussed for upper-extremity injuries. As noted by Hernandez and Peterson (2013), various disorders of the knee (such as meniscal tears in lesions, bursitis, and osteoarthritis) and the ankle (e.g., osteoarthritis) are most common for workers in occupations that have high physical demands on the lower limbs, such as construction workers and carpet and floor layers.

Table 1.5 Various risk factors for occupational musculoskeletal pain and disability disorders (from Wright & Gatchel, 2002)

Medical and medical-belief risk factors
- Patient's personal medical belief about a disorder
- Negative belief of ability to again perform the job that originally caused the injury
- Genetic, age, and body size factors
- Smoking status

Job-related risk factors
- High level of job stress
- Job dissatisfaction
- Heavy and dangerous labor
- Repetitive work tasks
- Poor employer–employee relations
- Low-wage earner

Compensation risk factors
- Availability of compensation payments
- Employment status

Social and demographic risk factors
- Personal or family difficulties
- Older age
- Current substance abuse

Psychosocial risk factors
- Presence of a major psychiatric disorder
- Passive coping strategies
- Tendency to catastrophize about and/or avoid stressful situations
- Presence of psychosocial stressors/emotional distress

Review of Causal Theories/Models of Occupational Musculoskeletal Disorders

Over the past two decades, there has been a plethora of research studies attempting to isolate specific risk factors that may be associated with the development and maintenance of various types of musculoskeletal pain and disability disorders. Hernandez and Peterson (2013) characterized such risk factors into three broad categories: (1) *biomechanical risk factors* (such as ergonomic variables in the workplace that increase repetitive body part movements or that increase repetitive body part movements or that demand improper and/or static postures/positions), (2) *psychosocial risk factors* (such as high work demands, low job control, lack of workplace/supervision support), and (3) *individual risk factors* (such as gender, age, sedentary lifestyle, personality characteristics). Indeed, the face validity of these three categories can be readily seen from earlier models/causal theories presented in the scientific literature, as will be delineated below. Likewise, Wright and Gatchel (2002) outlined a general list of various risk factors, as presented in Table 1.5.

Punnet and Wegman (2004) have also highlighted such risk factors, in stating that musculoskeletal disorders:

> … occur in certain industries and occupations with rates up to three or four times higher than the overall frequency. High-risk sectors include nursing facilities; air transportation; mining; food processing; leather tanning; and heavy and light manufacturing (vehicles, furniture, appliances, electrical and electronic products, textiles, apparel and shoes)… Upper extremity musculoskeletal disorders are also highly prevalent in manual-intensive occupations, such as clerical work, postal service, cleaning, industrial inspection and packaging… Back and lower limb disorders occur

> disproportionately among truck drivers, warehouse workers, airplane baggage handlers, construction traders, nurses, nursing aides and other patient-care workers, and operators of cranes and other large vehicles…. (p. 14)

Howard (2010) has provided a comprehensive review of the various models to be presented next. For example, in an early conceptual model of neck and upper-extremity musculoskeletal disorders, proposed by Armstrong et al. (1993), a number of individual characteristics (e.g., personality/coping skills, health status, work experience) were identified as important variables that directly moderated the effects of the work environment on stress and strain reactions. Subsequently, Sauter and Swanson (1996) extended this model into a broader ecological model of causation of upper-extremity injuries. They not only incorporated physiological and psychosocial variables but also included cognitive component factors (such as fear of losing one's job, poor performance, not meeting personal goals, as well as frustration with control and confidence issues) that could mediate the effects of work demands and workplace psychosocial stress on muscle tension and poor posture. An additional feature of their ecological model was the presence of a "positive feedback mechanism." That is to say, if an injury occurred, then the psychosocial impact of that injury would further exacerbate the symptoms, thereby leading to additional increased disability.

Feuerstein (1996) also proposed a *work-style model* in conceptualizing occupational upper-extremity disorders. There are three work-style factors in this model: physiological changes, behavioral changes, and cognitive changes. If these factors are occupationally altered by psychosocial stress, high-demand tasks, and/or ergonomic factors, then the probability of developing an upper-extremity musculoskeletal injury will be increased. In essence, this model again emphasizes the importance of the interaction between psychosocial and physical stressors (and their feedback) on the development/exacerbation of upper-extremity injuries.

For occupational musculoskeletal disorders in general, these aforementioned interactional processes have been highlighted by many other investigators. For example, earlier work by Hagbert et al. (1995) emphasized the dynamic interaction between psychosocial factors (such as mental fatigue, the ability to cope with stress) and physical factors (such as ergonomic features of the workplace, duration and intensity of work activities) as potentially causing a physical injury. Taking a slightly different perspective of workplace characteristics, Burton and Main (2000) indicate that, in addition to certain psychosocial "yellow flags" (such as workers' levels of distress, depression, coping strategies, and beliefs) that may serve as obstacles to recovery, certain "blue flags" may also work alongside these "yellow flags." These "blue flags" refer to two categories of work-related obstacles to recovery. *Individual worker-specific variables* refer to beliefs about the work/injury relationship (i.e., how it occurred), attribution of blame (e.g., the poor work environment "caused the injury"), and psychosocial aspects of work (e.g., level of stress). *Work-specific issues* refer to managerial attitudes towards workers, return-to-work policies, work organizational structure, and perceived work demands.

Thus, various different levels of interactions are viewed as important. Likewise, Carayon, Smith, and Haims (1999) and Kumar (2001) emphasized the importance of other dynamic interactions. According to Kumar (2001), four different causal-factor theories were proposed to account for the development of occupational musculoskeletal disorders:

- The *multivariate interaction theory* proposes the importance of evaluating the interactions among genetic, psychosocial, and biomechanical factors in better understanding their effects on the musculoskeletal system.
- The *differential fatigue theory* more specifically focuses on the strain of various occupational activities on the joints and muscle tissues. Thus, if the intensity of such strain surpasses the capability of the joints and muscles to safely handle it, then short-term results (e.g., fatigue) and long-term results (e.g., injury to the joint and/or muscle) can occur.
- *The cumulative load theory* emphasizes that one must consider the actual amount of strain that the musculoskeletal unit can tolerate

before it loses its ability to accommodate to it and thus its ability to mend. The continuation of increased strain on the musculoskeletal unit(s) causes the joints and muscles to deteriorate, often resulting in injury.

- The *overexertion theory* emphasizes that if the physical stress factors (e.g., increased force, repetitive motion, long duration of activities) exceed the level that the joints and muscles can tolerate, this will result in an injury.

It should be noted that Kumar (2001) indicates that these above four theories/models of occupational musculoskeletal injuries can "run simultaneously," so that any of the factors within each model can lead to an injury, depending on the particular worker and the specific circumstances of the job.

The one common thread that runs through the fabric of all of the above reviewed models/theories is the importance of comprehensively taking into account the potential dynamic interaction of multiple factors that can result in the initial development, exacerbation, and chronicity of an occupational musculoskeletal pain and disability disorder. As a result, a *biopsychosocial model* needs to be embraced in order to effectively take into account these interactions. Indeed, the *biopsychosocial model* has rapidly developed during the past decade in all areas of medicine and is now considered the most comprehensive and heuristic approach to the evaluation and treatment of medical disorders, including those of the musculoskeletal system (e.g., Gatchel, 2005; Mayer, Gatchel, & Polatin, 2000; Wright & Gatchel, 2002). This model will be further discussed later in this chapter.

Workers' Compensation Issues Related to Occupational Injuries

Workers' compensation insurance, and its various forms, was initially developed as a means to protect employees from the burden of lost wages and medical costs after an injury. Private insurance carriers are the largest providers of workers' compensation policies. As summarized by Butler (2000), in the United States, each State is required to have workers' compensation insurance in order to provide medical care, monetary benefits, and rehabilitation services to employees who experience an injury or illness as a result of their employment. It is important to note that each State has its own specific workers' compensation law so that one cannot expect similar compensation benefits from one State to the next. It should be also pointed out that monetary benefits that are paid for workers in lieu of lost wages is not completely comparable in the sense of replacing all lost wages. Usually, only roughly two-thirds of weekly wages are replaced for those wages that are between specific minimum and maximum amounts. Such minimum and maximum amounts, as well as a particular waiting period between the date of injury and when the worker is eligible to receive these cash benefits, are also determined separately from one State to the next. In addition, one would be remiss without mentioning that workers' compensation laws associated with such issues are quite complex from one State to the next.

At the outset, readers should also be aware of the differences among the three major constructs of pain, disability, and impairment because they are usually referred to in workers' compensation claims. *Pain* is a psychophysiologic construct based primarily on an experiential or subjective evaluation that some sort of bodily injury has occurred. *Impairment* is a physical/medical term that refers to an alteration of the injured workers' usual health status (i.e., some objective anatomical or pathological abnormality) that is evaluated by physical and medical means. This evaluation of impairment has traditionally been a medical responsibility in which there is an attempt to objectively evaluate structural limitations, through techniques such as a thorough medical examination and imaging results. Unfortunately, however, as we have noted before, current technology does not automatically allow a totally accurate or objective physical impairment evaluation. It relies on methods that may not have good validity (e.g., in terms of sensitivity and specificity as discussed earlier in this chapter), as well as not being completely reliable, and sometimes subject to examiner bias. Finally, *disability* has traditionally been an administrative term that refers to the diminished capacity or inability to perform certain activities of everyday living.

It is the resulting loss of function due to impairment. Disability evaluations, too, are often not totally unreliable and are subject to various examiner and patient response biases (e.g., Gatchel, 2005). The assessment of disability is usually based on subjective self-report measures of restrictions on activities of daily living, such as walking, work and recreational activities, and sleep. Because pain, physical impairment, and disability are separately assessed, they are often not highly correlated with one another. Thus, for example, one patient may verbally report a significant amount of pain but show little impairment that can be objectively evaluated, with disability perhaps lying somewhere between the two in severity. In contrast, another patient may report little pain but displays great disability and some impairment. As a result, this can create a legal/bureaucratic "nightmare" in terms of determining how much impairment and disability resulted from an occupational injury and, thus, the amount of workers' compensation that is paid to the injured employee. This, in turn, can create an adversarial and emotional distressing interaction between the injured worker and his/her employer and company. Is the injured worker being "truthful" in terms of how much pain is being experienced in order to get some time off work and receive workers' compensation disability payments? As a result, the term *malingering* has often been used to suggest that some workers may intentionally project exaggerated physical and/or psychosocial symptoms for the purpose of gaining some external rewards/secondary gain such as workers' compensation payments or a "lump-sum" monetary settlement for their pain and suffering. From a medicolegal standpoint, the presence of such financial reward/secondary gain following an occupational injury may potentially provide a worker with the motivation to "malinger" or to exaggerate physical and psychosocial symptoms. In point of fact, though, the presence of true malingering in chronic occupational pain populations has been shown to be fairly low (Howard, Kishino, Johnston, Worzer, & Gatchel, 2010). Unfortunately, many workers are still assumed to be malingering if they do not immediately return to work after an injury when there is no "objective" medical evidence of impairment. They are perceived as taking advantage of the medical, insurance, and legal systems. However, as we discussed, impairment evaluations are not necessarily totally reliable or valid. As Hadler (1996) has noted: *If you have to prove you are ill, you can never get well…* (p. 2397). Therefore, there may be additional external pressure on patients to prove that they are really ill, thus lessening their motivation to rehabilitate and return to work as soon as possible. This often creates another significant barrier to recovery that needs to be addressed in any comprehensive treatment program. Readers are referred to a recent chapter by Schatman (2013) which provides a more comprehensive review of the many potential problems in the workers' compensation systems, as practiced in the United States today, that may often perpetuate disability and nonreturn to work.

The Biopsychosocial Model of Occupational Musculoskeletal Disorders: Treatment Applications

As introduced earlier in this chapter, the biopsychosocial model focuses on the complex interaction among biologic, psychosocial, and medicolegal variables that patients encounter when coping with persistent and distressing occupational musculoskeletal disorders. This complex interaction may perpetuate or worsen the patient's medical condition, and negatively affect various aspects of the patient's life. This approach is in striking contrast to the formerly embraced *biomedical reductionist approach*, which mistakenly assumed that most medical/musculoskeletal disorders can be separated into distinct, independent physical and psychosocial components. However, every patient experiences a musculoskeletal injury uniquely, and the complexity of an injury can be especially evident when it persists over time, as a host of psychological, social/occupational, and economic factors comes into play. These factors interact with the physical pathology (much of which was briefly reviewed earlier in this chapter) to modulate the patient's discomfort and disability. Individual patients differ significantly in the frequency with which they report physical symptoms, their tendency to visit a physician for identical symptoms, and their response to identical treatment approaches (e.g., Gatchel, Kishino, & Strezak, 2006). As a consequence, the nature of a patient's response to treatment often has little to do with his or her objective physical condition.

The especially significant contribution of the biopsychosocial model has been its use in developing effective interdisciplinary assessment and treatment methods (Gatchel, 2004, 2005). Before discussing such methods, though, it is important to distinguish among primary, secondary, and tertiary musculoskeletal pain and disability because each of these types requires substantially different biopsychosocial assessment and treatment (e.g., Gatchel & Kishino, 2012):

- *Primary care* is usually applied to the treatment of acute pain of limited severity. Basic symptom-control methods are used for relieving pain during the normal healing period. Moreover, basic psychosocial reassurance that the acute pain is temporary, and that it soon will be resolved, frequently is effective.
- *Secondary care* represents a reactivation treatment for a patient whose musculoskeletal pain has not improved through the normal healing process. Secondary care is administered during the transition from acute (primary) care to the patient's return to work. This treatment is designed to promote a return to occupational productivity before the patient develops advanced physical deconditioning and significant psychosocial barriers to returning to work. A patient whose musculoskeletal pain does not appear to be decreasing may need more active psychosocial intervention (e.g., Turk & Monarch, 2002).
- *Tertiary care* is intended for patients who are physically deconditioned and have chronic pain and disability. This stage of care requires a comprehensive interdisciplinary intervention approach (Gatchel, 2005).

Interdisciplinary tertiary care, patterned after the pioneering functional restoration program developed by Mayer and Gatchel (1988), has been found to be extremely efficacious and cost-effective for treating patients with various occupational musculoskeletal pain and disability disorders (Gatchel, 2005; Gatchel & Okifuji, 2006; Wright & Gatchel, 2002). Table 1.6 outlines the major therapeutic elements of such a program.

Table 1.6 Major therapeutic elements of a functional restoration program for chronic occupational musculoskeletal pain and disability disorders

• An interdisciplinary (physician, nurse, psychologist/psychiatrist, physical therapist, occupational therapist) medically directed team approach, with formal staffing of patients, frequent team conferences, and a low staff-to-patient ratio
• Formal, repeated quantification of physical deficits (e.g., range of motion, strength, endurance) for use in individualizing and monitoring the progress of physical training
• A multimodal pain and disability management program using cognitive-behavioral approaches (such as relaxation training, biofeedback, cognitive-restructuring/coping skills)
• Psychopharmacologic interventions used for detoxification and psychosocial treatment
• Psychosocial and socioeconomic assessments for use in individualizing and monitoring pain and disability behavior-oriented interventions and outcomes
• Ongoing outcome assessments, using standardized objective criteria, comparing pretreatment levels to immediate post treatment, 3-month, 6-month, and 12-month levels
• Assessment of important socioeconomic outcomes, such as return to work, work retention, subsequent utilization, injury recurrence, and surgery

In striking contrast to interdisciplinary pain management programs, traditional unimodal medical treatment approaches for these musculoskeletal disorders have not been consistently therapeutically or cost-effective. Indeed, as comprehensively reviewed by Gatchel and Okifuji (2006), interdisciplinary programs such as functional restoration (based on the biopsychosocial model of pain and disability) have been shown to be effective not only for self-reported measures of pain and disability but also for more objective measures of function, such as range of motion, strength, and aerobic capacity. Even as important have been the significant positive effects it has had on important socioeconomic outcomes, such as return to work, subsequent healthcare utilization, surgery rates, and case closure, relative to conventional medical treatment approaches.

Another important piece of evidence for the robustness of such interdisciplinary pain and disability management programs has been provided by the repeated independent replication of functional restoration outcomes in randomized clinical trials conducted in different parts of the United States, as well as in Canada, Denmark, France, Germany, and Japan (Bendix et al., 1996; Corey, Koepfler, Etlin, & Day, 1996; Hazard et al., 1989; Hildebrandt, Pfingsten, Saur, & Jansen, 1997; Jousset et al., 2004; Patrick, Altmaier, & Found, 2004; Shirado et al., 2005). Thus, the therapeutic robustness and utility of this approach has been independently confirmed by different treatment teams functioning in regions and countries that have markedly different economic, social, occupational, and workers' compensation conditions/systems.

Summary and Conclusions

As we discussed, occupational musculoskeletal pain and disability disorders are highly prevalent and costly in industrialized countries. In terms of the specific musculoskeletal body region affected, 48 % are back injuries, 1.6 % are cervical injuries, 15.5 % are upper-extremity injuries, 8.1 % are lower-extremity injuries, and 4.7 % affect multiple body regions. In the United States alone, it is estimated that approximately $100 billion is spent annually on healthcare utilization and concomitant work productivity losses due to patients with the most commonly cited occupation musculoskeletal disorders. The current chapter presented four important areas related to these disorders. The first part reviewed the most prevalent of these disorders according to body part area: the lumbar spine, the cervical spine, the upper extremities, and the lower extremities. We then reviewed some of the causal theories/models that had been proposed to account for how these occupational injuries can become disabling and chronic in nature. Taken together, all these models emphasized the interaction of various physical, psychosocial, and socioeconomic variables that make the study of potential risk factors and treatment approaches quite difficult. Indeed, the third part of this chapter reviewed workers' compensation, secondary gain, and malingering issues that have led to additional complexities when addressing occupational injuries. We noted that workers' compensation laws are active in each State in order to pay for medical care, rehabilitation, and partial wage losses incurred by these injuries. However, this often creates an adversarial, emotionally and economically stressful interaction between employees and employers that can also greatly affect long-term disability and recovery related to the injury. Finally, an overview of the most common and effective treatment methods for these disorders was presented. Specifically, the biopsychosocial model was introduced as the most heuristic and effective approach for the treatment of occupational musculoskeletal disorders. This biopsychosocial model focuses on the complex interaction among biologic, psychosocial, and medical/legal variables that patients encounter when coping with persistent and distressing disorders. This complex interaction may perpetuate or worsen the patient's medical condition and negatively affect various aspects of the patient's life. One important product of this biopsychosocial model was the development of comprehensive interdisciplinary pain management programs that were patterned after the functional restoration approach initially developed by Mayer and Gatchel (1988). This approach has been found to be extremely efficacious and cost-effective for treating patients with various occupational musculoskeletal pain and disability disorders.

In conclusion, musculoskeletal pain is still the most common cause of short-term and long-term occupational disability (Melhorn, Lazarovic, & Roehl, 2005). Indeed, the near-epidemic dimensions of occupational musculoskeletal disorders in the United States have continued to remain unabated. Fortunately, however, some major advances in clinical research, with the new emphasis on the *biopsychosocial conceptualization* of pain, disability, and impairment, are beginning to provide solutions to this problem (Schultz & Gatchel, 2005). The interdisciplinary functional restoration approach is one such example. However, what is still needed is the examination of what combination of variables are most important in being able to prescribe the most effective therapeutic "package" in an interdisciplinary treatment program for *specific* types of musculoskeletal injuries.

Finally, in providing an overview of these disorders, Stowell and McGeary (2005) have concluded that:

> Regardless of the cause of the musculoskeletal injury, the disability, or the decisions to return to work, the progression of the disabled person through the CDD (Cause, Disability, Decision—AUTHORS' INSERT) stages, is populated by an array of individuals, many with different points of view. Whether it is the provider, the employer, the caretaker, or even society as a whole, the patient is bombarded with intricate communications and varying belief systems, concerning injury, compensation, risk, and litigation… Cause, Disability, and Decision: a continuum that spans the full range of a person's disability. Each individual stage in the musculoskeletal injury continuum must be thoroughly understood in part and in whole if we are to appreciate and apply the most effective and efficient treatment plans for disabled individuals. (p. 136)

The various other chapters in the present handbook will touch upon many of the above issues in order to provide the reader with a comprehensive understanding of the broad array of issues involved in occupational musculoskeletal pain and disability disorders.

References

Agency for Health Care Policy and Research. (1994). *Clinical practice guidelines no. 14: Low back problems in adults*. Rockville, MD: US Department of Health and Human Services.

Armstrong, T. J., Buckle, P., Fine, L. J., Hagberg, M., Jonsson, B., Kilbom, A., et al. (1993). A conceptual model for work-related neck and upper-limb musculoskeletal disorders. *Scandinavian Journal of Work, Environment & Health, 19*(2), 73–84.

Atroshi, I., Englund, M., Turkiewicz, A., Tägil, M., & Petersson, I. F. (2011). Incidence of physician-diagnosed carpal tunnel syndrome in the general population. *Archives of Internal Medicine, 171*(10), 943–944. doi:10.1001/archinternmed.2011.203.

Bendix, A. E., Bendix, T., Vaegter, K., Lund, C., Frolund, L., & Holm, L. (1996). Multidisciplinary intensive treatment for chronic low back pain: A randomized, prospective study. *Cleveland Clinic Journal of Medicine, 63*(1), 62–69.

Bureau of Labor Statistics. (2007). *Workplace injuries and illnesses in 2006: Annual report*. Washington, DC: United States Department of Labor.

Burton, A. K., & Main, C. J. (2000). Relevance of biomechanics in occupational musculoskeletal disorders. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders: Function, outcomes and evidence*. Philadelphia: Lippincott Williams & Wilkins.

Butler, R. J. (2000). Workers' compensation concepts and economics. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders: Function, outcomes and evidence*. Philadelphia: Lippincott Williams & Wilkins.

Carayon, P., Smith, M. J., & Haims, M. C. (1999). Work organization, job stress, and work-related musculoskeletal disorders. *Human Factors, 41*, 644–663.

Carragee, E. J., Deyo, R. A., Kovacs, F. M., Peul, W. C., Lurie, J. D., Urrutia, G., et al. (2009). Clinical research: Is the spine field a mine field? *Spine, 34*(5), 423–430.

Chou, R., & Shekelle, P. (2010). Will this patient develop persistent disabling low back pain? *Journal of the American Medical Association, 303*(13), 1295–1302.

Corey, D. T., Koepfler, L. E., Etlin, D., & Day, H. I. (1996). A limited functional restoration program for injured workers: A randomized trial. *Journal of Occupational Rehabilitation, 6*, 239–249.

Deyo, R. A., & Weinstein, J. N. (2001). Low back pain. *New England Journal of Medicine, 344*, 363–370.

Feuerstein, M. (1996). *Workstyle: Definition, empirical support, and implications for prevention, evaluation and rehabilitation of occupational upper-extremity disorders*. Bristol, PA: Taylor & Francis.

Garofalo, J. P., & Polatin, P. B. (1999). An epidemic in industrialized countries. In R. J. Gatchel & D. C. Turk (Eds.), *Psychosocial factors in pain: Critical perspectives*. New York: Guilford.

Gatchel, R. J. (2004). Comorbidity of chronic mental and physical health disorders: The biopsychosocial perspective. *American Psychologist, 59*, 792–805.

Gatchel, R. J. (2005). *Clinical essentials of pain management*. Washington, DC: American Psychological Association.

Gatchel, R. J., & Kishino, N. D. (2012). Psychosocial considerations in spinal disorders. In R. D. Rao & M. Smuck (Eds.), *Orthopaedic knowledge update: Spine 4*. Chicago, IL: American Academy of Orthopaedic Surgeons.

Gatchel, R. J., Kishino, N. D., & Strezak, A. (2006). The importance of outcome assessment in orthopaedics: An overview. In J. M. Spivak & P. J. Connolly (Eds.), *Orthopaedic knowledge update: Spine* (3rd ed., pp. 95–102). Chicago, IL: American Academy of Orthopaedic Surgeons.

Gatchel, R. J., & Mayer, T. G. (2000). Occupational musculoskeletal disorders: Introduction and overview of the problem. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders:*

Function, outcomes, and evidence (pp. 3–8). Philadelphia: Lippincott Williams & Wilkins.

Gatchel, R. J., & Okifuji, A. (2006). Evidence-based scientific data documenting the treatment and cost-effectiveness of comprehensive pain programs for chronic nonmalignant pain. *The Journal of Pain, 7*(11), 779–793. doi:10.1016/j.jpain.2006.08.005.

Goldberg, E. J., Singh, K., Van, U., Garretson, R., & An, H. S. (2002). Comparing outcomes of anterior cervical discectomy and fusion in workman's versus non-workman's compensation population. *The Spine Journal, 2*(6), 408–414. doi:10.1016/s1529-9430(02)00441-2.

Goldsmith, M. E., & Wiesel, S. W. (2000). Diagnostic imaging tests in low back pain. In T. G. Mayer, R. J. Gatchel, & P. Polatin (Eds.), *Occupational musculoskeletal disorders: Function, outcomes and evidence*. Philadelphia: Lippincott Williams & Wilkins.

Hadler, N. (1996). If you have to prove you are ill, you can't get well: The object lesson of fibromyalgia. *Spine, 20*, 2397–2400.

Hagbert, M., Silverstein, B. A., Wells, R., Smith, M. J., Hendrick, H. W., Carayon, P., et al. (1995). *Work-related musculoskeletal disorders (WMSDs): A reference book for prevention*. London: Taylor & Francis.

Hazard, R. G., Fenwick, J. W., Kalisch, S. M., Redmond, J., Reeves, V., Reid, S., et al. (1989). Functional restoration with behavioral support. A one-year prospective study of patients with chronic low-back pain. *Spine, 14*(2), 157–161.

Hernandez, A. M., & Peterson, A. L. (2013). Work-related musculoskeletal disorders and pain. In R. J. Gatchel & I. Z. Schultz (Eds.), *Handbook of occupational health and wellness*. New York: Springer.

Hildebrandt, J., Pfingsten, M., Saur, P., & Jansen, J. (1997). Prediction of success from a multidisciplinary treatment program for chronic low back pain. *Spine, 22*, 990–1001.

Holtby, R., & Razmjou, H. (2010). Impact of work-related compensation claims on surgical outcome of patients with rotator cuff related pathologies: A matched case–control study. *Journal of Shoulder and Elbow Surgery, 19*(3), 452–460. doi:10.1016/j.jse.2009.06.011.

Howard, K.J. (2010). *Prevalence, risk factors and treatment outcomes for various musculoskeletal injury sites associated with the development of chronic occupational disability.* Ph.D. Dissertation, University of Texas at Arlington, Arlington. Retrieved from https://www.uta.edu/ra/real/editprofile.php?onlyview=1&pid=18 (DISS-10603)

Howard, K. J., Kishino, N. D., Johnston, V. J., Worzer, W. E., & Gatchel, R. J. (2010). Malingering and pain: Is this a major problem in the medicolegal setting? *Psychological Injury and Law, 3*, 203–211.

Hoy, D., Bain, C., Williams, G., March, L., Brooks, P., Blyth, F., et al. (2012). A systematic review of the global prevalence of low back pain. *Arthritis and Rheumatism, 64*(6), 2028–2037. doi:10.1002/art.34347.

Hult, L. (1954). Cervical, dorsal and lumbar spinal syndromes. *Acta Orthopaedica Scandinavia, 24*, 172.

Institute of Medicine of the National Academy of Science. (2011). *Relieving pain in America: A blueprint for transforming prevention, care, education, and research* (pp. 5–5). Washington, DC: Institute of Medicine.

Jousset, N., Fanello, S., Bontoux, L., Dubus, V., Billabert, C., Vielle, B., et al. (2004). Effects of functional restoration versus 3 hours per week physical therapy: A randomized controlled study. *Spine, 29*(5), 487–493.

Kang, J. D., Sowa, G., & Woods, B. I. (2012). The pathophysiology of axial neck and low back pain. In R. D. Rao & M. Smuck (Eds.), *Orthopaedic knowledge update 4: Spine*. Rosemont, IL: American Academy of Orthopaedic Surgeons.

Katz, J. N. (2006). Lumbar disc disorders and low-back pain: socioeconomic factors and consequences. *Journal of Bone and Joint Surgery (American), 88*(Suppl. 2), 21–24.

Koes, B., van Tulder, M., Linc, C. W., Macedo, L., McAuley, J., & Maher, C. (2010). An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *European Spine Journal, 19*(12), 2075–2094. doi:10.1007/s00586-010-1502-y.

Kumar, S. (2001). Theories of musculoskeletal injury causation. *Ergonomics, 44*(1), 17–47.

LaPrade, R. F., Burnett, Q. M., Veenstra, M. A., & Hodgman, C. G. (1994). The prevalence of abnormal magnetic resonance imaging findings in asymptomatic knees. *The American Journal of Sports Medicine, 22*(6), 739–745. doi:10.1177/036354659402200603.

Licciardone, J. C. (2008). The epidemiology and medical management of low back pain during ambulatory medical care visits in the United States. *Osteopathic Medicine and Primary Care, 2*(1), 11.

Manek, N. J., & MacGregor, A. J. (2005). Epidemiology of back disorders: Prevalence, risk factors and prognosis. *Current Opinions in Rheumatology, 17*, 134–140.

Mayer, T. G., & Gatchel, R. J. (1988). *Functional restoration for spinal disorders: The sports medicine approach*. Philadelphia: Lea & Febiger.

Mayer, T. G., Gatchel, R. J., & Polatin, P. B. (Eds.). (2000). *Occupational musculoskeletal disorders: Function, outcomes and evidence*. Philadelphia: Lippincott Williams & Wilkins.

Melhorn, J. M., Lazarovic, J., & Roehl, W. K. (2005). Do we have a disability epidemic? In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention*. New York: Springer.

Official Disability Guidelines. (2012). Official disability guidelines. Retrieved May 30, 2012, from http://www.disabilitydurations.com/duration.htm

Patrick, L., Altmaier, E., & Found, E. (2004). Long-term outcomes in multidisciplinary treatment of chronic low back pain: Results of a 13-year follow-up. *Spine, 29*, 850–855.

Piasecki, D. P., Verma, N. N., Nho, S. J., Bhatia, S., Boniquit, N., Cole, B. J., et al. (2010). Outcomes after arthroscopic revision rotator cuff repair. *The American Journal of Sports Medicine, 38*(1), 40–46. doi:10.1177/0363546509346401.

Punnet, L., & Wegman, D. H. (2004). Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology, 14*, 13–23.

Rao, R. D., & Smuck, M. (2012). *Orthopaedic knowledge update 4: Spine Rosemont*. Chicago, IL: American Academy of Orthopaedic Surgeons.

Research and Markets. (2009). Back pain report 2008. Retrieved May 30, 2012, from http://www.researchandmarkets.com/reports/706585/back_pain_report_2008

Sauter, S. L., & Swanson, N. G. (1996). *An ecological model of musculoskeletal disorders in office work*. Bristol, PA: Taylor & Francis.

Schatman, M. E. (2013). Workers' compensation and its potential for perpetuation of disability. In R. J. Gatchel & I. Z. Schultz (Eds.), *Handbook of occupational health and wellness*. New York: Springer.

Schofferman, J. A., & Koestler, M. E. (2005). Whiplash and neck pain-related disability. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention*. New York: Springer.

Schultz, I., & Gatchel, R. (Eds.). (2005). *Handbook of complex occupational disability claims*. New York: Springer.

Shirado, O., Ito, T., Kikumoto, T., Takeda, N., Minami, A., & Strax, T. E. (2005). A novel back school using a multidisciplinary team approach featuring quantitative functional evaluation and therapeutic exercises for patients with chronic low back pain. *Spine, 30*, 1219–1225.

Stauffer, E. S. (1991). Relationship between cervical and lumbar spine disorders: The evaluation and nonoperative management. In T. G. Mayer, V. Mooney, & R. J. Gatchel (Eds.), *Contemporary conservative care for painful spinal disorders: Concepts, diagnosis, and treatment*. Philadelphia: Lea & Febiger.

Stowell, A. W., & McGeary, D. D. (2005). Musculoskeletal injury: A three-stage continuum from cause to disability to decision. In I. Z. Schultz & R. J. Gatchel (Eds.), *At risk claims: Predicting and managing occupational disabilities* (pp. 117–139). New York: Kluwer Academic/Plenum.

Turk, D. C., & Monarch, E. S. (2002). Biopsychosocial approaches on chronic pain. In R. J. Gatchel & D. C. Turk (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (pp. 3–29). New York: Guilford.

Wiesel, B. B., Sankar, W. N., Delahay, J. N., & Wiesel, S. W. (2010). *Orthopaedic surgery: Principles of diagnosis and treatment*. Philadelphia: Lippincott Williams & Wilkins.

Wright, A. R., & Gatchel, R. J. (2002). Occupational musculoskeletal pain and disability. In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed., pp. 349–364). New York: Guilford.

Back Pain

2

Andrew R. Block and Jessica Shellock

Introduction

Two men working in the same factory report the onset of back pain after the same type of incident—lifting a heavy object at the end of a long work day. One man, Mr. A, misses 2 days of work and then returns although, for the first few days back at work, he avoids the heavier tasks. Mr. Z, destined never to return to work, experiences increasing pain and limitations in his ability to function. He undergoes ever-more expensive and invasive treatments until, perhaps inevitably, he ends up having spine surgery. Even so, his pain does not remit. Eventually, he loses his job, his motivation and his self-esteem. He is declared to have failed back surgery syndrome (FBSS), and another surgery is proposed. He goes on to become, essentially, a ward of the State, on Social Security Disability, with almost no hope of resuming productive activity.

Are there signs that could have foretold the divergent course of these two men? What treatment options exist for those with spine injuries? Could something have been done to forestall the downward spiral of Mr. Z? In the present chapter, we explore the answers to these questions. First, we present data on the incidence rates of, and costs associated with, back injuries in general, emphasizing industrial injuries specifically. Next, we review physical causes of back pain. Psychosocial influences on the experience and course of back pain are subsequently reviewed. We then discuss the range of treatment options available for back pain. Finally, we discuss how multidisciplinary approaches to the assessment and treatment of back injuries can provide for cost-effective intervention, maximizing the opportunities for treatment success while reducing the likelihood of failure.

Epidemiology of Back Pain

Back pain is a nearly ubiquitous problem. Generally, research shows that 70–85 % of all individuals in the United States experience back pain at some point in their lives (Andersson, 1999). Several studies have shown that, each year, approximately 25–27 % of all US residents experience an episode of back pain (Deyo, Mirza, & Martin, 2006; Pleis & Lethbridge-Cejku, 2007). According to the Agency for Healthcare Research and Quality, about 70 % of these individuals seek medical treatment, so that, as reported by Katz (2006), there are 19 million office visits each year for low back pain (for a total cost of $3 billion in office visits alone). This represents 2 % of all office visits, exceeded only in quantity by routine examinations, hypertension and diabetes (Martin et al., 2008). Thus, the costs

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associated with back pain are tremendous. The total incremental costs for healthcare associated with spine pain were estimated in 2005 to be $85.9 billion, with only heart disease and stroke responsible for greater cost (Martin et al., 2008). These costs have been rising rapidly, as the total cost of spine pain treatment in 1997 was only about $26.3 billion. If one includes the indirect costs of back pain, including lost wages, the economic impact rises as high as $200 billion per year (Katz, 2006).

Given the overall incidence of back pain, it should not be surprising that occupational spine injuries are frequent and expensive and may have problematic outcomes. Five percent of all American workers miss at least 1 day annually due to low back pain, and the most common occupational injury in most States is to the spine. For example, 2011 data on occupational injuries in the State of Washington reveal a far greater number of claims for back injury (14,112) than for any other body part, with the next most common being finger injuries (11,679 claims). In the same year, the total incurred costs for back injury in Washington ($114,379,462) far exceeded the costs for the next most costly injury—multiple body parts ($92,034,875). In 2001, it was estimated that, nationally, annual workers' compensation expenditures on treatment for low back pain was approximately $20 billion (National Research Council and Institute of Medicine, 2001). Fortunately, job-related back injuries mostly resolve quickly and with minimal treatment—80 % of those injured on the job return to work within 1 month, and greater than 90 % return in 3 months. However, for a small percentage of patients, the pain becomes protracted, leading to extended disability and tremendous medical costs, as only 5 % of those with back injuries are responsible for the 75 % of the total costs of work-related low back pain (Frank et al., 1996).

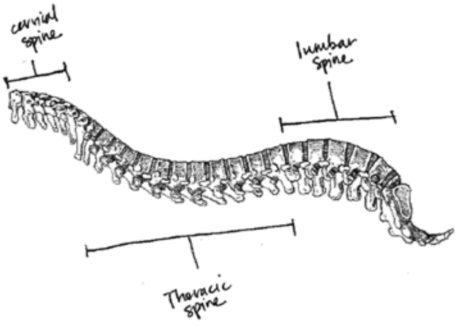

Fig. 2.1 Lateral view of entire spinal column

Structure of the Spine

An understanding of the causes and treatment options for occupational back pain is informed by an overview of the spine itself. The spinal column typically consists of 33 vertebrae: 7 cervical, 12 thoracic, and 5 lumbar vertebrae compose the mobile portion of the spine, with an additional 5 segments fused to form the sacrum, and 4 joined bones which compose the coccyx, or tailbone. The spinal column anatomy must be flexible enough to allow for effective motion of the trunk and yet rigid enough to serve as a protective structure for the spinal cord and nerve roots contained within its center. In general, an individual vertebra consists of an anterior (ventral) mass of predominantly cancellous bone (referred to as the vertebral body) and a posterior (dorsal) vertebral arch consisting mainly of denser cortical bone. The vertebral arch is the confluence of paired pedicles, laminae and a central spinous process from each level. The space between the dorsal arch and ventral body is the spinal canal, within which the spinal cord and spinal nerves are enclosed (Figs. 2.1, 2.2, and 2.3).

Each vertebral body in the cervical, thoracic and lumbar spine is effectively "linked" to the bodies above and below through intervertebral discs anteriorly, through paired facet joints posteriorly, and through numerous ligamentous attachments. The facet joints are diarthrodial (i.e., freely mobile) synovial joints formed from a more ventrally-located superior articular process originating from the inferior vertebral level and a dorsally located inferior articular process originating from the superior vertebral level. At the level of the sacrum, although there is no mobility between the individual segments, there

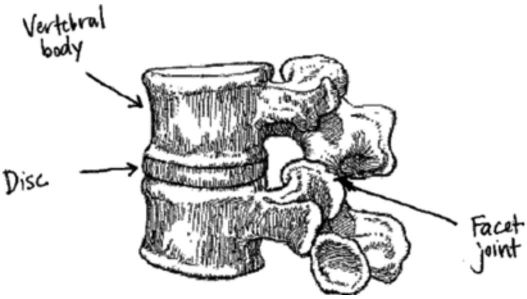

Fig. 2.2 Lateral view of a spinal segment, consisting of two vertebrae and an intervertebral disc

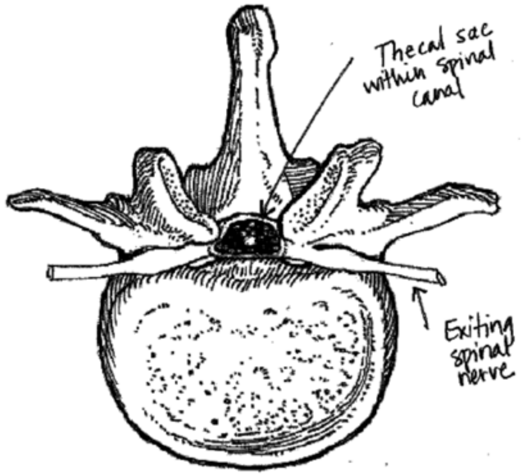

Fig. 2.3 Axial view of a lumbar vertebra, showing spinal nerves within the thecal sac

is the sacroiliac joint (SI joint), which functions to transmit loads from the trunk to the lower extremities. The SI joint is also a diarthrodial synovial joint, with stability imparted to it through a number of extremely strong ligamentous attachments.

Major Physical Sources of LBP

There are a number of potential anatomic sources of low back pain. The paraspinal musculature, intervertebral disc, facet joints, vertebral bodies and SI joints are the most common structures cited as "pain generators" in the spine. In many cases, more than one of these structures is ultimately responsible for the overall clinical presentation. Fortunately, the astute clinician is often able to determine the dominant source(s) of pain in a given patient and direct appropriate treatment.

Paraspinal Musculature

Low back pain resulting primarily from the paraspinal musculature is referred to as a *myofascial pain syndrome*. Spasm and overcontraction of injured muscles are the root cause for this syndrome, which was originally described by Simons, Travell, and Simons (1999) as a condition characterized by muscles that are shortened or contracted, with increased tone and stiffness, and that contain numerous trigger points (tender, firm nodules identified with muscular palpation). Usually there is an aggravating factor or history of direct or indirect trauma, but triggers can also include postural dysfunction and physical deconditioning (Panjabi, 2006).

Facet Joint Pain

The facet joints are paired diarthrodial synovial joints between the posterior elements of adjacent vertebrae, and have been implicated as a source of chronic low back pain since the early 1900s. The term *facet syndrome* was first coined by Ghormley (1933) when he described lumbosacral pain that often occurred after a twisting injury to the lumbar spine and that was accompanied by local paraspinal muscular tenderness, exacerbation of symptoms with hyperextension, and radiation of pain into the hips and buttocks without neurologic deficits. The innervation to the lumbar facet joints is derived from medial branches of the dorsal rami of the spinal nerves. With trauma to the joints, inflammation leading to pain, stiffness and secondary muscle spasm occurs. There is also an important correlation between degenerative changes and aging of the intervertebral disc and resultant increased transfer of stress to the facet joints, subsequently leading to accelerated degenerative changes there as well.

Intervertebral Disc

The outer annulus fibrosis of the intervertebral disc is innervated by the sinuvertebral nerves, first described by Luschka (1850). These nerves are derived primarily from the spinal nerves, with additional contributions from the sympathetic plexus. Only the outer third of the annulus is innervated; the inner two-thirds of the annulus and the nucleus pulposus are devoid of any nerve fibers. Thus, for the disc itself to be a pain generator, the presumption is that the outer third of the annulus must be exposed to a painful stimulus. Over time, as the disc succumbs to the physiology of aging, dehydration can result in annular tears or fissures (Vernon-Roberts & Pirie, 1977).

The disc can also play a role in back pain in the setting of an acute herniation. In this case, compression of an exiting nerve root or the collection of nerve roots contained within the dura from bulging disc material will result in lower extremity radicular pain—the classic *sciatica*. A large central disc herniation can present with predominantly low back pain in the setting of minimal or no lower extremity symptoms.

Vertebral Body

The vertebral body itself can be a source of low back pain in the setting of trauma, infection, or tumor. Compression fractures can be a source of significant acute and chronic back pain after trauma, especially in the elderly population where osteopenia (defined by WHO as a *T*-score on a bone density study of −1.0 to −2.5) or osteoporosis (defined by WHO as a *T*-score on bone density study below −2.5) is a predisposing factor for fracture even with minimal trauma (i.e., a fall from standing height). In the case of infection, osteomyelitis can cause bony destruction, leading to pain. Primary or metastatic spinal tumors can also lead to bony destruction and pain. A patient history of unintentional weight loss, fevers, chills or severe unremitting pain (i.e., the so-called red flags) should alert the physician to consider these possible differential diagnoses.

Sacroiliac Joint

The SI joint is an often unrecognized source of pain in many patients. It can be injured with minimal trauma in the setting of a combined axial loading and abrupt rotational force, such as in falls, motor vehicle accidents and athletic injuries (Chou et al., 2004). Despite the existence of numerous physical examination tests to help evaluate for SI joint dysfunction, history and exam findings alone are not consistently reliable in making the diagnosis (Dreyfuss, Michaelsen, Pauza, McLarty, & Bogduk, 1996; Slipman, Sterenfeld, Chou, Herzog, & Vresilovic, 1998). If clinical suspicion is strongly in favor of SI joint pain, a diagnostic block with an appropriate response during the anesthetic phase of the injection can help in supporting the diagnosis.

Psychosocial Influences on Back Pain

The experience of back pain can be traumatic, protracted, and life altering—or it can be merely an adversity which one learns to control or manage. Obviously, the physical basis of the pain is one of the factors that determines the impact of the pain. Patients whose back pain is sufficiently intense that surgery is considered based on an identifiable physical cause will, on average, experience pain for a greater duration and undergo more intense treatment than the 54 % of patients for whom no cause can be specified (Martin et al., 2008). However, regardless of its cause, the course of back pain can be strongly influenced by emotional and personality factors, which we now briefly review.

Depression

Back pain and depression are intimately linked—several general population studies have shown their relationship. Currie and Wang (2004), for example, analyzed data from the Canadian Community Health Survey to explore the relationship of depression (as assessed by a structured diagnostic interview) to back pain in over 110,000 household residents. Overall, 9 % of those interviewed experienced back pain, but the incidence rate of depression in those with back pain was 19.8 %, whereas depression was experienced by only 5.9 % of those with no back pain (see also Gureje et al., 2008). Among patients with chronic low back pain, lifetime rates of depression are much higher, ranging from 45 to 65 % (Polatin, Kinney, Gatchel, Lillo, & Mayer, 1993). The direction of causation between depression and back pain is uncertain. Clearly, the onset of pain can lead to many adverse consequences—loss of income, decreased function, loss of enjoyment, etc.—all of which may lead to the onset of depression. In fact, a number of cross-sectional and prospective studies have shown that emotional distress worsens as back pain becomes more protracted. However, several studies have found that individuals who are depressed are more likely to develop chronic pain (see Fishbain, Cutler, Rosomoff, & Rosomoff, 1997, for a review). Many of the symptoms of major depression and chronic pain overlap, including sleep disturbance, loss of enjoyment, social withdrawal, memory and concentration difficulties. Thus, while depression may place individuals at risk for the development of chronic low back pain, it is certainly the case that pain can create or exacerbate depression, leading to a quite recalcitrant chronic pain syndrome.

Anxiety and Fear

The experience of back pain, especially if it is protracted, is one that almost inevitably produces anxiety. Worries about the basis of the pain, ability to work and function, dependence on narcotics, worsening of the pain, and concerns about the possibility of spine surgery, are common and intense. In fact, data from Gureje et al. (2008), who analyzed results from the World Mental Health Survey, found that community members in the United States who reported pain in multiple body areas were at greatly increased risk of having diagnosable anxiety disorders (generalized anxiety, panic disorder, social phobia or post-traumatic stress disorder), compared to respondents who did not report any pain. In a similar vein, McWilliams, Goodwin, and Cox (2004), analyzing data from the Midlife Development in the United States Survey (MIDUS), found that, compared to those without back pain, individuals with back pain were at risk for diagnosable panic attacks (odds ratio 2.69) and generalized anxiety disorder (odds ratio 2.54). Again, the question of whether the anxiety precedes or results from the back pain remains an open one. However, what is clear is that patients who experience significant anxiety do not respond as well to treatments for back pain as those who are less anxious.

Pain Sensitivity

Back pain cannot be measured directly. It can only be assessed through the patient's self-report of the pain experienced, as well as changes in functional ability and usage of pain medication. Even when an underlying physiological cause of the pain can be identified, it is difficult to tell whether an individual's experience of pain is appropriate. The concept of pain sensitivity revolves around whether the patient experiences pain of an intensity, and in a physical distribution, consistent with an identified cause. To the extent that inconsistency is found, the patient can be deemed as excessively pain sensitive.

Pain sensitivity can be assessed in several ways. The most widely researched of these utilizes the MMPI and MMPI-2, in which Scales 1 and 3, reflecting somatic preoccupation, are frequently found to be elevated in patients with chronic back pain (Keller & Butcher, 1991). Classic research by Bigos et al. (1991), who prospectively studied over 3,000 aircraft employees, demonstrated that elevations on MMPI Scale 3 were strongly associated (along with low levels of vocational satisfaction) with the development of back pain over a 4-year period. Recent research by Block, Ben-Porath, and Marek (2013), using a newer version of the MMPI, the MMPI-2-RF (Ben-Porath & Tellegen, 2008), found that patients who are candidates for spine surgery have elevations on Scale Rc1 (somatic complaints), relative to the general population, and that elevations on Rc1 are associated with reduced outcome of spine surgery (Block, Ben-Porath, Ohnmeiss, Guyer, & Marek, 2012).

Pain sensitivity that is more specific to back pain can be assessed by providing the patient with a body outline and having the patient shade in areas where pain is experienced. To the extent that such "pain drawings" are not consistent with the underlying physical pathology, the patient can be seen to be excessively pain sensitive. Such inconsistent pain drawings are associated with elevations on MMPI Scales 1 and 3 (Dennis, Rocchio, & Wiltse, 1981) and are associated with reduced effectiveness of conservative treatment for back pain (Takata & Hirotani, 1995) as well as spine surgery (Block, Ohnmeiss, Guyer, Rashbaum, & Hochschuler, 2001).

Anger

Of the panoply of negative emotions experienced by back pain patients, perhaps the most significant one is anger. Fernandez, Clark, and Ruddick-Davis (1999) asked chronic pain patients to rate the frequency with which they had experienced six emotions during the previous 30 days. Although guilt, shame, fear, sadness, shame, and envy were all commonly experienced, anger was the most frequently reported—about 70 % of the time. Several intriguing studies have shown that anger may actually increase pain awareness through physiological mechanisms. In one study, chronic back pain patients and non-pain control subjects were asked to recall experiences of both anger and sadness while activity of the lumbar paraspinal muscles was monitored (Burns, 2006). While both the pain patients and controls had elevations in paraspinal muscle tension in both emotional recall conditions, the pain patients (but not the controls) showed greater muscle tension elevations in the anger recall condition than in the sadness recall condition. The author concluded that excessive lumbar paraspinal reactivity may increase pain awareness in chronic low back pain patients. In a separate study, Bruehl, Chung, Burns, and Diedrich (2007) found that a particular type of anger, in which patients tend to directly express anger rather than suppress it (termed "anger out"), is associated with dysfunction in endogenous opioid release during painful conditions, leading individuals with "anger out" traits to experience heightened pain sensations.

The results reported above indicate that anger appears to be the most commonly experienced emotion associated with chronic back pain, and also may increase the pain experience through association with heightened physiological responses to pain. Fernandez and Turk (1995) suggested another way in which anger may adversely affect the course of chronic low back pain. They posit that anger may lead to maladaptive lifestyle changes, such as excessive use of drugs or alcohol, poor health habits, and lack of physical exercise, all of which may compound the adverse impact of back pain. Furthermore, if the patient is angry at a particular person or event, such anger may drive the patient to continue experiencing pain as a means of vindication. Such a notion receives support from recent research showing that those chronic back pain patients, who report an inability to forgive others, experience higher pain and psychological distress than do patients who are more forgiving, and that this appears to be mediated by relatively higher levels of state anger (Carlson et al., 2005).

Physical and Sexual Abuse

Chronic back pain patients often have been the victims of abuse or abandonment as either adults or as children. In one study, more than half of the patients evaluated at a multidisciplinary pain clinic reported a history of at least one form of such abuse, with 90 % of the cases the abuse occurring during adulthood (Haber & Roos, 1985; see also Green, Flowe-Valencia, Rosenblum, & Tait, 1999). A number of other studies have shown that early experiences of abuse or abandonment may leave individuals particularly prone to the development of pain disorders, as well as general health problems. For example, Linton (1997) surveyed a sample of the general population in Sweden, as well as chronic pain patients, about their histories of physical and sexual abuse. All subjects, whether patients or not, were also questioned about any chronic pain symptoms they might have had. Analyses of the results revealed that the chances of women developing chronic pain were increased fivefold by physical abuse and fourfold by sexual abuse. In this study, there appeared to be little association of abuse with pain for the men. A different community-based study (Walsh, Jamieson, MacMillian, & Boyle, 2007) found that physical abuse, but not sexual abuse, predisposed woman toward chronic pain (see Davis, Luecken, & Zaruta, 2005, for a review). More generally, childhood physical abuse, parental instability and sexual abuse have been linked with poorer adult health outcomes (Irish, Kobayashi, & Delhanty, 2010) and with significantly increased likelihood of early disability retirement (Harkonmaki et al., 2008).

Opioid Medication Abuse/Misuse

Opioid medication abuse is an increasingly problematic issue in the United States. The National Survey on Drug Use and Health (NSDUH, 2007) found that among individuals over the age of 12, 4.8 % had used a prescription pain reliever non-medically in the previous 12 months. Despite such obvious indications that pain medications are frequently diverted for recreational purposes, they are still widely prescribed for individuals with low back pain. For example, Nyiendo, Haas, Goldberg, and Lloyd (2001) found that 31 % of patients with chronic non-malignant back pain who were referred to multispecialty clinics in Oregon were prescribed with opioid medications. Even more dramatically, Mahowald, Singh, and Majeski (2005) found a 61 % prescription rate among patients in a specialty spine clinic. These medications are frequently not used as prescribed, as exemplified by research conducted by Wunsch, Cropsey, Campbell, and Nicely (2008), who found that 61 % of chronic pain patients met the criteria for opioid abuse.

The use of narcotic medications in chronic back pain is controversial, with many expressing the view that chronic opioid therapy can be effective and cannot lead to abuse or addiction (c.f., Rosenblum, Marsch, Portenoy, & Jospeh, 2008). However, it appears that even when taken as prescribed, chronic opioid therapy is associated with poorer outcomes of both conservative treatment for spine pain (Dersh et al., 2008) and spine surgery. For example, Lawrence, London, Bohlman, and Chin (2008) found that 50 % of patients had been using narcotics on a daily basis for greater than 6 months prior to spine surgery, and such patients were much less likely to achieve excellent or good surgical results, compared to the patients who had not been on such a long-term opioid regimen. There is also evidence that opioid medications are not effective for relief of back pain nor are associated with improved functioning when prescribed for longer than 16 weeks (Martell et al., 2007). To the extent that back pain patients use opioids excessively, in a manner not prescribed, or for protracted periods, they are less likely to be responsive to any treatment.

Workers' Compensation

In the setting of an occupational injury, it is critical to be aware of the large body of research demonstrating that back pain patients covered by workers' compensation fare more poorly than do those who are covered by other insurance types. Workers' compensation patients report more severe pain, greater disability, more emotional distress and greater life interference than non-compensation patients (Turk & Okifuji, 1996). A number of studies have shown that spine surgery outcome is reduced in patients receiving workers' compensation payment (e.g., Atlas et al., 2009; Klekamp, McCarty, & Spengler, 1998). In fact, a meta-analysis by Harris, Mulford, Solomon, van Gelder, and Young (2005) found that workers' compensation significantly increases the odds ratio for worse outcome of lumbar spinal fusion (odds = 4.33) and lumbar spinal discectomy (odds = 4.77).

Poor treatment results among workers' compensation patients may not arise solely from economic considerations. Rather, workers' compensation patients have a number of additional issues that may lead to reports of high pain levels and poor treatment outcome. First, these patients have frequently been unable to work for extended periods at the time of surgery. Research on chronic pain has clearly shown that the length of time a patient has been nonfunctional strongly influences treatment outcome. Dworkin, Handlin, Richlin, Brand, and Vannucci (1985) using multiple regression to examine the relationships among compensation, litigation, and employment status (time off work) in 454 patients undergoing treatment for chronic pain found that only time off work (and not workers' compensation or litigation) predicted treatment outcome. In similar and even more dramatic fashion, Anderson, Schwaegler, Cizek, and Leverson (2006) found that patients who were working up to the time that they went in for anterior lumbar interbody fusion (ALIF) were 10.5 times more likely to have returned to work by 1-year post-op than were individuals who had not been working prior to surgery. Interestingly, this association was independent of workers' compensation status and number of spinal levels treated.

Responses to treatment by patients receiving workers' compensation may be influenced by a number of other work-related factors, including job dissatisfaction (Bigos et al., 1991) and high levels of anger or blame toward the employer (DeGood & Kiernan, 1996). Regardless of the cause, workers' compensation is so widely recognized as a risk factor that Frymoyer and Cats-Baril (1987) have proposed that *compensability* is one of the strongest predictors of excessive disability among back injury patients.

Treatments

Conservative Treatment

The natural history for patients suffering from an episode of back pain is actually quite positive. In the majority of patients (approximately 90 %), symptoms will resolve with or without treatment in a period of 6–12 weeks (Andersson, 1999). Therefore, in the absence of a progressive neurological deficit, spinal instability, infection, or tumor, conservative efforts toward managing back pain are the preferred initial approach.

Physical Therapy and Chiropractic Treatments

Physical therapy is one of the most commonly initiated rehabilitation programs for patients with low back pain. The goal of the various exercise regimens is to promote strengthening of the key postural muscles and thereby reduce stress or strain on the structures acting as pain generators. Numerous philosophies exist regarding the "best" technique for rehabilitation. "McKenzie exercises," which are extension-based exercises, are believed to reduce discogenic pain by alleviating pressure on the posterior annulus (Melzack & Wall, 1965; Nachemson & Elfström, 1970). Flexion-based regimens, or "Williams exercises," focus on decreasing compressive forces across the facet joints in an effort to decrease compressive loads at the posterior aspect of the disc, decompress the intervertebral foramen, and strengthen the core-stabilizing musculature (Williams, 1974). A study directly comparing both methods showed no significant difference between the two groups, except that sagittal mobility improved faster with flexion exercises (Elnaggar, Nordin, Sheikhzadeh, Parnianpour, & Kahanovitz, 1991).

Fitness programs including pilates and yoga are additional options targeting core strengthening for patients who are able to participate in them. The muscular conditioning afforded by these types of programs helps with maintaining appropriate posture and reducing low back strain. As well, it has been shown that exercise alone can improve function and decrease pain in adult patients suffering from chronic low back pain (Hayden, van Tulder, Malmivaara, & Koes, 2005). Chiropractic treatment, or spinal manipulation, is yet another option for the treatment of acute low back pain, and it has shown benefit equivalent to that from physical therapy in this group of patients (Cherkin, Deyo, Battie, Street, & Barlow, 1998).

Regardless of the specific type of rehabilitation program implemented, a key component for long-term success is patient education regarding appropriate biomechanics for proper lifting and bending techniques in order to avoid further injury and pain.

Injections

Various types of spinal injections can be employed as conservative treatment options. Depending on the presumed source of pain, facet injections, epidural injections, or even trigger point injections can play a role in conservative efforts. A goal of injection therapy is always to decrease or eliminate pain. However, in many cases, the diagnostic information obtained from a patient's response to an injection can also help direct the physician toward additional treatment options should conservative efforts fail.

Epidural Steroid Injections

Epidural Steroid Injections (ESIs) are commonly performed as a treatment for low back or leg pain resulting from a number of spinal etiologies. The administration of a potent anti-inflammatory agent, usually combined with an anesthetic agent, acts to reduce local inflammation that can be caused from chemical mediators at the site of injury or nerve irritation. Studies have shown very mixed results with epidural injections and, considering that there are a number of techniques for administration of the steroid, this should come as no surprise. There is some evidence to suggest that caudal ESIs can provide short- and long-term improvement for chronic, axial low back pain and for radicular pain (Abdi et al., 2007).

Facet Injections

Facet-mediated pain has been implicated in up to 20 % of low back pain complaints, although the diagnosis itself is often quite difficult to accurately make. In the suspected case of pain stemming from the facets, the physician will often order a diagnostic injection. Under image guidance, a needle is inserted into the facet joint being evaluated, and a low volume of anesthetic, often coupled with a small amount of steroid, is injected. The "diagnostic phase" of the first 6–8 h following the injection can provide clinical information as to whether the facet joints are a chief contributing cause to the pain. Unfortunately, there is a high false-positive rate for a single set of diagnostic injections (Manchukonda, Manckikanti, Cash, Pampati, & Manchikanti, 2007), so the treating physician might consider a second set of injections as a "confirmatory" block.

Surgery

Surgical treatment of low back pain is a last resort, but in appropriately selected patients who have failed extensive conservative management and continue to have unremitting pain or functional disability, it can provide symptomatic improvement.

Discectomy

For patients with a herniated disc and resulting leg and/or back pain, surgical treatment is aimed toward decompressing the affected nerve(s) by removing the herniated fragment of disc. In one study designed to evaluate the long-term success of the procedure, successful outcomes at 6 months for 91 % of patients only declined slightly to 83 % at 10 years (Findlay, Hall, Musa, Olivreia, & Fear, 1998). Surgically treated patients were shown to have more complete relief of leg pain and improved function and satisfaction compared with nonsurgically treated patients in another large study over a 10-year follow-up period (Atlas, Keller, Wu, Deyo, & Singer, 2005).

Fusion

Lumbar fusion surgery as a treatment for low back pain, particularly for discogenic pain, remains quite controversial. Results in the literature are variable, but evidence does suggest that in an appropriately selected group of patients with severe low back pain, fusion can diminish pain and decrease disability more effectively than nonsurgical treatment (Fritzell, Hagg, Wessberg, & Nordwall, 2001). It should also be noted that there are many different techniques for spinal fusion, ranging from posterior intertransverse process fusions, posterior lumbar interbody fusions (PLIF), transforaminal lumbar interbody fusions (TLIF), lateral interbody fusions (XLIF or DLIF), ALIF, and combined anterior–posterior approaches (360° fusion). Application of spinal instrumentation, typically pedicle screws and connecting rods, usually accompanies the fusion in order to provide a more stable construct to facilitate bone healing.

Arthroplasty

Total disc replacement (TDR) technology emerged as an alternative treatment option to fusion, beginning in Europe over 20 years ago, and migrating to the United States in 2000 with the first Food and Drug Administration (FDA) Investigational Device Exemption (IDE) trial of the Charite III disc. There are various implant designs, but the key feature they all have in common is preservation of motion at the surgical level. The established indication for TDR is chronic low back pain from single-level degenerative disc disease that has failed extensive conservative treatment. A large driving force for development of disc replacement technology has been the concern over symptomatic adjacent segment disease seen after lumbar fusion. In a systematic review analyzing the association of symptomatic adjacent segment disease (as distinguished from asymptomatic adjacent segment degeneration) in lumbar disc replacement compared to fusion, Harrop et al. (2008) reported that 14 % of fusion patients developed adjacent segment disease, compared with 1 % of disc replacement patients.

Absolute contraindications to TDR include osteopenia and osteoporosis, history of previous disc infection or ongoing infection, prior fusion at the level of consideration, severe posterior element pathology, instability at the operative segment, vertebral fracture, malignancy, scoliotic curve greater than 11°, metal allergy, or a psychosocial state that places a given patient at increased risk for a poor surgical outcome. Relative contraindications include prior abdominal surgery and obesity (Guyer & Shellock 2011)

Spinal Cord Stimulation

Spinal cord stimulation (SCS) is a treatment option for patients with chronic back and/or leg pain who have failed prior surgical treatment (often referred to as FBSS) or who have pain that is predominantly neuropathic, such as from complex regional pain syndrome or from diabetic neuropathy. The first SCS device was implanted in 1967 by Shealy, who placed a subdural electrode over the dorsal columns of the spinal cord and connected it to an external power source (Shealy, Mortimer, & Reswick, 1967). Although the exact mechanism of action is still debatable, it is generally held that the "gate control theory" of pain, originally described by Melzack and Wall (1965), is the foundation for SCS technology. According to their theory, the central transmission of pain could be blocked by electrically stimulating afferent (i.e., sensory) nerve fibers. In other words, the stimulator can act as a "signal jammer" so the brain does not interpret a stimulus as painful.

Patients who are candidates for SCS should have exhausted reasonable medical and therapy approaches for their symptoms prior to undergoing the procedure. SCS is better able to reduce leg pain as opposed to back pain, which should be considered in evaluating a given patient for the procedure. Additionally, patients generally undergo placement of a trial stimulator, done with percutaneously placed electrodes, in order to ascertain the type of benefit they can receive with an implant. If the trial period is deemed successful, a patient can undergo permanent implantation of the device. Turner, Loeser, Deyo, and Sanders (2004), reviewing the literature on SCS for FBSS, found that pain was reduced by about one-half for 50–60 % of patients undergoing this procedure.

Presurgical Psychological Screening

There is clearly strong evidence that spine surgery can be effective in providing pain relief and improved functional ability. For example, a study by Malter, Larson, Urban, and Deyo (1996) found that patients who underwent discectomy for lumbar disc herniation, even at 5-year post-surgery, had significantly better quality of life than those who were treated conservatively. Similarly, Atlas, Keller, Robson, Deyo, and Singer (2000) compared the 4-year outcomes of surgery vs. unstructured conservative care for lumbar stenosis.

They found that those treated surgically had significantly greater relief of pain and higher levels of satisfaction than those treated conservatively. However, spine surgery is not universally effective, and not-infrequently leads to worsening disability and the need for additional surgical intervention. For example, Sherman et al. (2010) found unfavorable outcomes in 28 % of lumbar discectomy patients, with 80 % of such patients undergoing repeat discectomy (average cost $6,907) and 20 % undergoing spinal fusion (average cost $24,375).

Beginning about 20 years ago, a growing body of research began to demonstrate that spine surgery failures can be predicted through the process of presurgical psychological screening (PPS). PPS is a procedure increasingly used in connection with a wide variety of surgical procedures, including bariatric surgery, organ transplantation, deep brain stimulation and reconstructive plastic surgery (Block & Sarwer, 2013). As applied to spine surgery, PPS utilizes a psychosocial diagnostic interview, psychometric testing and review of the medical records to identify empirically-determined psychosocial risk factors for reduced surgery outcome (Block, Gatchel, Deardorff, & Guyer, 2003). Many of these risk factors are those associated with back pain in general and reviewed above. These risk factors are weighted and combined to determine the patient's level of psychosocial risk for poor surgery results. Research on PPS indicates that unfavorable surgery results are obtained by approximately 84 % of patients who fall into the highest risk category, while 20 % of those with low levels of psychosocial risk obtain poor results (Block et al., 2001).

Chronic Pain Management Programs

For many patients with persistent back pain, there exists a viable, effective alternative to spine surgery—the interdisciplinary chronic pain management program (CPMP). Such programs teach patients to manage and cope with pain and its impacts, through a combination of physical conditioning, education, psychosocial treatment, relaxation training, and vocational counseling. The CPMP approach can be as effective in treating spine pain patients as is spine surgery. Brox et al. (2003), for example, assessed 64 Swedish patients with evidence of severe disc degeneration lasting more than 1 year. These patients were randomly assigned to undergo either (1) a modified CPMP involving cognitive-behavioral intervention with 3 daily physical exercise sessions for 3 weeks, or (2) a lumbar fusion with posterior transpedicular screws and postoperative physical therapy. At 1-year follow-up, both groups had significant improvements in function, as measured by the Oswestry Disability Index (ODI). However, there was no significant difference found in functional improvement between those treated surgically and those treated nonsurgically. Additionally, there were no significant differences in pain, use of analgesics, emotional distress, and return to work. Fear-avoidance beliefs were reduced significantly more in the nonsurgically treated group (see Brox et al., 2006, for similar results). The early complication rate for the surgically treated group was 18 %.

Further support for the use of CPMP has been obtained by Fairbank et al. (2005) who examined 349 patients uncertain about whether they should undergo spine surgery. These patients were randomly assigned to an "intensive rehabilitation program" (essentially a CPMP) or to spinal fusion. Subjects were followed for 24 months. The fusion patients showed a slightly greater improvement in function as measured by the ODI, but no other comparisons between the two groups reached significance. An additional study of these same patients (Rivero-Arias et al., 2005) found that the cost of fusion far exceeded that of CPMP (£7,830 vs. £4,256). The percentage of patients returning to work at 2 years were equivalent, indicating CPMP was much more cost-effective than spinal fusion. Turk and Burwinkle (2005), in a separate review of the literature extending such findings, determined that the CPMP approach can be approximately 26-times more cost-effective in patients returning to work than is spine surgery.

It appears, then, that CPMP is a viable alternative for some spine surgery candidates. This is particularly the case for those whose psychosocial risk profiles place them in the high-risk category for reduced spine surgery outcome, or those who are uncertain about whether to undergo spine surgery. However, there are many other potential candidates for spine surgery who could benefit by consideration of CPMP. For example, many patients may have expectations of poor outcome, or may be overly optimistic in their hopes. Iverson, Daltroy, Fossel, and Katz (1998) found that expectations of great pain relief by patients who underwent surgery for spinal stenosis were associated with more pain and less satisfaction at 6 months than were lower expectations of pain relief (however, in this study, higher expectations of improvement in functioning as a result of the surgery were associated with greater improvement in functioning and greater satisfaction). Thus, for patients expecting to have "no pain" as a result of spine surgery, CPMP may be a valuable alternative. Such is also the case for patients who have failed previous spine surgeries because, as noted by a number of authors including North, Campbell, James, and Conover-Walker et al., 1991), the success rate for repeat spine surgery is quite low (see also Franklin et al., 1994). Similarly, since substance abuse or overuse is associated with reduced spine surgery outcome (Spengler, Freeman, Westbrook, & Miller, 1980), patients with such problems would likely be better served by participation in a CPMP than by spine surgery.

Summary and Conclusions

Back pain is the most problematic complaint associated with occupational injuries. Fortunately, most patients, like Mr. A in the introduction to this chapter, recover rapidly and without much, if any, medical treatment. On the other hand, Mr. Z represents the relatively small percentage of patients whose pain continues unabated, consuming large economic and medical resources, devolving into increasing disability and emotional distress. This chapter provides strong evidence that, with appropriate medical or surgical treatment, even most of those with protracted back pain can experience significant improvement. However, many psychosocial factors are associated with the development and maintenance of back pain. These same factors are associated with reduced outcomes of conservative and surgical treatment. Costs to the insurer and employer, as well as frustration and emotional distress to the patient, can be reduced when medical providers are aware of, and address, such psychosocial issues, and avoid worsening them, by being cautious in the use of opioid therapy, spine surgery, or other high-risk procedures.

References

Abdi, S., Datta, S., Trescott, A., Schultz, D. M., Adlaka, R., Atluri, S. L., et al. (2007). Epidural steroids in the management of chronic spinal pain: A systematic review. *Pain Physician, 10*, 185–212.

Anderson, P. A., Schwaegler, P. E., Cizek, D., & Leverson, G. (2006). Work status as a predictor of surgical outcome of discogenic low back pain. *Spine, 31*, 2510–2515.

Andersson, G. B. J. (1999). Epidemiological features of chronic low-back pain. *Lancet, 354*, 581–585.

Atlas, S. J., Keller, R. B., Robson, D., Deyo, R. A., & Singer, D. E. (2000). Surgical and nonsurgical management of lumbar spinal stenosis: Four-year outcomes from the Maine lumbar spine study. *The Spine Journal, 35*(5), 556–562.

Atlas, S. J., Keller, R. B., Wu, Y. A., Deyo, R. A., & Singer, D. E. (2005). Long-term outcomes of surgical and non-surgical management of lumbar spinal stenosis: 8 to 10 year results from the Maine Lumbar Spine Study. *Spine, 30*, 936–943.

Atlas, S. J., Tosteson, T. D., Blood, E. A., Skinner, J. S., Pransky, G. S., & Weinstein, J. N. (2009). The impact of workers compensation on outcomes of surgical and nonoperative therapy for patients with lumbar disc herniation: Sport. *Spine, 2009*, 89–97.

Ben-Porath, Y. S., & Tellegen, A. (2008). *The Minnesota multiphasic personality inventory-2 restructured form (MMPI-2-RF): Manual for administration, scoring, and interpretation*. Minneapolis, MN: University of Minnesota Press.

Bigos, S. J., Battie, M. C., Spengler, D. M., Fisher, L. D., Fordyce, W. E., Hansson, T., et al. (1991). A prospective study of work perceptions and psychosocial factors affecting the report of back injury. *Spine, 16*, 1–6.

Block, A. R., Ben-Porath, Y. S., & Marek, R. J. (2013). Psychological risk factors for poor outcome of spine surgery and spinal cord stimulator implant: A review of the literature and their assessment with the MMPI-2-RF. *The Clinical Neuropsychologist*, *27*, 81–107. doi: 10.1080/13854046.2012.721007.

Block, A.R., Ben-Porath, Y.S., Ohnmeiss, D., Guyer, R.D., & Marek, R. (2012). Psychosocial factors and expectancy contribute separately to spine surgery outcome. Paper Presented at North American Spine Society Annual Convention, Dallas, TX.

Block, A. R., Gatchel, R., Deardorff, W., & Guyer, R. (2003). *The psychology of spine surgery*. Washington, DC: American Psychological Association.

Block, A. R., Ohnmeiss, D. D., Guyer, R. D., Rashbaum, R., & Hochschuler, S. H. (2001). The use of presurgical psychological screening to predict the outcome of spine surgery. *The Spine Journal, 1*, 274–282.

Block, A. R., & Sarwer, D. B. (Eds.). (2013). *Presurgical psychological screening: Understanding patients, improving outcomes*. Washington, DC: American Psychological Association.

Brox, J. I., Reikeras, O., Nygaard, O., Sørensen, R., Indahl, A., Holm, I., et al. (2006). Lumbar instrumented fusion compared with cognitive intervention and exercises in patients with chronic back pain after previous surgery for disc herniation: A prospective randomized controlled study. *Pain, 122*, 145–155.

Brox, J. I., Sorensen, R., Friis, A., Nygaard, Ø., Indahl, A., Keller, A., et al. (2003). Randomized clinical trial of lumbar instrumented fusion and cognitive intervention and exercises in patients with chronic low back pain and disc degeneration. *Spine, 28*, 1913–1921.

Bruehl, S., Chung, O. Y., Burns, J. W., & Diedrich, L. (2007). Trait anger expressiveness and pain-induced beta-endorphin release: Support for the opioid dysfunction hypothesis. *Pain, 130*, 208–215.

Burns, J. W. (2006). Arousal of negative emotions and symptom-specific reactivity in chronic low back pain patients. *Emotion, 6*, 309–319.

Carlson, J. W., Keefe, F. J., Goli, V., Fras, A. M., Lynch, T. R., Thorp, S. R., et al. (2005). Forgiveness and chronic low back pain: A preliminary study examining the relationship of forgiveness to pain, anger and psychological distress. *The Journal of Pain, 6*, 84–91.

Cherkin, D. C., Deyo, R. A., Battie, M., Street, J., & Barlow, W. (1998). A comparison of physical therapy, chiropractic manipulation, and provision of an educational booklet for the treatment of patients with low back pain. *New England Journal of Medicine, 339*, 1021–1029.

Chou, L. H., Slipman, C. W., Bhagia, S. M., Tsaur, L., Bhat, A. L., Isaac, Z., et al. (2004). Inciting events initiating injection-proven sacroiliac joint syndrome. *Pain Medicine, 5*, 26–32.

Currie, S. R., & Wang, J. L. (2004). Chronic back pain and major depression in the general Canadian population. *Pain, 107*, 54–60.

Davis, D. A., Luecken, L. J., & Zaruta, A. J. (2005). Are reports of childhood abuse related to the experience of chronic pain in adulthood? A meta-analytic review of the literature. *Clinical Journal of Pain, 21*, 398–405.

DeGood, D. E., & Kiernan, B. (1996). Perception of fault in patient with chronic pain. *Pain, 64*, 153–159.

Dennis, M. D., Rocchio, P. O., & Wiltse, L. L. (1981). The topographical pain representation and its correlation with MMPI scores. *Orthopedics, 5*, 432–434.

Dersh, J. D., Mayer, T. G., Gatchel, R. J., Polatin, P. B., Theodore, B. R., & Mayer, E. A. K. (2008). Prescription opioid dependence is associated with poorer outcomes in disabling spinal disorders. *The Spine Journal, 20*, 2219–2227.

Deyo, R. A., Mirza, S. K., & Martin, B. I. (2006). Back pain prevalence and visit rates: Estimates from U.S. national surveys. *Spine, 21*, 1957–1963.

Dreyfuss, P., Michaelsen, M., Pauza, K., McLarty, J., & Bogduk, N. (1996). The value of medical history and physical examination in diagnosing sacroiliac joint pain. *Spine, 21*, 2594–2602.

Dworkin, R. H., Handlin, D. S., Richlin, D. M., Brand, L., & Vannucci, C. (1985). Unraveling the effects of compensation, litigation and employment on treatment response in chronic pain. *Pain, 23*, 49–59.

Elnaggar, I. M., Nordin, M., Sheikhzadeh, A., Parnianpour, M., & Kahanovitz, N. (1991). Effects of spinal flexion and extension exercises on low-back pain and spinal mobility in chronic mechanical low-back pain patients. *Spine, 16*, 967–972.

Fairbank, J., Frost, H., Wilson-MacDonald, J., Yu, L. M., Barker, K., & Collins, R. (2005). Randomised controlled trial to compare surgical stabilisation of the lumbar spine with an intensive rehabilitation programme for patients with chronic low back pain: The MRC spine stabilisation trial. *British Medical Journal, 330*, 1233–1239.

Fernandez, E., Clark, T. S., & Ruddick-Davis, D. (1999). A framework for conceptualization and assessment of affective disturbance in pain. In A. R. Block, E. F. Kremer, & E. Fernandez (Eds.), *Handbook of pain syndromes: Biopsychosocial perspectives*. Mahwah, NJ: Lawrence Erlbaum.

Fernandez, E., & Turk, D. C. (1995). The scope and significance of anger in the experience of chronic pain. *Pain, 61*, 165–175.

Findlay, G. F., Hall, B. I., Musa, B. S., Olivreia, M. D., & Fear, S. C. (1998). A 10-year follow-up of the outcome of lumbar discectomy. *Spine, 10*, 1168–1171.

Fishbain, D., Cutler, R., Rosomoff, H., & Rosomoff, R. (1997). Chronic-pain associated depression: Antecedent or consequence of chronic pain? A review. *Clinical Journal of Pain, 13*, 116–137.

Frank, J. W., Brooker, A. S., DeMaio, S. E., Kerr, M. S., Maetzel, A., Shannon, H. S., et al. (1996). Disability resulting from occupational low back pain. Part II: What do we know about secondary prevention? A review of the scientific evidence on prevention after disability begins. *Spine, 21*, 2918–2929.

Franklin, G. M., Haug, J., Heyer, N. J., McKeefrey, S. P., & Picciano, J. F. (1994). Outcome of lumbar fusion in Washington state workers' compensation. *Spine, 19*(17), 1897–1904.

Fritzell, P., Hagg, O., Wessberg, P., & Nordwall, A. (2001). Volvo award winner in clinical studies: Lumbar fusion versus nonsurgical treatment for chronic low back pain: A multicenter randomized controlled trial from the Swedish lumbar spine study group. *Spine, 26*, 2521–2532.

Frymoyer, J. W., & Cats-Baril, W. L. (1987). An overview of the incidences and cost of low back pain. *Orthopedic Clinics of North America, 22*, 263–271.

Ghormley, R. (1933). Low back pain with special reference to the articular facets with presentation of an operative procedure. *Journal of the American Medical Association, 101*, 1773–1777.

Green, C. R., Flowe-Valencia, H., Rosenblum, L., & Tait, A. R. (1999). Do physical and sexual abuse differentially affect chronic pain states in women? *Journal of Pain and Symptom Management, 18*, 420–426.

Gureje, O., Von Korff, M., Kola, L., Demyttenaere, K., He, Y., Posada-Villa, J., et al. (2008). The relation between multiple pains and mental disorders: Results for the World Mental Health Survey. *Pain, 135*, 82–91.

Guyer, R. D., & Shellock, J. (2011). Lumbar disc arthroplasty: Indications and contra-indications. In J. J. Yue, R. D. Guyer, J. P. Johnson, T. L. Khoo, & S. H. Hochschuler (Eds.), *Comprehensive treatment of the aging spine: Minimally invasive and advanced techniques*. Philadelphia: Saunders.

Haber, J., & Roos, C. (1985). Effects of spouse abuse and/or sexual abuse in the development and maintenance of chronic pain in women. *Advances in Pain Research and Therapy, 9*, 889–895.

Harkonmaki, K., Korkeila, K., Vahtera, J., Kivimaki, M., Suominen, S., Silanmaki, L., et al. (2008). Childhood adversities as a predictor of disability retirement. *Journal of Epidemiology and Community Health, 61*, 479–484.

Harris, I., Mulford, J., Solomon, M., van Gelder, J. M., & Young, J. (2005). Association between compensation status and outcome after surgery. *Journal of the American Medical Association, 293*, 1644–1652.

Harrop, J. S., Youssef, J. A., Maltenfort, M., Vorwald, P., Jabbour, P., Bono, C. M., et al. (2008). Lumbar adjacent segment degeneration and disease after arthrodesis and total disc arthroplasty. *Spine, 33*, 1701–1707.

Hayden, J. A., van Tulder, M. W., Malmivaara, A., & Koes, B. W. (2005). Exercise therapy for the treatment of non-specific low back pain. *Cochrane Database Systems Review, 3,* CD000335.

Irish, L., Kobayashi, I., & Delhanty, D. L. (2010). Long-term health consequences of childhood sexual abuse: A meta-analytic review. *Journal of Pediatric Psychology, 35*, 450–461.

Iverson, M. D., Daltroy, L. H., Fossel, A. H., & Katz, J. N. (1998). The prognostic importance of patient pre-operative expectations for surgery for lumbar spinal stenosis. *Patient Education and Counseling, 34*, 169–178.

Katz, J. N. (2006). Lumbar disc disorders and low-back pain: Socioeconomic factors and consequences. *Journal of Bone and Joint Surgery, 88*(Suppl. 2), 21–24.

Keller, L. S., & Butcher, J. N. (1991). *Assessment of chronic pain patients with the MMPI-2*. Minneapolis, MN: University of Minnesota Press.

Klekamp, J., McCarty, E., & Spengler, D. (1998). Results of elective lumbar discectomy for patients involved in the workers' compensation system. *Journal of Spinal Disorders, 11*, 277–282.

Lawrence, J. T., London, N., Bohlman, H. H., & Chin, K. R. (2008). Preoperative narcotic use as a predictor of clinical outcome: Results following anterior cervical arthrodesis. *Spine, 33*(19), 2074–2078.

Linton, S. J. (1997). A population-based study of the relationship between sexual abuse and back pain: Establishing a link. *The Journal of Pain, 73*, 47–53.

Luschka, H. V. (1850). *Die Nerven des menshlichen Wirbelkanales*. Tubingen, Germany: Laub.

Mahowald, M. L., Singh, J. A., & Majeski, P. (2005). Opioid use by patients in an orthopedic spine clinic. *Arthritis and Rheumatism, 52*, 312–321.

Malter, A. D., Larson, E. B., Urban, N., & Deyo, R. A. (1996). Cost-effectiveness of lumbar discectomy for the treatment of herniated intervertebral disc. *The Spine Journal, 21*, 1048–1054.

Manchukonda, R., Manckikanti, K. N., Cash, K. A., Pampati, V., & Manchikanti, L. (2007). Facet joint pain in chronic spinal pain: An evaluation of prevalence and false-positive rate of diagnostic blocks. *Journal of Spinal Disorders & Techniques, 20*, 539–545.

Martell, B. A., O'Connor, P. R., Kerns, R. D., Becker, W. C., Morales, K. H., Kosten, T. R., et al. (2007). Systematic review: Opioid treatment for chronic back pain: Prevalence, efficacy and association with addiction. *Annals of Internal Medicine, 146*, 16–127.

Martin, B. I., Deyo, R. A., Mirza, S. K., Turner, H. A., Comstock, B. A., Hollingworth, W., et al. (2008). Expenditures and health status among adults with back and neck problems. *Journal of the American Medical Association, 299*, 656–664.

McWilliams, L. A., Goodwin, R. D., & Cox, B. J. (2004). Depression and anxiety associated with three pain conditions: Results from a nationally-representative sample. *Pain, 111*, 77–83.

Melzack, R., & Wall, P. D. (1965). Pain mechanism: A new theory. *Science, 150*, 971–979.

Nachemson, A., & Elfström, G. (1970). Intravital dynamic pressure measurements in lumbar discs: A study of common movements, maneuvers and exercises. *Scandinavian Journal of Rehabilitation Medicine, 1*(Suppl. 1), 1–40.

National Research Council and Institute of Medicine. (2001). *Musculoskeletal disorders and the workplace: low back and upper extremities* (Panel on Musculoskeletal disorders and the work place. Commission on Behavioral and Social Science and education). Washington, DC: National Academy Press.

North, R. B., Campbell, J. N., James, C. S., Conover-Walker, M. K., Wang, H., Piantadosi, S., et al. (1991). Failed back surgery syndrome: 5-year follow up in 102 patients undergoing repeated operation. *Neurosurgery, 28*(5), 685–691.

Nyiendo, J., Haas, M., Goldberg, B., & Lloyd, C. (2001). A descriptive study of medical and chiropractic patients with chronic low back pain and sciatica: management by physicians (practice activities) and patients (self-management). *Journal of Manipulative and Physiological Therapeutics, 24*, 5423–5551.

Panjabi, M. M. (2006). A hypothesis of chronic back pain: Ligament subfailure injuries lead to muscle control dysfunction. *European Spine Journal, 5*, 668–676.

Pleis, J. R., & Lethbridge-Cejku, M. (2007). Summary health statistics for U.S. adults: National Health Interview Survey, 2006. National Center for Health Statistics. *Vital and Health Statistics, 10*(235), 1–153.

Polatin, P. R., Kinney, R. K., Gatchel, R. J., Lillo, E., & Mayer, T. G. (1993). Psychiatric illness and chronic low-back pain. The mind and the spine—which goes first? *Spine, 12*, 66–71.

Rivero-Arias, O., Campbell, H., Gray, A., Fairbank, J., Frost, H., & Wilson-MacDonald, J. (2005). Surgical stabilisation of the spine compared with a programme of intensive rehabilitation for the management of patients with chronic low back pain: Cost utility analysis based on a randomised controlled trial. *British Medical Journal, 330*, 1239–1243.

Rosenblum, A., Marsch, L. A., Portenoy, R. K., & Jospeh, H. (2008). Opioids and the treatment of chronic pain: Controversies, current status and future directions. *Experimental and Clinical Psychopharmacology, 16*, 405–416.

Shealy, C. N., Mortimer, J. T., & Reswick, J. B. (1967). Electrical inhibition of pain by stimulation of the dorsal columns: preliminary clinical report. *Anesthesia and Analgesia, 46*, 489–491.

Sherman, J., Cauthen, J., Schoenberg, D., Burns, M., Reaven, N. L., & Griffith, S. L. (2010). Economic impact of improving outcomes of lumbar discectomy. *The Spine Journal, 10*, 108–116.

Simons, D. G., Travell, J. G., & Simons, L. S. (1999). *Myofascial pain and dysfunction. The trigger point manual* (2nd ed.). Baltimore: Williams & Wilkins.

Slipman, C. W., Sterenfeld, E. B., Chou, L. H., Herzog, R., & Vresilovic, E. (1998). The predictive value of provocative sacroiliac joint stress maneuvers in the diagnosis of sacroiliac joint syndrome. *Archives of Physical Medicine and Rehabilitation, 79*, 288–292.

Spengler, D. M., Freeman, C., Westbrook, R., & Miller, J. W. (1980). Low-back pain following multiple lumbar spine procedures: Failure of initial selection? *Spine, 5*(4), 356–360.

Substance Abuse and Mental Health Services Administration. (2008). Results from the 2007 national survey on drug use and health: National findings (Office of Applied Studies, NSDUH Series H-34, DHS publication No. SMA 08-4343), Rockville, MD.

Takata, K., & Hirotani, H. (1995). Pain drawings in the evaluation of low back pain. *International Orthopaedics, 19*, 361–366.

Turk, D. C., & Burwinkle, T. M. (2005). Assessment of chronic pain in rehabilitation: Outcomes measures in clinical trials and clinical practice. *Rehabilitation Psychology, 50*, 56–64.

Turk, D. C., & Okifuji, A. (1996). Perception of traumatic onset, compensation status, and physical findings: Impact on pain severity, emotional distress, and disability in chronic pain patients. *Journal of Behavioral Medicine, 19*, 435–453.

Turner, J. A., Loeser, J. D., Deyo, R. A., & Sanders, S. B. (2004). Spinal cord stimulation for patients with failed back surgery syndrome or complex regional pain syndrome: A systematic review of effectiveness and complications. *The Journal of Pain, 108*, 137–147.

Vernon-Roberts, B., & Pirie, C. J. (1977). Degenerative changes in the intervertebral discs of the lumbar spine and their sequelae. *Rheumatology Rehabilitation, 16*, 13–21.

Walsh, C. A., Jamieson, E. L., MacMillian, H., & Boyle, M. (2007). Child abuse and chronic pain in a community survey of women. *Journal of Interpersonal Violence, 22*, 1536–1554.

Williams, P. (1974). *Low back and neck pain: Causes and conservative treatment* (3rd ed.). Springfield, IL: Charles C. Thomas.

Wunsch, M. J., Cropsey, K. L., Campbell, E. D., & Nicely, J. S. (2008). Oxycontin abuse and overuse. *Journal of Opioid Management, 4*, 73–79.

3

Cervical Pain

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Overview

Cervical pain is described as the perception of pain in the region defined as below the superior nuchal line, between the lateral margins of the neck and above the level of the T1 spinous process (Merskey & Bogduk, 1994). Given the co-location of the neck with the head and upper extremities, pathologic conditions in the cervical spine may result in pain in other sites such as the jaw, head, shoulder, arms and upper back. For example, pain arising from the upper cervical zygapophyseal (or "facet") joints tends to be perceived as headache in the suboccipital region (Cooper, Bailey, & Bogduk, 2007), and cervical radicular pain is perceived as upper extremity pain (Bogduk, 2011a). Thus, for the purposes of this chapter, the authors will focus on clinical states in which the patient's perception of pain lies within the anatomic bounds of the neck. Of course, not all painful disorders involving the neck are constrained to this region; they may result in the perception of pain in other discrete anatomic sites or even generalized throughout the body. Therefore, such disorders will also be addressed insofar as they also result in the perception of pain in the neck.

Discussion of cervical pain is a key component to consider when undertaking a study of pain and disability in the workplace because cervical pain is a common source of occupation-related pain disorders, following only low back pain as a source of workplace absenteeism (Kvarnstrom, 1983). Spine pain, including the neck and lower back, is second only to arthritis and joint pains in terms of healthcare expenses utilized for musculoskeletal conditions. It is estimated that, from 2002 to 2004, approximately $194 billion was spent on spine pain alone. Furthermore, the vast majority (79 %) of spine pain occurs in adults of working age (18–64), thus accounting not only for large use of healthcare dollars but also a large source of lost workforce wages and productivity (Jacobs et al., 2008). One year prevalence of neck/shoulder pain has been reported to be in the 15–20 % range (Anderson, 1984; Kvarnstrom, 1983; Westerling & Jonsson, 1980), while lifetime prevalence has been reported to be nearly two-thirds (Cote, Cassidy, & Carroll, 1998). Also, the increasing automation and specialization in the modern workplace is thought to result in more homogeneous and repetitive work tasks that ultimately contribute to cumulative trauma and increased report of injury (Hagberg & Wegman, 1987; Nordin, Andersson, & Pope, 1997). Occupational cervical pain is more commonly reported in

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women than men and is a more frequent source of sick leave amongst women (Anderson, 1984; Westerling & Jonsson, 1980). Psychosocial factors may also contribute to the development of occupational musculoskeletal disorders. Stress, lack of control, monotony, poor job satisfaction, and low skill requirements have been reported to correlate with development of occupational musculoskeletal disorders (Nordin et al., 1997). Of note, though, is a recent literature review on the course and prognosis of neck pain in workers (Carroll, Hogg-Johnson, et al., 2011; Carroll, Holm, et al., 2011) which concluded that age, gender, and job-demand differences showed only small associations at best in predicting prognosis of cervical pain. The reviewers ultimately conclude that the strongest evidence for poor prognostic indicators included prior episodes of pain, prior sick leave, occupation (e.g., blue collar vs. white collar, enlisted personnel vs. officers), and, finally, the perception of little influence over one's work situation. Further research on such prognostic factors is important because knowledge of such factors may allow for instituting changes in workplace policies or environments in order to avoid cervical pain, as well as to select for workers who may need specific interventions to ameliorate or altogether avoid episodes of cervical pain. Fortunately, the natural history of acute episodes of cervical pain tends toward resolution in the majority of cases, although some estimate that from 10 to 30 % of patients will go on to have chronic cervical pain (Bogduk, 2011a) and that, at any time, 4.6 % of adults have disabling neck pain (Cote et al., 1998).

Given the increasing personal and economic burden of chronic cervical pain, it has become increasingly important for the clinician to have a strong grasp of the various pathologic conditions resulting in chronic cervical pain. Proper evaluation and management of cervical pain require knowledge of the various anatomic elements that make up the cervical spine, their normal function, and the common pathologies that result in painful conditions. Special attention will be given in this chapter to the identification of the anatomic elements of the cervical spine and the pathologic conditions resulting in pain in this region. Treatment of such conditions will be addressed in other chapters in this handbook.

The Cervical Spine

The musculature of the neck is a common source of cervical pain, as well as headache and upper back or shoulder pain due to common insertions between the anatomic sites. Such myofascial pains will be addressed at length, as well as "whiplash" syndrome because it has become the subject of great interest due to its increasing commonality and levels of chronic pain and disability associated with this disorder. Specific anatomic topics and associated pathologic conditions that will be addressed in this chapter include the motion segments of the cervical spine, the bony and the intervertebral discs. Other conditions will be addressed insofar as they contribute to cervical pain and include fibromyalgia, rheumatologic conditions, neoplasms, vascular anomalies, and a variety of less common degenerative conditions.

Anatomy

The cervical spine begins at the base of the skull and ends at the first thoracic vertebra. It is comprised of seven vertebral segments that differ in morphology and articulation from the lower thoracic and lumbar segments. The upper two cervical vertebrae differ even more so due to their primary function, support, and axial motion of the skull. Each vertebra generally has an anterior body connected to paired pedicles which project posteriorly and form the lateral borders of the spinal canal. Posteriorly, the spinal canal is formed by the superior and inferior articular processes and the lamina. There are also bony projections posterior to the lamina (known as spinous processes) and lateral to the body (known as the transverse processes). The transverse processes contain a foramen that houses the vertebral artery as it projects up from the aortic arch to the skull. The vertebral bodies below C2 are separated by intervertebral discs, composed of a nucleus and an outer fibrous annular layer. The anterior annulus fibrosis is much thicker and stronger than the rest of the disc, which contributes to the lordotic curvature in this part of the spine. The primary role of the intervertebral discs is absorption of axial load.

Table 3.1 Cervical nerve roots

Nerve	Sensory dermatome	Muscle and function	Deep tendon reflex
C3	Anterior and posterior neck	Sternocleidomastoid (lateral neck flexion)	
C4	Shoulder	Levator scapula (shrugging)	
C5	Lateral arm to elbow	Deltoid (arm abduction), biceps (elbow flexion)	Biceps
C6	Lateral forearm, thumb	Biceps (elbow flexion), forearm extensors (wrist extension)	Biceps, brachioradialis
C7	Posterior forearm and middle finger	Triceps (elbow extension), forearm flexors (wrist flexion)	Triceps
C8	Medial forearm, little finger	Flexor digitorum (finger flexion)	Triceps
T1	Medial upper arm to elbow	Hand interossei (finger abduction)	

The first cervical vertebra (C1), also known as the atlas, is comprised of an anterior and posterior arch along with lateral masses. The lateral masses articulate with the occipital condyles of the skull superiorly and with the body of C2 inferiorly. The C2 vertebra, also known as the axis, has a bony projection (dens or odontoid process) that passes through the middle of C1 and articulates with the posterior aspect of its anterior arch. The atlanto-occipital joint (C1 to skull) allows for flexion and extension of the skull. It is important to note that normal range of flexion and extension at this joint can range up to 35° (Mercer & Bogduk, 2001), but further movement of the neck can be obtained with motion of inferior cervical segments. The atlantoaxial joint (C1–2) allows for axial rotation of the skull by pivoting on the odontoid process. The normal range of motion for this segment is about 45° of lateral rotation before low cervical segments begin moving.

Below this level, the cervical vertebra articulates via two separate joints bilaterally, allowing for anterior and posterior contact. This formation allows for transmission of axial load to the inferior spine. The uncovertebral joints, or joints of Luschka, are articulations of the uncinate process along the posterolateral borders of the vertebral body. The zygapophyseal, or facet, joints are articulations of the superior and inferior articular processes along the posterior element of the vertebra. The vertebrae are further stabilized by ligaments. The anterior longitudinal ligament runs anteriorly to the vertebral bodies and intervertebral discs, while the posterior longitudinal ligament runs posteriorly. The ligamentum flavum forms the posterior border of the epidural space and runs anterior to the lamina. The interspinous ligament runs between adjacent spinous processes while the supraspinous ligament runs along the distal ends of the spinous processes. Finally, the spinal canal protects the spinal cord as it descends from the foramen magnum, and it protects the nerve roots which exit the intervertebral foramina. There are eight paired cervical nerve roots, with the first exiting between the skull base and C1 (thus the C2 roots exit between C1/2 and so on).

Cervical Nerves

A thorough understanding of cervical nerves is necessary to interpret physical exam findings. Sensory dermatomes include the shoulder (C4), lateral arm to elbow (C5), thumb and index finger (C6), posterior forearm and middle finger (C7), and little finger (C8). Common muscle innervation includes the levator scapula tested with shrugging (C4), biceps tested with elbow flexion (C5), wrist extensors (C6), triceps tested with elbow extension (C7), and finger flexors (C8). Relevant deep tendon reflexes include the biceps (C5/6) and triceps (C7/8) (see Table 3.1).

Cervical Musculature

The major posterior muscles of the neck include the trapezius, levator scapulae, splenius, semispinalis, and suboccipital muscles. The trapezius and levator scapulae muscles attach between the spine and the shoulders/back, and they are essentially involved in coordinated neck and shoulder movements. The splenius (capitis and cervicis) muscle attaches the head to the posterior spine and upper thoracic vertebrae. Its primary function is tilting the head backward and head rotation. The semispinalis (dorsi, cervicis, and capitis) is a large paraspinal muscle whose main action is extension of the neck. The suboccipitals (rectus capitis posterior major and minor, obliquus capitis superior and inferior) are involved in fine movements of the head including rotation and extension.

Laterally, the scalene muscles (anterior, middle, and posterior) attach from the cervical spine to the first and second ribs. They are involved in rotation, flexion, and lateral bending. Anteriorly, the sternocleidomastoid and prevertebral muscles are present. The sternocleidomastoid is mostly involved in flexion of the head and lateral movement. The prevertebral muscles (longus colli and capitis, rectus capitis anterior and lateralis) are mostly involved in neck flexion.

Cervical Zygapophyseal Joints

The cervical zygapophyseal (or “facet”) joints are formed by paired articular cartilaginous surfaces of corresponding upper and lower cervical vertebra to form one diarthrodial joint on each side of the cervical spine (Hertling & Kessler, 2006; Jaumard, Welch, & Winkelstein, 2011). These joints participate in bearing the weight of the head, and they allow motion in multiple planes including flexion, extension, axial rotation, and lateral bending. The upper cervical segments (i.e., C2 and above) have specialized anatomy allowing great range of motion and secure coupling with the head at the foramen magnum. The lower segments (i.e., C2–7) appear more similar to the thoracic and lumbar segments with specialized adaptations to bear the weight of the head and neck and facilitate the range of motion of the neck (Hertling & Kessler, 2006; Onan, Heggeness, & Hipp, 1998). Pain arising from the cervical zygapophyseal joints may be responsible for up to one-half of chronic pain associated with chronic whiplash injuries (Barnsley, Lord, & Bogduk, 1993; Lord, Barnsley, & Bogduk, 1995; Lord, Barnsley, Wallis, & Bogduk, 1996). It is unclear as to the incidence of zygapophyseal joint pain outside the setting of whiplash trauma (because such studies are lacking), but suspicion of these joints as a pain generator can be tested with diagnostic blocks of the suspected joints (Bogduk, 2011a).

Disorders of the Cervical Spine

Cervical Spondylosis

Spondylosis is a commonly utilized term and is often misunderstood in its role in neck pain. Cervical spondylosis denotes degenerative changes in various elements of the cervical spine, including the intervertebral discs, ligaments, and bony elements (i.e., pedicles, zygapophyseal joints). These degenerative changes become ubiquitous as population ages and are readily visible on imaging studies (Bogduk, 2011a; Hadler, 1999). Due to the ease with which such changes are noted by imaging and the exceedingly common nature of such degeneration, they are commonly implicated as the causative agent in neck pain. Unfortunately, such degenerative changes are not well correlated with physical signs and symptoms, and they are generally considered a normal part of the aging process, although they may be accelerated by trauma, heavy lifting, smoking, or operating vibrating equipment. Despite the fact that these degenerative changes are asymptomatic in most patients, if they are of sufficient severity, they may lead to stenosis of the neuroforamen or central canal and then to radicular symptoms (Bogduk, 2011a; Ehni, 1984; Kaplan & Tanner, 1989; Nordin et al., 1997).

Cervical Spondylolisthesis

Spondylolisthesis is anterior or posterior displacement of a vertebra in relation to the vertebra below it. Cervical spondylolisthesis, although less common than lumbar spondylolisthesis, still accounts for a significant portion of patients with neck pain. It is most often of degenerative etiology that can be due to trauma. Pain due to spondylosis or spondylolisthesis can be axial and/or radicular depending on the underlying pain generator. If the pain originates from the joints, it tends to be axial and localized (Van Eerd et al., 2010). Radicular pain could be due to irritation of nerve roots due to neuroforaminal stenosis or osteophytes. Degenerative spondylolisthesis is generally preceded by degeneration of the intervertebral disc and facet joints. The most common level of degenerative disease tends to be the C3/4 and C4/5 junctions (Jiang, Jiang, & Dai, 2011). Of concern is that patients may develop myelopathy. Although it has been noted that the severity of spondylolisthesis did not always correlate with myelopathy, others have argued that dynamic canal stenosis was of more importance in accounting for progression of myelopathy (Hayashi, Okada, Hashimoto, Tada, & Ueno, 1988).

Plain radiography of the cervical spine can help elucidate spondylosis and spondylolisthesis, while additional flexion/extension views can be obtained to determine any instability of the spine. MRI can be used to further assess for spinal cord or nerve compression, if suspected. Treatment options include physiotherapy, spinal manipulation (not for spondylolisthesis), pain management interventions, and surgery.

Cervical Stenosis/Myelopathy

Stenosis refers to the narrowing of the spinal canal. Common causes include disc herniation/bulging, spondylosis, and ligamentous changes (such as hypertrophy and buckling). Canal stenosis is often asymptomatic; however, it can lead to compression of the spinal cord with possible myelopathy and cord changes. Occasionally, one may see an acute disc protrusion leading to myelopathy which requires surgical consultation. More likely, it is marked by the patient with clinically "silent disease" that progressively leads to decline in function. The clinical course is highly variable and can often be asymptomatic despite imaging findings (Alexander, 2011). There are several classification systems for severity of stenosis. One used involves the relation of the AP diameter at the affected level to normal: mild is classified as 75–99 % of normal, moderate is 50–74 %, and severe is less than 50 %.

Myelopathy refers to a disorder of the spinal cord with a neurologic deficit. It can be caused by stenosis, trauma, malignancy, infection, or autoimmune processes. Patients may often present with paresthesias, mild weakness, or clumsiness in the initial stages. Eventually, weakness of the extremities, sensory changes, ataxic gait, and bowel/bladder changes may be seen. In addition, hyperreflexia, Lhermitte's sign, Hoffman's sign, or a Babinski reflex may be elicited. A commonly seen disorder in a clinical setting is cervical spondylitic myelopathy. It most often presents as a slow decline in function, whereas acute changes are often a harbinger of some other etiology. It has been noted that long periods of severe cervical stenosis can be associated with demyelination of white matter and necrosis of grey and white matter, leading to potentially irreversible effects. It is important to recognize patients with severe symptoms and/or long-standing symptoms because the likelihood of improvement with nonoperative treatment is low (Matz et al., 2009). Imaging is helpful at delineating underlying etiologies. MRI or CT with or without myelography can be used. Treatment is generally surgical decompression of the affected area.

Nerve Compression

Spinal nerves can be compressed by disc disorders (herniation/bulges), spondylosis, tumors, and other less common etiologies. This often manifests as radicular pain that is felt extending from the neck into the upper back or extremities. This pain is due to activation of nociceptors by direct compression or due to inflammatory changes (Alexander, 2011). Patients may also develop radiculopathy (which is a sensory or motor deficit) of the upper extremity. It is important to note that patients may manifest with neck pain and intermittent upper extremity complaints or vice versa. In a study looking at patients from 1976 to 1990 within the Mayo clinic system (Van Zundert, Huntoon, & Patijn, 2010), it was noted that the highest incidence of cervical radiculopathy was seen in patients who were male, in the 50–54-year-old subgroup, and those who had prior lumbar radiculopathy. There has also been an association with heavy manual jobs, persons who operate vibrating equipment, frequent travel by automobile, and smoking (Alexander, 2011). The most commonly affected nerve dermatomes were at the C7 and C6 levels. If cervical disc herniation is the etiology, it is usually due to the intervertebral disc above the nerve root.

Diagnosis is mainly based on history and physical exam. Testing can include Spurling's maneuver, which should reproduce radicular pain, and the axial manual traction test, which should alleviate pain (Nordin et al., 2009; Van Zundert et al., 2010). These tests have been found to have high specificity but low sensitivity (Van Zundert et al., 2010); there is consistent evidence that the clinical exam has higher negative predictive value than positive predictive value for cervical radiculopathy (Nordin et al., 2009). Overall, MRI is the imaging modality of choice due to its superior soft tissue resolution. However, many studies have shown that imaging abnormalities do not always equate with symptomatology (Alexander, 2011; Boden et al., 1990; Dai, 1998; Ernst, Stadnik, Peeters, Breucq, & Osteaux, 2005; Schellhas, Smith, Gundry, & Pollei, 1996; Sohn, You, & Lee, 2004; Zheng, Liew, & Simmons, 2004). Plain films can demonstrate spondylosis and potential neuroforaminal narrowing. Electrodiagnostic testing is useful in cases where the history and physical, and possibly the imaging, are inconclusive. Treatment usually includes physiotherapy, medications, pain management interventions, and surgery. Of note, in a review by the American Physical Therapy Association (Childs et al., 2008), patients with cervical radiculopathy had the best outcomes, relative to patients with other etiologies of neck pain.

Discogenic Pain

The prevalence of discogenic pain has been found to be near 20 % in patients presenting with neck pain (Manchikanti et al., 2009). Discogenic pain is presumed to be due to internal disc disruption characterized by nerve in-growth, inflammation, and mechanical hypermobility (Lotz & Ulrich, 2006). Disc degeneration begins in the second and third decade of life due to the aging process, axial loading stress, and of other uncertain etiologies (Alexander, 2011; Dvorak et al., 2007). Pain due to internal changes is mediated by several nerves depending on the portion of the disc. The outer posterior annulus is innervated by the sinuvertebral nerves, the outer lateral annulus is innervated by branches of the grey rami communicante nerves, and the outer ventral annulus is innervated by branches of the ventral rami (Bogduk, Windsor, & Inglis, 1989; Manchikanti et al., 2009; Walker, Spitzer, Veeramani, & Russell, 2005). Discogenic pain generally presents as axial neck pain, which is often hard to distinguish from facetogenic pain (Dwyer, Aprill, & Bogduk, 1990). Imaging studies (XR, CT, MRI) are often used to delineate abnormal discs. However, this information does not necessarily correlate with painful discs (Boden et al., 1990; Dai, 1998; Ernst et al., 2005; Nordin et al., 2009; Sohn et al., 2004; Zheng et al., 2004). In addition, it has been found that fissures in discs do not necessarily correlate with symptomatology (Oda, Tanaka, & Tsuzuki, 1998). Imaging findings indicative of degeneration can include disc space narrowing, vacuum phenomenon, desiccation, end plate sclerosis, osteophytosis, and herniations/bulges. Finally, cervical discography has been advocated as another tool for diagnostic evaluation of discogenic pain. While it does have value by provoking pain within discs and elucidating disc degeneration based on dye spread, there is significant controversy in the literature regarding its use due to a high false-positive rate and risk (Manchikanti et al., 2009; Nordin et al., 2009; Yin & Bogduk, 2008). In addition, there are no studies showing that outcomes are improved using this test in patients who are considering surgery (Margareta et al., 2008).

Myofascial Pain

The major muscle groups of the cervical region were discussed in detail earlier in this chapter. These muscles play a major role in both the mobilization and the stabilization of the neck. It is no surprise, then, that the cervical musculature and its associated fascia are a common source of neck pain. Myofascial pain syndrome is a regional pain disorder, characterized by muscle pain, stiffness, and decreased range of motion. Strain, overload, or trauma are primary causes, whereas coexisting arthropathies, neuropathies, radiculopathies, or visceral disease are potential secondary causes. Much of the literature addressing myofascial pain describes trigger points in the discussion of the pathogenesis of these disorders. Myofascial pain is traditionally defined as pain arising from one or more myofascial trigger points, which are hyperirritable spots in the skeletal muscle that are associated with hypersensitive palpable nodules in taut bands. They can be located at the muscle, fascia, or tendinous insertions. These points are painful on compression and can give rise to characteristic referred pain, referred tenderness, motor dysfunction, and, in some cases, even autonomic phenomena including abnormal sweating, lacrimation, dermal flushing, and vasomotor and temperature changes (Simons, Travell, & Simons, 1999). By comparison, fibromyalgia is a widespread chronic pain disorder with defined diagnostic criteria that includes widespread muscle pain, fatigue, sleep disturbance, and 18-paired tender points in the upper and lower body and in the axial skeleton (Mense, Simons, & Russell, 2001). It is reported that 72 % of patients with fibromyalgia have active trigger points and that 20 % of patients with myofascial pain syndrome also have fibromyalgia. Although these studies suggest that there may be clinical overlap between these two conditions, this present section will focus specifically on myofascial pain.

There are several epidemiologic studies suggesting myofascial trigger-point pain as one of the major causes of neck pain and an important source of morbidity and disability in the community. Trigger points were the primary source of pain in 74 % of 96 patients with musculoskeletal pain seen by a neurologist in a community pain center and in 85 % of 283 patients consecutively admitted to a comprehensive pain center (Fishbain, Goldberg, Meagher, Steele, & Rosomoff, 1986; Gerwin, 1995). Over one-half of the 164 patients referred to a dental clinic for chronic head and neck pain were found to have active myofascial trigger points as the cause of their pain, as were nearly a third of those from a consecutive series of 172 patients presenting with pain to a university primary care internal medicine group (Fricton, Kroening, Haley, & Siegert, 1985; Skootsky, Jaeger, & Oye, 1989). Patients presenting with myofascial pain usually note localized or regional deep-aching sensations, which can vary in intensity from mild to severe. Cervical myofascial pain may be associated with neurologic and otologic symptoms, including imbalance, dizziness, and tinnitus. Functional complaints include decreased work tolerance, impaired muscle coordination, stiff joints, fatigue, and weakness. Other associated neurologic symptoms include paresthesias, numbness, blurred vision, twitches, and trembling (Fricton et al., 1985). Later stages can be compounded by sleep disturbance, mood changes, and stress. Patients with chronic trigger points must be carefully screened for perpetuating factors, such as postural abnormalities, ergonomic factors, or hypothyroidism (Borg-Stein & Simons, 2002). These symptoms can result in significant disability, at least temporarily.

The pathogenesis of trigger points remains unknown. Electromyographic studies have suggested that there are mini-end plate potentials found routinely in trigger points that may be used to characterize this phenomenon. However, these mini-end plate potentials are not found consistently enough to be considered pathognomonic. Other investigators have examined oxygen tension in trigger points and noted consistently lower oxygen levels in these muscle fibers (Borg-Stein & Simons, 2002). The mechanism that permits creation and maintenance of this lower level of muscle fiber oxygenation remains unclear. Another hypothesis of the pathogenesis of trigger points contends that uncontrolled acetylcholine release results in chronic muscle fiber contraction. This is the basis for the clinical use of botulinum toxin to break this cycle as a potential therapy (Lang, 2003). Overall, the pathophysiology of cervical myofascial pain appears to be complex and likely involves multiple levels of both the peripheral and central nervous systems.

Although there is very limited empirical evidence to guide therapy, there are many pharmacologic and nonpharmacologic treatments used in the management of myofascial pain by clinicians. Medications, such as nonsteroidal anti-inflammatory drugs, anticonvulsants, alpha-2 adrenergic agonists, antidepressants, and tramadol, have been used for this condition despite limited controlled data examining their efficacy. Stretching and range of motion exercises form the basis of the nonpharmacologic treatment of myofascial pain. This treatment addresses the muscle tightness and shortening that are closely associated with pain in this disorder, and it permits gradual return to normal activity (Borg-Stein & Simons, 2002). Trigger-point injections are a commonly used supplemental interventional option for the treatment of myofascial pain. There are many variations of these injections, including dry needling, local anesthetic-only injections, and the injection of local anesthetics combined with corticosteroid. These variations appear to have comparable efficacy. However, anecdotal clinical experience and the available literature on trigger-point injections suggest that the benefits achieved may not be sustained if performed in isolation. In general, pain relief lasts approximately 1–2 weeks when trigger-point injections are used as a stand-alone treatment. However, administration of these injections as one component of a comprehensive rehabilitation program, as mentioned above, may yield better results. The etiology, diagnosis, and treatment of myofascial cervical pain disorders will be discussed in greater detail elsewhere in this handbook.

Seronegative Spondyloarthropathies

Seronegative spondyloarthropathies are a group of inflammatory rheumatic diseases with common etiologic and clinical features. Clinically, patients have axial and peripheral inflammatory arthritis, enthesitis (inflammation at tendinous and ligamentous insertions points), extra-articular manifestations, and a close link with the presence of the HLA-B27 antigen (Olivieri, Barozzi, Padula, De Matteis, & Pavlica, 1998; Zochling & Smith, 2010). This group of arthropathies includes ankylosing spondylitis, Reiter's syndrome and reactive arthritis, psoriatic arthritis, arthritis associated with inflammatory bowel disease (IBD), ulcerative colitis and Crohn's disease, and other forms that do not meet criteria for definite categories, which are known as undifferentiated spondyloarthropathies (Zochling & Smith, 2010). Ankylosing spondylitis is by the far the most common of the seronegative spondyloarthropathies. It usually presents with lower back pain and stiffness. However, pain and stiffness in the cervical spine generally tend to develop after some years (Olivieri et al., 1998). Occasionally, neck pain may occur in the beginning stages of ankylosing spondylitis. However, some patients may complain of recurrent episodes of stiff neck or torticollis. Although an uncommon cause of cervical pain, seronegative arthritis should remain on the differential diagnosis list in cases that prove to be a diagnostic challenge.

Vascular Etiologies

Carotidynia is a historical diagnosis and an uncommon cause of neck pain that was first used by Fay, in 1927 (Stanbro, Gray, & Kellicut, 2011). The term is used to describe patients presenting with continuous or intermittent, dull, throbbing pain in the side of the neck located in the region of the carotid artery, sometimes radiating to the ipsilateral face and/or ear. The pain is typically exacerbated with light pressure. It can also be aggravated by neck movements, swallowing, or coughing. It has been related to various processes such as dissection, thrombosis, fibromuscular dysplasia, aneurysm, giant cell arteritis, or Takayasu's arteritis, as well as other nonvascular processes such as lymphedema, sialadenitis, peritonsillar abscess, or neck neoplasm, amongst others (Castrillo Sanz, Mendoza Rodríguez, Gil Polo, & Gutiérrez Ríos, 2011). Carotidynia has since been removed as a distinct disease entity and reclassified by the International Headache Society into a syndrome of unilateral neck pain (Stanbro et al., 2011). Currently, carotidynia remains a poorly understood and controversial subject.

Some authors continue to use the term to describe neck pain due to any etiology, whereas others maintain that it is a separate disease entity. It is important to recognize that the underlying vascular structures can be involved in the patient presenting with neck pain, and a high index of suspicion along with a thorough history and investigation must be performed by the clinician in order to rule out correctable or even life-threatening disease processes (Holland & Patel, 2010).

Fracture/Trauma

As this handbook is not intended to be for emergent evaluation and treatment, our discussion of fracture and trauma will be mostly limited to the clinic setting. Patients may present after a fall, blunt trauma, workplace accident, or motor-vehicle accident. Any subsequent neck pain should be evaluated seriously. One must be aware of potential cervical fracture, instability, and possible cord or nerve compromise. Suspicion should be particularly high in patients with predisposing factors, or “red flags,” that signify underlying pathologies that alter the spine, such as malignancy (unexplained weight loss, prior cancer history, failure to improve with conservative therapy), systemic diseases (osteoporosis, inflammatory arthritis), infection (history of intravenous drug abuse, fever), and medication use (corticosteroid). In such patients, increased axial loading of the spine can lead to end plate compression or burst fractures. However, fractures of any bony element of the spine can be seen. Bone pain is mediated by interosseous and periosteal C nerve fibers. Additionally, fracture of bony elements or alteration of intervertebral disc or ligamentous structures can lead to canal compromise or nerve compression. Neurologic changes along with cord compression should prompt early surgical intervention (Dvorak et al., 2007). Appropriate referral to a surgical specialist is based on clinical exam and imaging findings.

If trauma has occurred, patients can be stratified with the Canadian Cervical Spine Rule, assuming they are alert and have a Glasgow Coma Scale score of 15. High-risk patients include those older than 65 years of age, persons who have had a dangerous mechanism of injury (essentially any incident other than simple rear-end motor-vehicle collision, but please refer to reference), or who have upper extremity paresthesia (Margareta et al., 2008). These patients should undergo CT imaging (Margareta et al., 2008) which has better bony resolution than MRI, or if not available, then cervical plain films should be taken. Referral to an acute care setting should be made based on history and exam. Low-risk patients are screened initially as being able to sit in the waiting room, being ambulatory at any time, having had a simple rear-end collision, those who have delayed onset of neck pain, or those who do not have midline spinal tenderness. Patients who fit any of these criteria, and who are then able to actively rotate their head 45° in each direction, are deemed low risk and do not acutely require imaging (Childs et al., 2008; Margareta et al., 2008). If pain persists beyond 4–6 weeks despite symptomatic treatment, plain films can be taken to evaluate further.

There are no physical exam findings that are pathognomonic for fracture. However, tenderness with palpation over the spine is a commonly used sign. Interestingly, it has been found that return-to-work after surgery for cervical spine fracture can range anywhere from 1 to 26 weeks, depending on the injury (Lewkonia et al., 2012). In addition, there is significant controversy regarding expected functional limitations after such injuries, with surgeon opinions differing in literature.

Neoplasm

Neoplastic conditions represent a rare, albeit serious, etiology of neck pain. Estimates based on population studies calculate that neck pain due to serious conditions, such as infection or neoplasm, represents less than 0.4 % of all cases of neck pain (Bogduk, 2011a). Pain associated with neoplastic lesions is commonly noted to worsen with motion and at night. This is thought to be due to vascular engorgement while maintaining a recumbent position for a long period of time.

The symptoms will vary widely depending on the location and size of tumors within or around the spine, although patients often display other constitutional symptoms not commonly seen with other etiologies of neck pain. Neoplastic lesions in the cervical spine may represent primary or metastatic processes. Metastatic lesions are often due to breast, prostate, lung, or kidney cancer. Imaging studies often confirm the presence of a lesion, although biopsy may be required in order to determine the type of neoplasm and appropriate course of treatment (Hadler, 1999; Tollison & Satterthwaite, 1992).

Whiplash

Whiplash, as a clinical entity, was first introduced by H. E. Crowe in 1928 and has been a source of confusion and controversy since that time in both the medical and legal communities (Bannister, Amirfeyz, Kelley, & Gargan, 2009; Ferrari, 1999). Even the term "whiplash" has been a source of controversy. Originally, it described the mechanism of injury, namely rear-end collision in a motor-vehicle accident, but the term has grown to be synonymous with the injury resulting from this mechanism, as well as the constellation of symptoms surrounding the injury associated with the mechanism. At least there is some agreement at this time that the elements which define whiplash include neck pain, possibly resulting from injury, along with a variety of related symptoms that occur as a result of the forces applied to the head and neck during a motor-vehicle collision, usually a rear-end collision (Bannister, Amirfeyz, Kelley, & Gargan, 2009; Barnsley, Lord, & Bogduk, 1994; Ferrari, 1999). In fact, now terms such as "whiplash-associated disorder" or "late whiplash syndrome" have been coined to describe the spectrum of signs and symptoms seen after a whiplash injury, especially in the chronic setting. Gradations of severity have been proposed to further characterize the severity of whiplash-associated disorder (WAD) (Carroll et al., 2008; Poorbaugh, Brismee, Phelps, & Sizer, 2008). In Grade 0 WAD, the patient has no neck complaints and there are no physical signs of injury; thus, there is no whiplash. Grade I WAD indicates complaints of neck pain, stiffness, or tenderness without any physical signs, while Grade II WAD notes similar complaints, along with musculoskeletal physical signs such as decreased range of motion or point tenderness. Grade III WAD refers to neck complaints along with neurologic physical signs such as diminished deep tendon reflexes, weakness, and/or sensory deficits. Finally, Grade IV WAD indicates neck complaints in the setting of fractures or dislocations (see Table 3.2). Interest in the prevention, prognosis, and treatment of WAD has grown as its incidence has increased. While all agree that the syndrome is quite common, estimates vary on the actual incidence, ranging from 70 to 328 per 100,000 in North America (Walton, Pretty, Macdermid, & Teasell, 2009). Other authors have noted that estimation of the incidence is challenging due to the possibility of selection bias when utilizing insurance claims as a source for estimating true incidence (Barnsley et al., 1994). Further complicating the issue is that neck pain is exceedingly common, affecting up to 40 % of the general population at any one time, and may lead to overestimation of the true incidence (Hogg-Johnson et al., 2008). The economic burden associated with whiplash disorders has also drawn the interest of insurance providers and government policy makers to begin to make headway effective prevention and treatment strategies. In the USA, it is estimated that approximately 6 % of the population may suffer from chronic whiplash symptoms, with an annual medical cost of $10 billion

Table 3.2 Whiplash-associated disorder grading

	Signs	Symptoms
Grade 0	None	None
Grade I	None	Pain, stiffness, or tenderness
Grade II	Decreased cervical range of motion, point tenderness	Pain, stiffness, or tenderness
Grade III	Diminished/absent deep tendon reflexes, weakness, or sensory deficits	Pain, stiffness, or tenderness
Grade IV	Cervical fracture or dislocation	Pain, stiffness, or tenderness

(Poorbaugh et al., 2008) while in the UK, such costs are estimated to be $3.6 billion per year and represent 76 % of auto-insurance claims in that country (Bannister et al., 2009).

While a variety of symptoms have been described, all agree that the predominant feature of whiplash injury is neck pain. The neck pain should occur in conjunction with a motor-vehicle accident, although the pain may not occur immediately after the collision. It is quite common for the pain to begin several hours, or even a day, later (Bannister et al., 2009; Barnsley et al., 1994; Schofferman, Bogduk, & Slosar, 2007; Tollison & Satterthwaite, 1992). The next most common symptom seen in the acute phase of whiplash is headache. They may be unilateral or bilateral and are most commonly reported in the suboccipital region, although patients may describe referral patterns into other parts of the head (Schofferman et al., 2007). Other symptoms include neck stiffness, arm pain, low back pain, dizziness, visual disturbances, weakness, cognitive dysfunction, and psychological disturbances (Bannister et al., 2009; Barnsley et al., 1994; Tollison & Satterthwaite, 1992).

Of note, there has been much interest in pursuing the role of psychosocial disorders in whiplash disorders. An all-encompassing clinical description that ties together the mechanism of injury with quantifiable tissue injury has been largely lacking throughout most of the course of investigation of whiplash injuries. Such a lack of quantifiable injuries for so long led many to conclude that the pain reported from whiplash injuries was due to psychosomatic origin or malingering. This concept was sometimes referred to as "traumatic neurosis," in which symptoms were real but were not a result of actual physical injury (Barnsley et al., 1994; Ferrari, 1999). Comparisons of patients with chronic whiplash symptoms with patients who had non-whiplash chronic musculoskeletal pain displayed no difference in the prevalence or type of psychosocial conditions, and, furthermore, patients with chronic whiplash pain who obtained improvement with radio-frequency neurotomy also showed improvement with psychosocial testing as well (Wallis, Lord, & Bogduk, 1997). This would indicate that pain was driving the psychosocial disturbances, not the other way around. For decades, the lack of quantifiable tissue injury in whiplash drove many to discount the veracity of the diagnosis and led to the conclusion that whiplash syndromes were born from psychological, not physical, factors. This idea was bound to persist until researchers could posit a likely site or sites of physical injury to explain the symptoms seen in the clinical setting.

In a rear-end collision, the initial result of impact is forward acceleration of the target vehicle within 100 ms of impact. The force of the impact causes the vehicle to travel forward and, by extension, the car seat followed by the seated passenger's trunk and shoulders. Initially, the head has no force acting upon it and remains stationary due to its inertia. Studies have shown that such forces cause upward and forward displacement of the torso resulting in a sigmoid, or "S"-shaped, deformation where the lower cervical segments are in extension while the upper cervical segments are in flexion. As the head's inertia is overcome, it begins forward acceleration, mainly at the base of the skull where the cervical spine attaches, thus resulting in rearward rotation of the head. Following this, the head is "whipped" forward, using the neck as a lever and placing the neck in flexion. Any rotation of the neck present at the time of impact will place stress on the cervical elements, such as zygapophyseal joints, intervertebral discs, and ligaments, and the force of the impact will result in further rotation of the cervical spine and place further stresses on the said structures (Barnsley et al., 1994; Bogduk, 2011b; Poorbaugh et al., 2008; Schofferman et al., 2007). Studies have attempted to recreate such movements in an experimental environment in animal, human cadaver, and live human volunteer tests. One important concept born from such experiments is that of the change in velocity as a result of a collision, or the delta-V. This refers to the positive change in the velocity of the vehicle that is struck in a rear-end collision or, in contrast, the negative change in the velocity of the striking vehicle. The speed with which such a change in velocity occurs denotes acceleration and it is denoted in multiples of the acceleration of gravity, or g. For example, dropping an object results in acceleration of 1 g relative to the object. A more rapid acceleration requires greater force, thus researchers looked at the delta-V and *g*-forces sustained in collisions to try to determine the magnitude of such forces required to induce pain and/or injury. Also note that the mass of the vehicles involved will affect the relative transfer of force in a collision. For example, if a kindergartener and an NFL offensive lineman ran at the same speed and attempted to tackle the author, the force expended on the author would be drastically different due to the differences in mass of the striking objects. One could surmise that such differences in force expended would translate into greater delta-V and *g*-forces after being struck by the lineman and could, hypothetically, result in greater pain and/or injury in the author. Based on experimental studies, it appears that delta-V over 5 mph and acceleration in the 12–20 g range result only in mild, temporary pain in experimental models and would represent the minimum forces required to cause whiplash syndrome. In comparison, sneezing can induce 3 g acceleration on the neck, and falling from standing into a chair can result in 8 g acceleration on the neck (Ferrari, 1999). Review of postmortem studies of fatal MVC victims did show nonlethal injuries to the C-spine that were not visible on radiography. These included lesions to the zygapophyseal joints, intervertebral discs, and nerve roots (Bogduk, 2011b). While it is unclear whether such injuries would result in whiplash-like pain, as the studies were postmortem analyses, it is interesting to note that such injuries were unable to be visualized with radiographic imaging. Biomechanical studies show that the abnormal sigmoid deformation of the cervical spine in experimental whiplash models causes nonphysiologic movement of the cervical motion segment, such that there is rotation of the upper cervical segment relative to the lower segment, causing a pinching or grinding motion of the cervical zygapophyseal joint and a simultaneous distraction of the anterior longitudinal ligament and annulus fibrosis (Bogduk, 2011b; Poorbaugh et al., 2008; Schofferman et al., 2007). Such non-physiologic motions may result in articular or capsular injury of the zygapophyseal joints, as well as annular tears or disruption of the anterior longitudinal ligaments. Damage to the alar and transverse ligaments has been described in whiplash patients (Barnsley et al., 1994; Poorbaugh et al., 2008). Such injuries can contribute to pain and hypermobility in the atlantoaxial joints, though if such injuries are severe, it may result in compromise of the atlantoaxial joints causing severe neurologic injury or even death. Muscular injuries are commonly implicated in whiplash given the description of pain after whiplash injuries. Studies have shown elevated creatine kinase levels at 24 h post-injury in whiplash patients, although not at 48 h (Scott & Sanderson, 2002). Acute whiplash pain is thought to be due to muscular strain and tears which subsequently heal within 2 or 3 months, explaining the short course of pain experienced by most whiplash patients (Barnsley et al., 1994; Schofferman et al., 2007). The role of chronic muscular pathology in whiplash is poorly understood. There has been evidence in whiplash patients of transformation of neck muscle fibers from slower twitch, oxidative fibers to fast twitch, glycolytic fibers. While the causative factor for such transformation is unclear, it is theorized that since one of the primary responsibilities of neck musculature is the stabilization of the cervical spine, the overabundance of fast twitch fibers results in more rapid fatigue of these muscles. This fatigue limits muscular endurance, and it is thought to contribute to decreased cervical stability and worsening of muscle spasms (Poorbaugh et al., 2008). There is some evidence showing fatty infiltrates by T1-weighted MRI in the neck muscles of patients with chronic whiplash pain and, interestingly, not in the neck muscles of patients with chronic idiopathic neck pain nor in patients with only acute whiplash pains (Sterling, McLean, et al., 2011). While the development of a radiologically identifiable muscular lesion is interesting, to say the least, its role in the development of chronic whiplash pain is unclear and requires further study. Other reviewers conclude that, because cervical musculature overlies the zygapophyseal joints, tenderness elicited over these muscles may be due to those joints, especially if the clinician is unable to palpate bands or twitch response over the painful site (Barnsley et al., 1994). Insertion of the cervical multifidi muscles on cervical facet capsules are thought to contribute to pain with neck movement in the setting of zygapophyseal joint injury; thus, neck pain with movement may be more of a function of zygapophyseal pathology rather than muscular pathology (Anderson, Hsu, & Vasavad, 2005). Headache is the second-most commonly reported symptom in whiplash and is thought to be due to injury in the upper cervical segments because C2–3 zygapophyseal joint pain is often referred to the suboccipital region (Cooper et al., 2007) and the trigeminal nucleus has inputs from the C1–3 nerves which may result in referred pain in the trigeminal distribution from damage to these structures (Barnsley et al., 1994; Poorbaugh et al., 2008).

Vertebral artery dissection has also been shown to be more common in whiplash patients (Hauser, Zangger, Winter, Oertel, & Kesselring, 2010) and is postulated to be due to a combination of the non-physiologic movements of the cervical spine seen in whiplash patients and the torturous course of the vertebral arteries through the cervical region. While there is an association between vertebral artery flow anomalies and chronic whiplash symptoms, there is no diagnostic tool showing that such injuries contribute to neck pain in the setting of whiplash (Curatolo et al., 2011). Thus, acute whiplash pain is thought to be due to muscle strain which resolves with time, accounting for the majority of patients who have mild pain that resolves within 3 months. Other sites may be injured as a result of a motor-vehicle collision due to the abnormal physiologic movement of the spine and mainly include the cervical zygapophyseal joint, cervical intervertebral discs, and cervical ligaments, although muscles and vascular structures may also be damaged.

Many of the proposed sites of tissue injury in whiplash injury models are difficult to study in vivo as there are few diagnostic tools to rule in or rule out various structures. This is not the case, however, with the cervical zygapophyseal joints and, to a lesser degree, with the cervical intervertebral discs. The use of cervical medial branch nerve blocks to diagnose zygapophyseal joint pain is well established (Barnsley et al., 1993; Lord et al., 1995, 1996). These studies show that cervical zygapophyseal joint pain is responsible for approximately 50 % of chronic whiplash pain, as evidenced by relief with diagnostic blocks. These patients can then pursue cervical medial branch radio-frequency neurotomy for more long-lasting relief. Discogenic pain is thought to be mediated by its innervation from the sinuvertebral nerves from the ventral primary ramus of the spinal nerve (Bogduk, Windsor, & Inglis, 1988). Provocation discography can be used to diagnose pain arising from the cervical intervertebral discs in which distension of the disc by injection of contrast elicits pain concordant with the patient's usual pain, thus establishing the problem disc. The problem arises in that it can be difficult for the patient to determine whether pain elicited with discography is their usual pain (Barnsley et al., 1994). Furthermore, pain reproduced on discography has been effectively treated with zygapophyseal joint blocks (Aprill & Bogduk, 1992), thus calling into question the reliability of discography in the diagnosis of discogenic pain. One model presented recommends diagnostic cervical medial branch nerve blocks in patients with chronic whiplash symptoms, as this represents the best studied diagnostic procedure and may reveal the source of up to one-half of chronic whiplash cases. If positive, radio-frequency neurotomy can be pursued and, if negative, consideration can be given to pursue provocative discography (Barnsley et al., 1994). Other potential sites of injury, such as ligaments, muscles, and vascular structures, do not have similar diagnostic tests of sufficient reliability to recommend at this time (Fig. 3.1).

While the natural course of whiplash injuries tends toward complete recovery in the majority of affected individuals, an alarming number of patients continue to experience pain many months or even years later. Estimates of the percentage of patients who reports acute whiplash symptoms that go on to have chronic symptoms vary greatly. Difficulty arises in defining the chronicity of whiplash syndromes in that studies utilize different end points and different populations to make such estimates. There is widespread

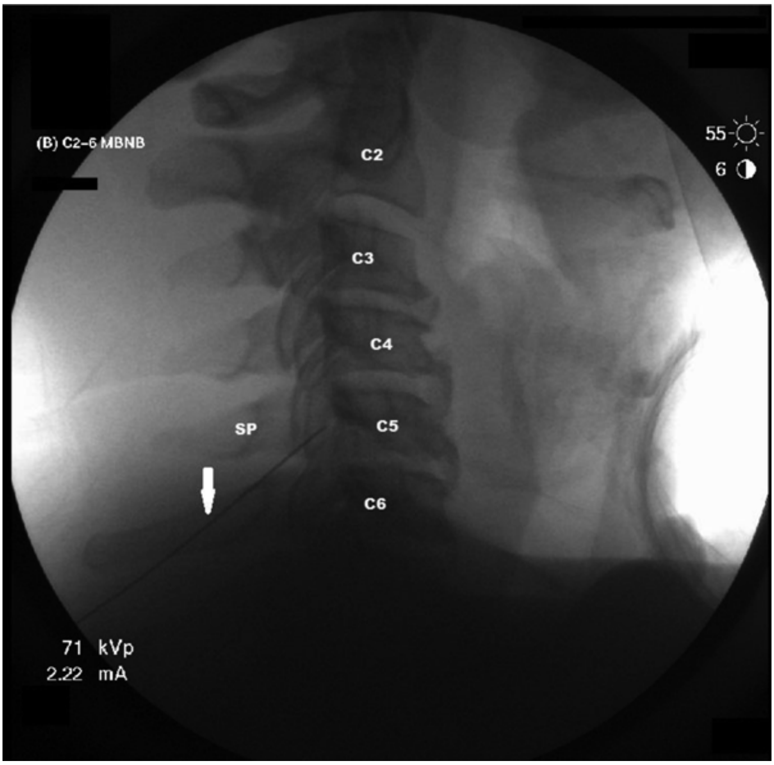

Fig. 3.1 Lateral radiographic image of diagnostic blockade of the C5 medial branch nerve for treatment of facetogenic pain. *SP* spinous process. *Arrow* needle. The needle tip can be visualized at the midsection of the C5 articular pillar

agreement that the percentage of whiplash patients that go on to note symptoms on a chronic basis ranges from 14 to 42 % and that up to 10 % will have severe pain and/or disability (Barnsley et al., 1994; Poorbaugh et al., 2008; Schofferman et al., 2007). Aside from potential anatomic lesions that may provide a source of pain, some theorize that other factors may contribute to the development of chronic whiplash syndromes. One such possibility is that hypersensitivity occurs due to augmentation of central nociceptive processing. Such changes can result in hyperalgesia and allodynia and are commonly seen in other chronic pain syndromes (Sterling, McLean, et al., 2011). A study comparing patients who had recovered from whiplash injury after 1 year to non-recovered patients showed increased peak pain and decreased endurance to cold pressor test (Kasch, Qerama, Bach, & Jensen, 2005). While not completely understood, such changes are thought to be multifactorial in origin depending on the nature of the inciting injury, psychosocial conditions, and stress-response systems. One interesting report studied whiplash patients and the genetic variation of the catechol-O-methyltransferase (COMT) gene, which is an enzyme that breaks down catecholamines. There was an association between the haplotype coding for the least enzyme activity, and thus the highest catecholamine levels, and the highest pain sensitivity (Diatchenko et al., 2005).

Much research has gone toward determining prognostic factors that may predict which patients will continue on to develop chronic whiplash pain. To be able to make such predictions with accuracy, it would help to identify at-risk patients and develop strategies to intervene prior to the development of chronic symptoms and, perhaps, blunt the course of the disease process. High initial levels of acute pain after collision are considered to be the best predictor of chronic symptoms (Bannister et al., 2009; Schofferman et al., 2007; Sterling, Carroll, Kasch, Kamper, & Stemper, 2011; Walton et al., 2009). Meta-analysis comparing WAD Grade III patients to WAD Grade II patients showed significant differences in initial symptom, but such differences lost significance by 24 months (Walton et al., 2009). Patients with Grade II or III WAD symptoms reported greater pain and functional limitations from 6 to 24 months post-collision when compared with Grade 0 or I WAD, although the inclusion of Grade 0 patients may skew the results as these patients do not have symptoms and, therefore, do not have whiplash (Sterner, Toolanen, Gerdle, & Hildingsson, 2003; Walton et al., 2009). Despite such limitations, high initial pain levels are still considered the strongest predictor of chronic whiplash symptoms. Age and gender are commonly studied variables as well. Age, in particular, has been a difficult factor to draw conclusions about due to different age cutoffs used in various studies. Many have found a positive association between either female gender or older age and chronic whiplash symptoms (Bannister et al., 2009; Barnsley et al., 1994; Carroll et al., 2008; Radanov, Stefano, Schnidrig, & Ballinari, 1991; Schofferman et al., 2007; Walton et al., 2009). The effect of age, though, was only modest in predicting persistent disability or speed of recovery, and there was no significant difference in persistent pain in patients over 50 (Carroll et al., 2008; Walton et al., 2009). Female gender was found to have, at best, modest predictive ability for chronic whiplash pain, although some studies showed no difference (Carroll et al., 2008). Lower educational status, usually defined as lack of postsecondary education, is noted to be another predictor for chronic whiplash pain and/or disability (Bannister et al., 2009; Carroll et al., 2008; Walton et al., 2009). Preexisting neck pain has also been found to be a strong predictor of chronic whiplash symptoms, but studies of this factor often used patient self-report to establish such a history, thus introducing a possible source of recall bias (Walton et al., 2009).

Passengers not wearing seat belts at the time of collision have also been found to be at higher risk for developing whiplash (Walton et al., 2009), but passengers in vehicles utilizing specialized seats and head restraint systems designed to absorb more of the force of impact have 50 % less permanent impairment (Kullgren, Krafft, Lie, & Tingvall, 2007). There is some concern regarding the veracity of such claims because the studies were supported by manufacturers, thus introducing a potential source of bias (Curatolo et al., 2011). As noted above, the presence of psychosocial disturbances in patients with chronic whiplash pain is more likely to be a result of chronic pain, rather than a causative factor. There is evidence that some psychosocial factors are associated with the development of chronic symptoms following whiplash. Depressive symptoms prior to whiplash injury may predict slower recovery (Carroll et al., 2008), but other reviewers report no significant difference based on this factor (Walton et al., 2009). Catastrophizing behaviors, on the other hand, are strongly associated with poor outcome following whiplash injury and indeed amongst many chronic pain syndromes. Such behaviors are characterized by focus on somatic symptoms, emotional distress, pronounced pain behaviors, and a defeatist attitude regarding outcomes (Nederhand, Ijzerman, Hermens, Turk, & Zilvold, 2004; Sterling, McLean, et al., 2011; Walton et al., 2009). Fear-avoidance behaviors are another potentially confounding psychosocial factor contributing to impairment in the setting of chronic pain. Such behaviors are characterized by a patient's fear and anxiety related to exacerbating pain leading to avoidance of physical activity, disuse, and deconditioning (Vlaeyen & Linton, 2000). Thus, many factors have been explored to attempt to find which ones will allow prediction of the development of chronic symptoms in whiplash patients. As research efforts continue, this list will likely change, but it appears that the best prognostic indicators of progression to chronic whiplash pain are higher initial pain intensity, WAD Grades II or III, prior history of neck pain, presence of abnormal cold pressor tests, and psychosocial disturbances such as catastrophizing or fear-avoidance behaviors. Some weaker prognostic indicators would include female gender, age >50 years, and lack of postsecondary education.

The effect of litigation related to chronic whiplash pain is another source of controversy as it represents a potential source of secondary gain. Contributing to this issue is the finding of vast differences in reporting of chronic whiplash in various countries that is often dependent on whether there is a legal means by which patients may seek financial compensation or disability status following motor-vehicle collisions resulting in chronic WADs. For example, recent data show that 76 % of personal injury claims in the UK are for whiplash disorders vs. about 5 % in France (Haddrill, 2008). The presence of such a disparity in chronic whiplash claims in societies where the medicolegal framework allows compensation for such issues has led to the belief that secondary gain or malingering is the cause of such differences. Such implications would suggest that post-litigants would show improvement in pain and disability as they have achieved their conscious or unconscious goal of obtaining compensation for the purported injury. A study comparing current and post-litigants, though, showed no difference in pain-related disability or psychosocial distress, but current litigants did report greater pain intensity in more locations and with greater impact on daily activities (Swartzman, Teasell, Shapiro, & McDermid, 1996). Prior reviews also refute the assertion that symptoms will improve following closing of litigation (Bannister et al., 2009; Mendelson, 1992; Schofferman et al., 2007). In fact, one prospective study comparing litigants and non-litigants with persistent whiplash symptoms undergoing radio-frequency medial branch neurotomy showed similar reductions in pain following the procedure, thus providing further evidence refuting the purported link between litigation status as a marker for secondary gain or malingering in chronic whiplash patients (Sapir & Gorup, 2001).

As treatment measures for chronic whiplash pain remain limited, some have focused on prevention to try to decrease the societal burden of such injuries. A consortium, representing the insurance industry in Britain, has four recommendations to help prevent motor-vehicle collisions which result in whiplash injuries or to mitigate the damage sustained in such collisions (Haddrill, 2008). The first recommendation involves changing driver behaviors, mainly in discouraging tailgating. This mainly involves teaching new driver tactics to estimate proper following distances, encouraging employers to institute similar policies in the workplace, and public awareness campaigns regarding the risk of tailgating behaviors. The second recommendation involves encouraging vehicle manufacturers to utilize anti-collision technologies utilizing systems akin to radar which determines the location of objects around a vehicle and coupled with alarms that alert the driver that collision is imminent or automated-braking systems that attempt to avoid such collisions. The third, proper head restraint positioning was recommended in which the top of the restraint is level with the top of the head and the back of the head is as close to the restraint as possible. Such positions allow the restraint to stop the motion of the head and neck during a collision and may decrease the risk of sustaining a whiplash injury by up to 24 % (Farmer, Wells, & Werner, 1999). Finally, manufacturers were encouraged to develop seats that more effectively absorb the force of a collision and potentially decrease the forces transmitted to passengers thus decreasing whiplash injuries. Such systems are widely utilized and advertised in European automobile fleets.

In conclusion, WADs are a common form of injury sustained mainly during motor-vehicle collisions. Such injuries are normally self-limited and resolve without intervention, but a substantial portion of patients reporting such injuries go on to report chronic pain and, less commonly, disability. While multiple potential sites of injury exist based on experimental data, the most clearly studied are the cervical zygapophyseal joints which appear to be responsible for roughly one-half of all chronic whiplash pain. While issues, such as underlying psychosocial problems and secondary gain or malingering, have been implicated as a source of these chronic pains, the evidence does not support such claims. High initial pain complaints, prior history of neck pain, evidence of hyperalgesic responses, and specific pain behaviors (such as catastrophizing or fear avoidance) are the best prognostic factors to date. Collision prevention and mitigation of injury during collisions represent a significant opportunity to prevent whiplash injuries or to limit the severity of such injuries.

Conclusions

In conclusion, cervical pain is a common complaint in the population and is a frequent source of disability amongst those of working age. The source of cervical pain is variable, and diagnosis requires knowledge of relevant anatomy, neurology, referral patterns, and mechanisms. Many times an in-depth history and physical exam is sufficient to establish the diagnosis, but at other times it may be necessary to obtain imaging, laboratory studies, electrophysiologic studies, or diagnostic procedures to establish the diagnosis. On a larger scale, it is important to consider other prognostic factors that contribute to development of cervical pain, from one's perception of the work environment to the design and manufacture of work implements. Careful evaluation of such elements by healthcare providers and policy makers could potentially result in improved outcomes following injury or perhaps even prevention of injury or disability.

References

Alexander, E. (2011). History, physical examination, and differential diagnosis of neck pain. *Physical Medicine and Rehabilitation Clinics of North America, 22*, 383–393.

Anderson, J. (1984). Shoulder pain and tension neck and their relation to work. *Scandinavian Journal of Work, Environment & Health, 10*, 435–442.

Anderson, J., Hsu, A., & Vasavad, A. (2005). Morphology, architecture and biomechanics of human cervical multifidus. *Spine, 30*, E86–E91.

Aprill, C., & Bogduk, N. (1992). The prevalence of cervical zygapophyseal joint pain: A first approximation. *Spine, 17*, 744–747.

Bannister, G., Amirfeyz, R., Kelley, S., & Gargan, M. (2009). Whiplash injury. *Journal of Bone and Joint Surgery (British), 91-B*, 845050.

Barnsley, L., Lord, S., & Bogduk, N. (1993). Comparative local anesthetic blocks in the diagnosis of cervical zygapophyseal joints pain. *Pain, 55*, 99–106.

Barnsley, L., Lord, S., & Bogduk, N. (1994). Whiplash injury. *Pain, 58*, 283–307.

Boden, S. D., McCowin, P. R., Davis, D. O., Dina, T. S., Mark, A. S., & Wiesel, S. (1990). Abnormal magnetic-resonance scans of the cervical spine in asymptomatic subjects. A prospective investigation. *Journal of Bone and Joint Surgery America, 72*, 1178–1184.

Bogduk, N. (2011a). The anatomy and pathophysiology of neck pain. *Physical Medicine & Rehabilitation Clinics of North America, 22*, 367–382.

Bogduk, N. (2011b). On cervical zygapophyseal joint pain after whiplash. *Spine, 36*(25S), S194–S199.

Bogduk, N., Windsor, M., & Inglis, A. (1988). The innervation of the cervical intervertebral discs. *Spine, 13*, 2–8.

Bogduk, N., Windsor, M., & Inglis, A. (1989). The innervation of the cervical intervertebral discs. *Spine, 13*, 2–8.

Borg-Stein, J., & Simons, D. G. (2002). Focused review: Myofascial pain. *Archives of Physical Medicine and Rehabilitation, 83*(3 Suppl. 1), S40–S47, S48–S49.

Carroll, L., Holm, L., Cote, P., Cassidy, J., Haldeman, S., Nordin, M., et al. (2008). Course and prognostic factors for neck pain in whiplash-associated disorders. Results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Spine, 33*(4 Suppl), S83–S92.

Carroll, L., Hogg-Johnson, S., Cote, P., van der Velde, G., Holm, L. W., Carragee, E. J., et al. (2011). Course and prognostic factors for neck pain in workers. *Spine, 33*(4S), S93–S100.

Carroll, L., Holm, L., Hogg-Johnson, S., Côté, P., Cassidy, J. D., Haldeman, S., et al. (2011). Course and prognostic factors for neck pain in whiplash-associated disorders. *Spine, 33*(4S), S83–S92.

Castrillo Sanz, A., Mendoza Rodríguez, A., Gil Polo, C., & Gutiérrez Ríos, R. (2011). Symptomatic carotidynia; neck pain of vascular origin (translated from Spanish). *Neurología, 26*, 310.

Childs, J. D., Cleland, J. A., Elliott, J. M., Teyhen, D. S., Wainner, R. S., Whitman, J. M., et al. (2008). Neck pain: Clinical practice guidelines linked to the international classification of functioning, disability, and health from the orthopaedic section of the American Physical Therapy Association. *Journal of Orthopaedic and Sports Physical Therapy, 38*(9), A1–A34.

Cooper, G., Bailey, B., & Bogduk, N. (2007). Cervical zygapophyseal joint pain maps. *Pain Medicine, 8*, 344–353.

Cote, P., Cassidy, J., & Carroll, L. (1998). The Saskatchewan health and back pain survey: The prevalence of neck pain and related disability in Saskatchewan adults. *Spine, 23*(15), 1689–1698.

Curatolo, M., Bogduk, N., Ivancic, P., McLean, S. A., Siegmund, G. P., & Winkelstein, B. A. (2011). The role of tissue damage in whiplash-associated disorders. *Spine, 36*(25S), S309–S315.

Dai, L. (1998). Disc degeneration and cervical instability. Correlation of magnetic resonance imaging with radiography. *Spine, 23*, 1734–1738.

Diatchenko, L., Slade, G., Nackley, A., Bhalang, K., Sigurdsson, A., Belfer, I., et al. (2005). Genetic basis for individual variations in pain perception and the development of a chronic pain condition. *Human Molecular Genetics, 14*, 135–143.

Dvorak, M., Fisher, C., Fehlings, M., Rampersaud, Y. R., Oner, F. C., Oner, B., et al. (2007). The surgical approach to subaxial cervical spine injuries: An evidence based algorithm based on the SLIC classification system. *Spine, 32*(23), 2620–2629.

Dwyer, A., Aprill, C., & Bogduk, N. (1990). Cervical zygapophyseal joint pain patterns: A study in normal volunteers. *Spine, 15*, 453–457.

Ehni, G. (1984). *Cervical arthrosis: Diseases of the cervical motion segments*. Chicago: Year Book Medical Publishers.

Ernst, C. W., Stadnik, T. W., Peeters, E., Breucq, C., & Osteaux, M. J. (2005). Prevalence of annular tears and disc herniations on MR images of the cervical spine in symptom free volunteers. *European Journal of Radiology, 55*, 409–414.

Farmer, C., Wells, J., & Werner, J. (1999). Relationship of head restraint positioning to driver injury in rear-end crashes. *Accident Analysis and Prevention, 31*, 719–728.

Ferrari, R. (1999). The Whiplash Encyclopedia: The Facts and Myths of Whiplash. Aspen Publishers, Gaithersburg.

Fishbain, D. A., Goldberg, M., Meagher, B. R., Steele, R., & Rosomoff, H. (1986). Male and female chronic pain patients categorized by DSM-III psychiatric diagnostic criteria. *Pain, 26*, 181–197.

Fricton, J. R., Kroening, R., Haley, D., & Siegert, R. (1985). Myofascial pain syndrome of the head and neck: A review of clinical characteristics of 164 patients. *Oral Surgery, Oral Medicine, and Oral Pathology, 60*, 615–623.

Gerwin, R. D. (1995). A study of 96 subjects examined both for fibromyalgia and myofascial pain [abstract]. *Journal of Musculoskeletal Pain, 3*(Suppl. 1), 121.

Haddrill, S. (2008). *Tackling whiplash: Prevention, care, compensation* (p. 6). London: Association of British Insurers.

Hadler, N. (1999). *Occupational musculoskeletal disorders* (2nd ed.). Philadelphia: Lippincott, Williams & Wilkins.

Hagberg, M., & Wegman, D. (1987). Prevalence rates and odds ratios of shoulder-neck diseases in different occupational groups. *British Journal of Industrial Medicine, 44*, 602–610.

Hauser, V., Zangger, P., Winter, Y., Oertel, W., & Kesselring, J. (2010). Late sequelae of whiplash injury with dissection of cervical arteries. *European Neurology, 64*, 214–218.

Hayashi, H., Okada, K., Hashimoto, J., Tada, K., & Ueno, R. (1988). Cervical spondylotic myelopathy in the aged patient. A radiographic evaluation of the aging changes in the cervical spine and etiologic factors of myelopathy. *Spine, 13*, 618–625.

Hertling, D., & Kessler, R. (2006). *Management of common musculoskeletal disorders* (4th ed.). Philadelphia: Lippincott, Williams & Wilkins.

Hogg-Johnson, S., van der Velde, G., Carroll, L., Holm, L. W., Cassidy, J. D., Guzman, J., et al. (2008). The burden and determinants of neck pain in the general population. Results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Spine, 33S*, S39–S51.

Holland, N. W., & Patel, B. B. (2010). A pain in the neck. *The American Journal of Medicine, 123*(6), 508–509.

Jacobs, J., Andersson, G., Bell, J., Weinstein, S., Dormans, J., Furman, M., et al. (2008). *Chapter 9: Health care utilization and economic cost of musculoskeletal diseases. In the burden of musculoskeletal diseases in the United States* (1st ed.). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Jaumard, N., Welch, W., & Winkelstein, B. (2011). Spinal facet joint biomechanics and mechanotransduction in normal, injury and degenerative conditions. *Journal of Biomechanical Engineering, 133*(7), 071010.

Jiang, S. D., Jiang, L. S., & Dai, L. Y. (2011). Degenerative cervical spondylolisthesis: A systematic review. *International Orthopaedics, 35*, 869–875.

Kaplan, P., & Tanner, E. (1989). *Musculoskeletal pain and disability*. Norwalk, CT: Appleton & Lange.

Kasch, H., Qerama, E., Bach, F., & Jensen, T. (2005). Reduced cold pressor pain tolerance in non-recovered whiplash patients: A 1-year prospective study. *European Journal of Pain, 9*, 561–569.

Kullgren, A., Krafft, M., Lie, A., & Tingvall, C. (2007). The effect of whiplash protection systems in real-life crashes and their correlation to consumer crash test programmes. In *Proceedings of the 20th international technical conference enhancement safety of vehicles*, Lyon

Kvarnstrom, S. (1983). Occurrence of musculoskeletal disorders in a manufacturing industry, with special attention to occupational shoulder disorders. *Scandinavian Journal of Rehabilitation Medicine. Supplement, 8*, 1–112.

Lang, A. M. (2003). Botulinum toxin type A therapy in chronic pain disorders. *Archives of Physical Medicine and Rehabilitation, 84*(3 Suppl. 1), S69–S73.

Lewkonia, P., DiPaola, C., Schouten, R., Noonan, V., Dvorak, M., & Fisher, C. (2012). An evidence based medicine process to determine outcomes after cervical spine trauma. *Spine, 37*(18), E1140–E1147.

Lord, S., Barnsley, L., & Bogduk, N. (1995). The utility of comparative local anaesthetic blocks versus placebo-controlled blocks for the diagnosis of cervical zygapophyseal joint pain. *Clinical Journal of Pain, 11*, 208–213.

Lord, S., Barnsley, L., Wallis, B., Bogduk, N., et al. (1996). Chronic cervical zygapophyseal joint pain after whiplash: A placebo-controlled prevalence study. *Spine, 21*, 1737–1745.

Lotz, J. C., & Ulrich, J. A. (2006). Innervation, inflammation, and hypermobility may characterize pathologic disc degeneration: Review of animal model data. *Journal of Bone and Joint Surgery America, 88*, 76–82.

Manchikanti, L., Dunbar, E. E., Wargo, B. W., Shah, R. V., Derby, R., & Cohen, S. P. (2009). Systematic review for cervical discography as a diagnostic test for chronic spinal pain. *Pain Physician, 12*, 305–321.

Margareta, N., Carragee, E., Hogg-Johnson, S., Weiner, S., Hurwitz, E., Peloso, P., et al. (2008). Assessment of neck pain and its associated disorders: Results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Spine, 33*(4 Suppl), S101–S122.

Matz, P. G., Anderson, P. A., Holly, L. T., Groff, M. W., Heary, R. F., Kaiser, M. G., et al. (2009). The natural history of cervical spondylotic myelopathy. *Journal of Neurosurgery: Spine, 11*, 104–111.

Mendelson, G. (1992). Compensation and chronic pain. *Pain, 48*, 121–123.

Mense, S., Simons, D. G., & Russell, I. J. (2001). *Muscle pain: Understanding its nature, diagnosis, and treatment*. Philadelphia: Lippincott, Williams & Wilkins.

Mercer, S., & Bogduk, N. (2001). Joints of the cervical vertebral column. *Journal of Orthopaedic and Sports Physical Therapy, 31*(40), 174–182.

Merskey, H., & Bogduk, N. (1994). *Classification of chronic pain. Descriptions of chronic pain syndromes and definition of pain terms* (2nd ed.). Seattle, WA: IASP Press.

Nederhand, M., Ijzerman, M., Hermens, H., Turk, D. C., & Zilvold, G. (2004). Predictive value of fear avoidance in developing chronic neck pain disability: Consequences for clinical decision making. *Archives of Physical Medicine and Rehabilitation, 85*, 496–501.

Nordin, M., Andersson, G., & Pope, M. (1997). *Musculoskeletal disorders in the workplace*. St. Louis, MO: Mosby.

Nordin, M., Carragee, E. J., Hogg-Johnson, S., Weiner, S. S., Hurwitz, E. L., Peloso, P. M., et al. (2009). Assessment of neck pain and its associated disorders: Results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Journal of Manipulative and Physiological Therapeutics, 32*(2), S117–S140.

Oda, J., Tanaka, H., & Tsuzuki, N. (1998). Intervertebral disc changes with aging of human cervical vertebra. From the neonate to the eighties. *Spine, 13*, 1205–1211.

Olivieri, I., Barozzi, L., Padula, A., De Matteis, M., & Pavlica, P. (1998). Clinical manifestations of seronegative spondyloarthropathies. *European Journal of Radiology, 27*, S3–S6.

Onan, O., Heggeness, M., & Hipp, J. (1998). A motion analysis of the cervical facet joint. *Spine, 23*(4), 430–439.

Poorbaugh, K., Brismee, J. M., Phelps, V., & Sizer, P. S. (2008). Late whiplash syndrome: A clinical science approach to evidence-based diagnosis and management. *Pain Practice, 8*(1), 65–89.

Radanov, B., Stefano, G., Schnidrig, A., & Ballinari, P. (1991). Role of psychosocial stress in recovery from common whiplash. *Lancet, 338*, 712–715.

Sapir, D., & Gorup, J. (2001). Radiofrequency medial branch neurotomy in litigant and nonlitigant patients with cervical whiplash: A prospective study. *Spine, 26*, E268–E273.

Schellhas, K. P., Smith, M. D., Gundry, C. R., & Pollei, S. R. (1996). Cervical discogenic pain. Prospective correlation of magnetic resonance imaging and discography in asymptomatic subjects and pain sufferers. *Spine, 21*, 300–311.

Schofferman, J., Bogduk, N., & Slosar, P. (2007). Chronic whiplash and whiplash-associated disorders: An evidence-based approach. *Journal of the American Academy of Orthopaedic Surgeons, 15*, 596–606.

Scott, S., & Sanderson, P. (2002). Whiplash: A biochemical study of muscle injury. *European Spine Journal, 11*, 389–392.

Simons, D. G., Travell, J. G., & Simons, P. T. (1999). *Travell and Simons' myofascial pain and dysfunction: the trigger point manual. Vol 1. Upper half of body*. Baltimore: Williams & Wilkins.

Skootsky, S. A., Jaeger, B., & Oye, R. K. (1989). Prevalence of myofascial pain in general internal medicine practice. *Western Journal of Medicine, 151*, 157–160.

Sohn, H. M., You, J. W., & Lee, J. Y. (2004). The relationship between disc degeneration and morphologic changes in the intervertebral foramen of the cervical spine: A cadaveric MRI and CT study. *Journal of Korean Medical Science, 19*, 101–106.

Stanbro, M., Gray, B. H., & Kellicut, D. C. (2011). Carotidynia: Revisiting an unfamiliar entity. *Annals of Vascular Surgery, 25*(8), 1144–1153.

Sterling, M., Carroll, L., Kasch, H., Kamper, S. J., & Stemper, B. (2011). Prognosis after whiplash injury. *Spine, 36*(25S), S330–S334.

Sterling, M., McLean, S., Sullivan, M., Elliott, J. M., Buitenhuis, J., & Kamper, S. J. (2011). Potential processes involved in the initiation and maintenance of whiplash-associated disorders. *Spine, 36*(25S), S322–S329.

Sterner, Y., Toolanen, G., Gerdle, B., & Hildingsson, C. (2003). The incidence of whiplash trauma and the effects of different factors on recovery. *Journal of Spinal Disorders & Techniques, 16*, 195–199.

Swartzman, L., Teasell, R., Shapiro, A., & McDermid, A. J. (1996). The effect of litigation status on adjustment to whiplash injury. *Spine, 21*, 53–58.

Tollison, C., & Satterthwaite, J. (1992). *Painful cervical trauma*. Baltimore: Williams & Wilkins.

Van Eerd, M., Patijn, J., Lataster, A., Rosenquist, R. W., van Kleef, M., Mekhail, N., et al. (2010). Cervical facet pain. *Pain Practice, 10*(2), 113–123.

Van Zundert, J., Huntoon, M., & Patijn, J. (2010). Cervical radicular pain. *Pain Practice, 10*(1), 1–17.

Vlaeyen, J., & Linton, S. (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: A state of the art. *Pain, 85*, 317–332.

Walker, M., Spitzer, E., Veeramani, M., & Russell, E. (2005). *Chapter 8: Anatomy, imaging and common pain-generating degenerative pathologies of the spine. In essentials of pain medicine and regional anesthesia* (2nd ed.). Philadelphia: Churchill Livingstone.

Wallis, B., Lord, S., & Bogduk, N. (1997). Resolution of psychological distress of whiplash patients following treatment by radiofrequency neurotomy: A randomized, double-blind, placebo-controlled trial. *Pain, 73*, 15–22.

Walton, D., Pretty, J., Macdermid, J., & Teasell, R. (2009). Risk factors for persistent problems following whiplash injury: Results of a systemic review and meta-analysis. *Journal of Orthopaedic and Sports Physical Therapy, 39*(5), 334–350.

Westerling, D., & Jonsson, B. (1980). Pain from the neck and shoulder region and sick leave. *Scandinavian Journal of Social Medicine, 8*, 131–136.

Yin, W., & Bogduk, N. (2008). The nature of neck pain in a private pain clinic in the United States. *Pain Medicine, 9*(2), 196–203.

Zheng, Y., Liew, S. M., & Simmons, E. D. (2004). Value of magnetic resonance imaging and discography in determining the level of cervical discectomy and fusion. *Spine, 29*, 2140–2145.

Zochling, J., & Smith, E. U. (2010). Seronegative spondyloarthritis. *Best Practice & Research. Clinical Rheumatology, 24*(6), 747–756.

Upper Extremity Pain

4

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Overview

Work-related upper extremity disorders (WRUEDs) are a major problem in modern society, and they represent the primary cause of absenteeism in North America and Western Europe (Health and Safety Executive (HSE), 2002; Punnett & Wegman, 2004). The impact of WRUEDs on workers themselves in terms of pain and disability is important, but these conditions, often chronic, also incur significant loss of quality of life and impact the workers' families, co-workers, and employers (Huang, Feuerstein, & Sauter, 2002; Punnett & Wegman, 2004). The productivity loss and economic costs of WRUEDs for society are substantial, and the economic burden of WRUEDs is increasing, despite efforts in prevention and implementation of novel intervention strategies for sustainable return to work (RTW) (Fabrizio, 2002; Feuerstein et al., 1993; Katz et al., 2000). At the outset, it should also be noted that WRUED is an "umbrella term" used to describe a wide range of disorders of the muscles, tendons, bursae, nerves, or blood vessels, potentially caused or aggravated by work, that may affect the neck/shoulder region, the shoulder itself, the elbow, the wrist, or the hand (Burton, Kendall, Pearce, Birrell, & Bainbridge, 2009; Zakaria, Robertson, MacDermid, Hartford, & Koval, 2002). These disorders range from those that are relatively well defined and specific (disorders with a well-defined set of diagnostic criteria established from evidence-based approaches) to those that are considered nonspecific (ill-defined disorders for which signs and symptoms may be present without a clear pattern allowing for a specific diagnosis) (Van Eerd et al., 2003). Numerous other terms have also been used to describe WRUED, such as cumulative trauma disorders, repetitive physical overuse, or repetitive strain injuries, but this lack of consensus on the definition of WRUED has led to confusion (Burton et al., 2009; Katz et al., 2000).

Workers suffering from WRUED will typically complain of physical symptoms, such as pain, paresthesia, stiffness, swelling, redness, or weakness, depending on the type of disorder.

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Workers may also report associated psychosocial complaints, such as anxiety, stress, depression, or irritability (Huisstede, Bierma-Zeinstra, Koes, & Verhaar, 2006; Staal, de Bie, & Hendriks, 2007). The etiology of these disorders seems to be multifactorial. Physical workplace factors have often been associated with WRUEDs, but nonphysical factors, such as personal and psychosocial factors inside and outside the workplace, may also play a role and contribute to the risk of developing WRUED. There is emerging evidence suggesting that a combination of exposures to these factors will increase the risk of developing a WRUED (Burton et al., 2009; Macfarlane, Hunt, & Silman, 2000). Adequate and effective treatment for workers suffering from a WRUED remains a challenge, although there is evidence that many treatment approaches are effective in reducing pain and disability. Some of these approaches, however, have been found to be less effective than expected for this population, suggesting that a multimodal approach, including workplace interventions for physical and nonphysical factors, may be more efficient (Burton et al., 2009; Health and Safety Executive (HSE), 2002). The direct and indirect costs of WRUED are also important, and workers' compensation claims have dramatically increased in the last decades. It is therefore important to better understand WRUEDs and to identify the most effective treatment to reduce the risk of long-term disability and to facilitate prompt RTW. In this chapter, we will present a review based on selected articles from the available literature in this field. In the first section of this chapter, we will look at the epidemiological data for WRUEDs in terms of incidence and prevalence, review risk factors, and present an overview of the direct and indirect costs associated with WRUEDs. In the second part of the chapter, we will present the most common WRUEDs and summarize the evidence regarding clinical intervention for these conditions. Finally, in the third and last section, we will look at RTW following a WRUED and at specific workplace strategies for intervention and prevention.

The Importance of WRUED

Epidemiology of WRUED

The epidemiology of WRUED is important to understand the nature of the problem and the natural history of these disorders, as well as to identify workers at risk for these disorders. First, it is important to mention that there is a very high background prevalence of upper extremity pain in the general population; some studies reported a 1-week prevalence as high as 50 % in the general population (Burton et al., 2009). Consequently, WRUED is also found to be very prevalent, but it remains difficult to establish its exact prevalence, as there is no consensus on the exact diagnostic labels or classification of these disorders. There is variability in the literature for the inclusion of neck disorders and whether or not they should be considered as an upper extremity disorder. In this chapter, neck disorders are not considered a WRUED and will be slightly discussed. Moreover, methodological issues related to data collection, such as whether the prevalence is based on a self-reported questionnaire, on clinician diagnosis, or retrieved from administrative data from workers' compensation agencies, also introduce variability in the estimation of prevalence or incidence (Huisstede et al., 2006; Zakaria et al., 2002).

A systematic review by Huisstede et al. that included studies with a cohort of at least 500 participants found that the point prevalence for WRUED may range from 30 to 47 % (Huisstede et al., 2006). Interestingly, in one of these studies, the point prevalence was measured first with a self-reported questionnaire and secondly with a physical examination of the positive cases found with the questionnaire. The point prevalence estimated by questionnaire was 47 % but dropped to 26.9 % following a clinical examination (Mccormack, Inman, Wells, Berntsen, & Imbus, 1990). In this systematic review, the 12-month prevalence for WRUED was found to range from 2.3 to 41 % in different populations of workers, either manual workers or office workers (Huisstede et al., 2006). Also, as expected, certain industries or occupations entail greater hazards for a WRUED (Buckle & Devereux, 1999; Burton et al., 2009). Prevalence of WRUED is highest in industries such as agriculture, fishery, forestry, mining, food packing, manufacturing, construction, wholesale, retail, or hotels and restaurants. Higher prevalence has also been found in certain specific occupations, such as loaders/unloaders, assembly line workers, postal workers, and clerical workers (Buckle & Devereux, 1999; Punnett & Wegman, 2004). Evidence suggests that WRUED affects women more often, potentially because of the type of work they do; still, gender differences because of personal, biological, or psychosocial factors may also be at cause (Huisstede et al., 2006; Zakaria et al., 2002). The shoulder is the region most frequently reported as symptomatic by workers suffering from a WRUED, followed by the wrist/hand; the elbow is the least frequent site of symptoms (Buckle & Devereux, 2002).

In terms of incidence, results from a systematic review found that the incidence rates have shown a dramatic increase in WRUEDs in the last decades (Zakaria et al., 2002). Changes in the work environment, such as the increase in productivity demands, increased use of computers, aging of the workforce, or workers' dissatisfaction, may explain this increased incidence (Staal et al., 2007; Zakaria et al., 2002). The authors cautioned, however, that other factors such as better reporting of WRUEDs and generous workers' compensation systems may also be responsible for the phenomenon and may not reflect an actual rise in the incidence of WRUED (Zakaria et al., 2002).

Economic Costs of WRUED

The economic costs of musculoskeletal (MSK) disorders are important, and future estimates indicate that the financial burden will continue to escalate (Boocock et al., 2007). In the USA, the overall burden for MSK disorders, including direct healthcare costs for medical treatment and rehabilitation and indirect costs in lost wages, has been estimated at $849 billion or 7.7 % of the national gross domestic product (American Academy of Orthopaedic Surgeons, 2011). In the State of Washington, one-third of workers' compensation costs in the private sector were estimated to be caused by a WRUED (Boocock et al., 2007; Silverstein, Viikari-Juntura, & Kalat, 2002). In the Netherlands, total direct and indirect yearly costs for WRUEDs were estimated at 2.1 billion euros. In terms of productivity loss, lost working days for the UK workers have been estimated at 4.7 million days in the fiscal year 2003–2004 (Bongers, Ijmker, van den Heuvel, & Blatter, 2006). It is important to point out that most data on economic costs are derived from administrative databases and that these numbers may underestimate actual costs associated with WRUEDs. For example, these estimates do not take into account productivity loss while at work (presenteeism). Emerging evidence suggests that most workers suffering from WRUEDs will not be absent from work for long periods of time, even though they continue suffering from pain and disability impacting their productivity (Baldwin & Butler, 2006). Although only a small fraction of workers with WRUEDs will be absent from work for long periods of time, WRUEDs are associated with the highest proportion of cases with work absence exceeding 31 days (Baldwin & Butler, 2006). The mean costs of WRUED-compensation claims have been estimated from databases in the USA and Canada and range between $5,000 and $8,000 per case. However, because of the highly skewed nature of the duration distribution of WRUED claims and work absences, measuring only the mean costs is not ideal. Webster and Snook found that 25 % of claims accounted for 89 % of the costs of WRUEDs (Webster & Snook, 1994). Other studies have since confirmed, similar to other work-related MSK disorders, that a minority of chronic cases exhibit lengthy spells of work absence and drive the overall healthcare costs (Baldwin & Butler, 2006).

Risk Factors for WRUED

Identifying and measuring risk factors for WRUEDs may help target workers at risk for WRUEDs and allow the implementation of preventive interventions to decrease the likelihood of their development (Burton et al., 2009). Although the body of literature on risk factors for WRUEDs is vast, at the present time, it remains difficult to identify workers who will develop a WRUED. One potential explanation for this situation is that WRUEDs have a multifactorial origin (Bongers et al., 2006). Although many classification schemes exist, possible risk factors for WRUED are often divided into three categories: 1—work-related physical factors; 2—work-related psychosocial factors; and 3—personal/sociodemographic factors (Buckle & Devereux, 2002; Burton et al., 2009; Staal et al., 2007; Zakaria et al., 2002). Multiple conceptual models have been developed to better understand the exact relationships among these factors and the onset of a WRUED. However, empirical support for such models is scarce (Bongers et al., 2006). Nonetheless, emerging evidence suggests that a combination of physical, psychosocial, and personal factors may be necessary for the development of a WRUED, but the exact amount of exposure to a given set of factors remains elusive and is further complicated by the fact that the influence of these factors may be mediated by demographic, cultural, and societal factors (Bongers et al., 2006; Burton et al., 2009; Staal et al., 2007). Methodologically, the majority of studies on risk factors have used a cross-sectional design, and often, the outcome of interest is poorly defined. For example, in many studies, it is not clear if the focus is on the association between a given risk factor and the first onset of symptoms, recurrence, need for care, disability, or work loss. These methodological limitations make it difficult to isolate a causal relationship between the given risk factors and the development of WRUED (Burton et al., 2009; Punnett & Wegman, 2004).

Work-Related Physical Risk Factors

Repetitious and Forceful Work: Initially, research focused mostly on work-related physical exposure, such as repetitiveness and forceful work (Bongers et al., 2006). A review by the National Institute for Occupational Safety and Health (NIOSH) in the USA concluded that there was evidence for a relationship between these occupational factors and the development of a WRUED (Bernard, 1997). Although a dose–response relationship is not always apparent in the studies, the associations are often strong, especially if exposure is prolonged. They are also believed to be causative because they are supported by plausible biomechanical and physiological mechanisms of action (Burton et al., 2009). Repetitious high-force tasks potentially increase physical stress on tendons and muscles, as well as a decrease of blood flow to these structures. Repetitiveness is thought to lead to fatigue and shorter time for recuperation, which induces metabolic changes that, in turn, lead to injury and inflammation. Muscles and tendons are hence likely to be at more risk of tears or microtears, ultimately translating at the individual level into pain and disability for the worker (Zakaria et al., 2002).

Awkward or Sustained Positions: Awkward or sustained positions have been found to be risk factors for a WRUED (Staal et al., 2007). For office workers, a systematic review concluded that ergonomic variables related to keyboard and mouse use, including use of more than 10–20 h per week, were risk factors for a WRUED (IJmker et al., 2007). For shoulder disorders, overhead work was also found to be a significant risk factor in manual laborers (Grieco, Molteni, De Vito, & Sias, 1998; Mayer, Kraus, & Ochsmann, 2012). Awkward positions put increased mechanical stress on muscles and tendons as they will be placed in biomechanical positions that are not optimal to complete the required tasks. Sustained positions may reduce blood flow or increase pressure on tendons, blood vessels, or nerves and may impede normal metabolism (Zakaria et al., 2002).

Cold Temperatures: A recent systematic review concluded that cold temperatures could be considered as a risk factor for tenosynovitis and for carpal tunnel syndrome (CTS). However, the association was considered small (van den Heuvel, van der Beek, Blatter, & Bongers, 2006). Cold temperatures may reduce blood flow and reduce neuromuscular function, leading to a need for greater force generation than necessary to complete tasks (Zakaria et al., 2002).

Vibrations: Exposure to vibrations has been recognized as a risk factor for hand–arm vibration syndrome (HAVS) for a long time (Buckle & Devereux, 1999). A more recent systematic review also found a strong association between exposure to vibrations and risk of shoulder complaints (odd ratio range: 1.6–2.5) (Mayer et al., 2012). Exposure to vibrations may produce a circulatory vasospasm that, in turn, induces sensory and motor nerve damage. It may also alter proprioception and cause a tonic vibration reflex that may damage soft tissue structures of the upper extremity (Zakaria et al., 2002).

Work-Related Psychosocial Factors

Psychosocial factors are believed to play an important role in the onset of a WRUED, especially if exposures to physical factors are also present (Staal et al., 2007). Most studies have looked at the association between the onset of a WRUED and perceived stress, work demands, control of work tasks, and social support from the work environment. One methodological issue with the literature for psychosocial risk factors is the definition of the type of exposures, as different models have been used to quantify the effect of these risk factors. Thus, comparing results across studies is difficult (Bongers et al., 2006).

Work Stress: Work stress is one of the most studied risk factors for WRUEDs. It is believed to illicit responses that increase muscle co-activation and thus increase loading of the MSK system. It may also reduce the ability to "unwind" and may hamper the ability to bring physiological activation to resting levels after work shifts in order to allow the worker to recuperate (Bongers, Kremer, & ter Laak, 2002). In epidemiological studies, high perceived work stress has consistently been found to be associated with WRUEDs, in both cross-sectional and longitudinal studies (Bongers et al., 2002, 2006).

Work Demands, Control over Work Tasks, and Social Support: More recently, models of risk factors that consider psychosocial demands at work have been developed. The demand–control–support model developed by Karasek and colleagues hypothesizes that high demand with low control of work leads to stress (Karasek, 2006). Stress will also be enhanced in the presence of low-work social support (Karasek, 2006). This model has received great attention, and many studies have looked at the association between these risks factors and the development of WRUEDs. A recent review found that the vast majority of cohort studies that looked at high demand, low control, or poor social support as potential risk factors for WRUEDs found at least one of these factors to be significantly associated with the risk of developing a WRUED. However, the combination of high demand and low control was only found to be significantly associated with neck/shoulder disorders and not with other upper extremity disorders (Staal et al., 2007).

Effort–Reward Imbalance (ERI): The ERI model of Siegrist is another model of psychosocial risk factors which has received attention (Siegrist, 1996). The assumption of the ERI model is that an imbalance between high efforts and low rewards at work will lead to adverse health effects, such as stress and cardiovascular diseases. Specifically for WRUEDs, three recent cohort studies found significant associations between the ERI model and the development of WRUEDs in cohorts of transit operators, hospital workers, and call center computer operators (Gillen et al., 2007; Krause, Burgel, & Rempel, 2010; Rugulies & Krause, 2008). However, another recent cross-sectional study, in a cohort of nurses, did not find such an association (Herin et al., 2011).

Personal and Sociodemographic Factors

Female gender and older age are risk factors for WRUEDs, which is consistent with the risks women and older people face for other MSK disorders (Zakaria et al., 2003). Comorbidities, such as the presence of other non-related MSK disorders or poor medical condition, as well as psychosocial distress and depressive symptoms, have all been identified as significant risk factors for the development of a WRUED (Bongers et al., 2006; Burton et al., 2009; Zakaria et al., 2002). Of note, body mass index is a consistent and important risk factor for CTS (Zakaria et al., 2002).

Classification of Work-Related Upper Extremity Disorders

The need for a single and simple classification system for WRUEDs is greatly needed. There is, however, no universally accepted classification system (Van Eerd et al., 2003). In fact, a proliferation of classification systems has been observed because different groups have tried to conceptualize these disorders (Van Eerd et al., 2003). According to a review by Van Eerd et al. (2003), more than 27 different classification systems have been proposed for WRUEDs. For a classification system to be effective, two clearly defined components are needed (Van Eerd et al., 2003). First, the disorders/syndromes must be identified and, second, the criteria for each disorder/syndrome should be presented. Boocock et al. proposed a classification system of WRUEDs that considers these two components (Boocock et al., 2009). Their model incorporates 14 specific conditions and one non-specific condition. Furthermore, 34 other specific conditions were also identified and included in their model in recognition of those conditions for which there are currently low prevalence rates, difficult or controversial diagnoses, and difficulties in establishing work relatedness (Boocock et al., 2009). The specific conditions are classified in five categories according to the type of condition: tendon-related, nerve-related, circulatory/vascular, and joint-related conditions, as well as pain syndromes.

Although, as in any classification system, the one proposed by Boocock and colleagues has some limitations (Miedema & Huisstede, 2009), it will be used in the present section to describe the types of WRUEDs. This classification was chosen because it is based on an extensive literature search of 15 electronic databases, supplemented by personal communications by the authors with representatives from national and international health and safety organizations (Van Eerd et al., 2003). Therefore, the next section describes the 14 WRUED-specific conditions defined by Boocock and colleagues. As there is very limited evidence on the effects of interventions for workers with WRUED for each of these specific conditions, a general presentation of the interventions suggested for these conditions in the general population is presented. However, later in this chapter, evidence is presented on the effects of interventions specifically designed for workers suffering from a WRUED.

Specific Conditions

Tendon-Related Specific Conditions

Flexor–Extensor Peritendinitis or Tenosynovitis of the Forearm–Wrist Region: This condition is defined as an inflammation of the extensor or flexor tendon sheaths at the wrist, characterized by intermittent pain located in the ventral or dorsal forearm or wrist region (Harrington, Carter, Birrell, & Gompertz, 1998). Pain may be associated with crepitus or local swelling of surrounding tendons (Boocock et al., 2009) and is elicited when grasping or picking up objects, when moving the wrist and hand, or when resisting movement of the affected tendons (Sluiter, Rest, & Frings-Dresen, 2001). Worksite modifications to provide rest from aggravating movements should be the initial treatment approach (Piligian et al., 2000). If symptoms persist, rehabilitation interventions may be added, as well as nonsteroidal anti-inflammatory drugs (NSAIDs). However, the long-term effect of NSAIDs remains to be shown (Almekinders & Temple, 1998). Few studies looked at the effect of rehabilitation modalities; still, the modalities widely used include myofascial release and deep friction massage, ultrasound, iontophoresis, stretching, and strengthening exercises (Piligian et al., 2000). For conditions unresponsive to conservative treatment, steroid injection or surgical intervention may be required.

De Quervain's Disease: De Quervain's disease is a stenosing tenosynovitis of the first dorsal compartment involving the tendons and synovial sheaths of the abductor pollicis longus and the extensor pollicis brevis (Ilyas, 2009). It is characterized by intermittent pain localized over the radial side of the wrist (radial styloid), which may radiate either proximally to the forearm or distally to the thumb, as well as by tender swelling of the first extensor compartment. Clinically, pain is provoked on resisted thumb extension, resisted thumb abduction, or on the Finkelstein's test (Sluiter et al., 2001). Treatment options include rest of the affected limb, modification of the workplace, thumb-spica splinting, therapeutic modalities such as stretching, and strengthening, medication (such as NSAIDs) and, in severe cases, cortisone injection (Ilyas, 2009; Piligian et al., 2000; Winzeler & Rosenstein, 1996). Certain movements, such as forceful radial deviation of the wrist with abduction and extension of the thumb, rapid rotational movements of the forearm, and repetitive movements of ulnar deviation of the wrist, should be initially avoided (Piligian et al., 2000; Putz-Anderson, 1988; Turek, Weinsten, & Buckwalter, 1994). If conservative treatment fails, then surgical debridement can be considered, although evidence of its efficacy is scarce.

Epicondylitis—Lateral and Medial: Epicondylitis is described as a lesion at the common extensor origin of the lateral epicondyle or at the origin of flexor–pronator of the anterior medial epicondyle (Harrington et al., 1998). It is characterized by activity-dependent (grasping or lifting objects) pain directly located around the lateral or medial epicondyle but sometimes radiating distally to the forearm. Clinically, pain is provoked on resisted wrist extension (lateral) or flexion (medial) (Sluiter et al., 2001). Work that requires manual tasks, with a combination of force and repetition in awkward positions, increases the risk of developing this condition (Coombes, Bisset, & Vicenzino, 2009). Untreated, complaints are estimated to last from 6 months to 2 years. Modifications of the worksite are usually the initial treatment approach for epicondylitis. Compression straps can also be used to minimize repetitive trauma of the tendon insertion (Piligian et al., 2000). For rehabilitation of lateral epicondylitis, a combination of concentric, eccentric, and isometric exercises with mobilization techniques at the elbow has been recommended (Coombes et al., 2009). For medial epicondylitis, rehabilitation interventions usually include gradual increase of tissue loading and manual therapy (Hume, Reid, & Edwards, 2006). Corticosteroid injections should be avoided as no long-term significant benefits have been demonstrated (Coombes et al., 2009). Surgery may be considered if conservative treatment fails; however, some studies suggest that it rarely leads to successful outcomes (Piligian et al., 2000).

Rotator Cuff Syndrome/Shoulder Tendonitis: Rotator cuff (RC) syndrome is the most common pathology of the shoulder (Chard, Hazleman, Hazleman, King, & Reiss, 1991; van der Windt, Koes, de Jong, & Bouter, 1995). It represents a spectrum of pathologies, ranging from subacromial bursitis to RC tendinopathy and full-thickness RC tears (Harrison & Flatow, 2011). Etiology is likely multifactorial, with contributions from external compression, age-related degeneration, trauma, and vascular compromise of the RC (Harrison & Flatow, 2011). Prevalence of RC disease has been shown to increase as a function of age, starting at 40 years of age, and to exceed 50 % by the age of 60 years (Seitz, McClure, Finucane, Boardman, & Michener, 2011). The main structures presenting inflammation and degeneration in the context of a RC syndrome are the subacromial bursa, rotator cuff tendons, and the long head of the biceps. Treatment usually includes activity/worksite modification, NSAIDs, and exercises. Strengthening of the scapulothoracic and scapulohumeral muscles, stretching, manual therapy, and motor control exercises have all been shown to be effective (Ellenbecker & Cools, 2010; Kromer, Tautenhahn, de Bie, Staal, & Bastiaenen, 2009; Kuhn, 2009). If conservative interventions fail, surgery can be considered, such as subacromial decompression. However, no difference has been observed between subacromial decompression and active non-operative treatment for RC syndrome (Ellenbecker & Cools, 2010; Kromer et al., 2009; Kuhn, 2009).

Nerve-Related Specific Conditions

Carpal Tunnel Syndrom: CTS is the most common entrapment neuropathy and involves gradual ischemia and mechanical deformation of the median nerve produced by elevated pressure within the carpal tunnel due to the compression of the median nerve under the flexor retinaculum (Werner & Andary, 2002). Clinical presentation involves symptoms of sensory (tingling, numbness, and pain) and motor impairments (weakness, loss of hand dexterity, and function) in the territory of the median nerve in the hand. Night complaints are common, and a subjective feeling of weakness and radiation of complaints can occur. Conservative management includes activity/worksite modification, night splinting, nerve gliding, and carpal bone passive mobilization, which have all been shown to improve symptoms (O'Connor, Marshall, & Massy-Westropp, 2003). Local corticosteroid injection has only been found to bring short-term clinical improvement, while NSAIDs are ineffective and oral steroid treatment improves in the short term the clinical symptoms, based on current evidence (Marshall, Tardif, & Ashworth, 2007; O'Connor et al., 2003). Patients with severe CTS or who failed conservative management could be offered surgical treatment such as carpal tunnel release.

Ulnar Nerve Compression at the Elbow (*Cubital Tunnel Syndrome*): It is the most common site of ulnar nerve compression and leads to complaints of paresthesia or numbness in the fourth and fifth digits and on the ulnar border of the forearm, wrist, or hand (Sluiter et al., 2001). Pain in the medial aspect of the elbow, which can radiate proximally or distally, has also been described (Piligian et al., 2000). Symptoms are usually worse during the night (Piligian et al., 2000). Clinical symptoms observed include loss of power grip or dexterity and weakness of ulnar intrinsic muscles of the hand. Symptoms are provoked with a combined pressure and flexion test. Mild cubital tunnel syndrome can often be treated without surgery if provocative causes can be avoided (Palmer & Hughes, 2010). Conservative treatment includes activity/worksite modification, splints to limit maximum and repetitive flexion, and nerve mobilization techniques (Palmer & Hughes, 2010; Robertson & Saratsiotis, 2005). Surgical treatment (such as in situ decompression) is indicated when non-operative treatment fails or in patients who present with more advanced clinical findings, such as motor weakness, muscle atrophy, or fixed sensory changes (Assmus et al., 2011).

Ulnar Nerve Compression at the Wrist (*Guyon's Canal Syndrome*): Compression of the ulnar nerve can also occur at the wrist in the Guyon's canal, which is located between the hamatum and pisiform bones (Sluiter et al., 2001). Patients usually complain of paresthesia or numbness in the fourth and fifth digits and of pain in the ulnar-innervated area of the hand. It does not affect the dorsal ulnar hand sensation because the dorsal branch rises proximal to the tunnel (Sluiter et al., 2001). Clinical signs include weakness or atrophy in the ulnar-innervated intrinsic hand muscles, and provocative signs include Tinel's sign, reversed Phalen's test, and pressure over the Guyon's canal (Sluiter et al., 2001). Suggested treatment is similar to other nerve-related conditions. First, activities that might cause the symptoms should be modified. Worksite modifications, splints to position the wrist in a resting position, and nerve mobilization techniques are suggested as part of conservative management. Again, decompression surgery is indicated when non-operative treatment fails or in the presence of severe symptoms.

Radial Nerve Compression—Radial Tunnel Syndrome (RTS): RTS is an entrapment of the radial nerve in the forearm (Sluiter et al., 2001). The nerve can be compressed at different sites along its trajectory in the upper limb (Sluiter et al., 2001). The signs and symptoms are related to the location of the compression. It is usually characterized by pain in the lateral elbow region or in the forearm muscle mass of the wrist extensors/supinator, positive tests for resisted forearm supination or middle finger extension, and sometimes weakness on extending the wrist and fingers (Sluiter et al., 2001). Initially, repetitive activities that require the wrist to be repeatedly bent backward or twisting motion should be avoided. According to the findings of a systematic review by Huisstede et al., surgical decompression of the radial tunnel might be effective in patients with RTS (Huisstede et al., 2008). The effectiveness of conservative treatments, such as splinting, rest, NSAIDs, work modification, and ergonomic modification, for RTS is unknown because, for most treatments, no studies are available (Huisstede et al., 2008).

Thoracic Outlet Syndrome (TOS): TOS is a cause of neck and upper limb pain due to a compression of the neurovascular bundle during its passage through the cervicothoracobrachial region (Harrington et al., 1998; Laulan et al., 2011). Various forms of TOS are distinguished: vascular forms (arterial or venous) and neurological forms, which are by far the most frequent as they represent more than 95 % of all cases (Laulan et al., 2011). Provocative signs include Adson's test, Wright's test, Roosj test, and Tinel's test. Conservative management includes activity/worksite modifications to minimize any risk factors and exercises to correct postural abnormalities, muscular imbalances, or joint stiffness (Ferrante, 2012). Surgery includes supraclavicular scalenectomy and transaxillary resection of the first rib (Laulan et al., 2011). According to results of a Cochrane review by Povlsen and colleagues, there is very low-quality evidence that transaxillary first rib resection decreased pain more than supraclavicular neuroplasty (Povlsen, Belzberg, Hansson, & Dorsi, 2010). There is no evidence supporting the use of other currently used treatments (Povlsen et al., 2010).

Circulatory/Vascular-Specific Conditions

Raynaud's Phenomenon and Peripheral Neuropathy Associated with Hand–Arm Vibration: HAVS is a potentially disabling condition comprising one or more specific neurological, vascular, and MSK features (Heaver, Goonetilleke, Ferguson, & Shiralkar, 2011). Raynaud's phenomenon is described as a local digital pallor upon exposure to cold or emotional stress (Sluiter et al., 2001). The vascular component of the HAVS is a form of secondary Raynaud's phenomenon, commonly called vibration-induced white finger (Sluiter et al., 2001). Clinical symptoms include pain or paresthesia in the digits, with well-demarcated local blanching of at least one finger, cold intolerance, and history of hand–arm vibration preceding symptoms (Piligian et al., 2000; Sluiter et al., 2001). In the early stage, recognition of early symptoms and exposure avoidance are the best form of intervention (Heaver et al., 2011). Further, splinting at night to treat the associated neuropathies can be used (Piligian et al., 2000). Some patients have found physical coping mechanisms that decrease the duration or severity of attacks, such as swinging the hands or warming them in water (Heaver et al., 2011). Pharmacological treatment, such as calcium channel antagonists, alpha-antagonists, and prostaglandins, may be indicated for severe cases, although there is very little evidence about their efficacy (Heaver et al., 2011). Surgical intervention, e.g., cervical sympathectomy, has been found unsuccessful for treating HAVS (Piligian et al., 2000).

Joint-Related Specific Conditions

Osteoarthritis (OA) *of Upper Extremity*: OA is a joint disease defined as a degeneration of the cartilage and subchondral bone, characterized by joint pain, swelling, early morning stiffness, or stiffness after a rest period (Helliwell, Bennett, Littlejohn, Muirden, & Wigley, 2003; Sluiter et al., 2001). Work-related OA of the upper extremity is mostly observed at the distal joints (elbow, wrist, carpal–metacarpal, and fingers—distal interphalangeal and proximal interphalangeal) (Sluiter et al., 2001). Clinical signs include restriction in active and passive movements of affected joints (Sluiter et al., 2001). Suggested conservative management includes the use of orthoses, adaptive equipment, patient education, modification of activities of daily living, exercise (such as strengthening, mobilization, and low-impact general conditioning), as well as heat and cold modalities (Beasley, 2012). Pharmacological approaches comprise the use of acetaminophen, oral or topical NSAIDs, hyaluronic acids, and glucocorticoids. Intra-articular steroid injections can be considered for short-term relief (Altman, 2010; Hinton, Moody, Davis, & Thomas, 2002). Surgical interventions can also be suggested, although they have not proven as successful as hip or knee arthroplasty.

Shoulder Capsulitis (*Frozen Shoulder*): It is characterized by spontaneous onset of shoulder pain, accompanied by progressive limitation of glenohumeral movement (Carette et al., 2003). Various degrees of inflammatory changes in the synovial membrane have been described in relation to frozen shoulder (Carette et al., 2003). Three overlapping phases are usually observed (Maund et al., 2012): *Phase 1* or painful phase—progressive stiffening and loss of motion with increasing pain on movement; *Phase 2* or stiffening phase—gradual decrease in pain but stiffness remains and there is considerable restriction in the range of movement; and *Phase 3* or resolution phase—improvement in range of movement. Regardless of stage, a rehabilitation program that includes mobilization and stretching, combined with home exercises, is recommended (Neviaser & Neviaser, 2011). The addition of corticosteroid injections to rehabilitation has been found to be more effective than rehabilitation alone (Carette et al., 2003). Most patients recover with nonsurgical treatment. Patients who do not improve can be treated surgically with procedures such as arthroscopic capsular release and manipulation under anesthesia (Neviaser & Neviaser, 2011).

Radiating Neck Complaints: Radiating neck complaints result from an inflammation of a cervical nerve root induced by a lesion reducing the intervertebral foramen (Langevin, Roy, & Desmeules, 2012; Radhakrishnan, Litchy, O'Fallon, & Kurland, 1994). This impingement typically produces neck and radiating arm pain or numbness, sensory deficits, or motor dysfunction in the neck and upper extremities (Eubanks, 2010). Specific symptoms include pain in the cervical or periscapular region and in the upper limb, as well as neurological signs such as paresthesia, numbness, weakness, and loss of reflexes in the affected nerve root distribution (Langevin et al., 2012; Radhakrishnan et al., 1994). Rehabilitation programs that include mobilization, traction, and stretching, strengthening, and postural exercises are usually the conservative treatment approach (Eubanks, 2010; Langevin et al., 2012). Pharmacotherapy, such as oral steroids, NSAIDs, and muscle relaxants, may be beneficial in alleviating acute pain. Cervical steroid injections or surgery may also be considered when nonoperative treatment fails or with severe symptoms.

Pain Syndrome

Fibromyalgia: Fibromyalgia is characterized by widespread body pain and multisystem complaints (Marcus, 2009). It is diagnosed in women 3–6 times more often than in men. According to the American College of Rheumatology, the diagnostic criteria for fibromyalgia are as follows: widespread pain index (WPI) ≥ 7 and symptom severity (SS) scale score ≥ 5 or WPI 3–6 and SS scale score ≥ 9; symptoms present at a similar level for at least 3 months; patient does not have a disorder that would otherwise explain the pain (Wolfe et al., 2010). The major drug classes considered for treatment of fibromyalgia include antidepressants, muscle relaxants, dopamine agonists, and analgesics (Wierwille, 2012), but there is conflicting evidence about their efficacy. Still, antidepressants have been shown to alleviate pain and relieve symptoms of depression (Wierwille, 2012). According to the results of systematic reviews by Brosseau et al., aerobic fitness and strengthening exercises are recommended (Brosseau et al., 2008a, 2008b). Finally, psychosocial therapies have a moderate to strong effect in reducing the severity of symptoms (Mease, 2005).

Other Specific Conditions

In the classification suggested by Boocock et al. (2009), 34 other specific conditions were identified. These are categorized into six

Table 4.1 Other specific conditions described by Boocock et al.

Tendon-related conditions	Nerve-related conditions	Muscle-related conditions	Joint-related conditions	Bursa-related conditions	Pain syndrome
Bicipital tendinitis	Digital neuritis	Cramp of the hand	Acromioclavicular syndrome	Bursitis/cellulitis of the hand or elbow	Arm myalgia
Dupuytren's contracture	Lateral antebrachial neuritis	Tension neck syndrome	Cervical degenerative disease	Olecranon bursitis	Arthralgia
Ganglion	Pronator teres syndrome		Glenohumeral joint degenerative disease	Subdeltoid bursitis	Cervicobrachial fibromyalgia
Intersection syndrome	Posterior interosseous nerve entrapment		Painful first metacarpal		Forearm myalgia
Linburg's syndrome	Wartenberg's syndrome				Intrinsic hand myalgia
Tendon disorders (forearm and hand)					Levator scapulae myalgia
Triceps tendonitis					Myalgia
					Shoulder pain
					Scapulothoracic pain syndrome
Trigger finger					Status post whiplash
					Thoracalgia
					Trapezius myalgia

groups: tendon-related conditions, nerve-related conditions, muscle-related conditions, joint-related conditions, bursa-related conditions, and pain syndromes. Table 4.1 presents the other work-related specific conditions.

Nonspecific Condition

A nonspecific condition category has also been included in the classification of Boocock et al. (2009). It is characterized by pain in the muscles, tendons, nerves, or joints, without evidence of a specific combination of symptoms and signs typical for one of the specific MSK disorders (Sluiter et al., 2001). Discomfort, fatigue, limited movement, and loss of muscle power can also be described. They have been grouped under the headings of "nonspecific diffuse forearm pain," "nonspecific upper limb disorder," and "nonspecific upper extremity musculoskeletal disorders" by different authors (Boocock et al., 2009; Harrington et al., 1998; Helliwell et al., 2003). As there are no diagnostic criteria, no study on specific interventions were found for the treatment of nonspecific conditions.

Clinical Interventions for Workers with WRUED

Conservative interventions such as those used by rehabilitation professionals play a major role in the treatment of WRUED (Piligian et al., 2000). In fact, several randomized controlled trials (RCTs) evaluated the effectiveness of these interventions in workers suffering from WRUED. Furthermore, at least three systematic reviews (Burton et al., 2009; Crawford & Laiou, 2007; Dick, Graveling, Munro, & Walker-Bone, 2011) and a Cochrane review (Verhagen et al., 2007) have been published on this topic. The next section will look at the results of the RCTs specifically designed for workers with WRUED and will summarize the conclusions of the systematic and Cochrane reviews. Of note, no RCT was found on the effects of surgical interventions specifically for workers suffering from WRUED.

Exercises: The effectiveness of exercise programs has been specifically assessed in at least five RCTs for workers with WRUED. First, Waling et al. allocated 103 women with nonspecific work-related neck/shoulder pain to one of the three exercise groups (strength training, endurance training, or coordination training) or a control group (Waling, Sundelin, Ahlgren, & Jarvholm, 2000). The results showed that all three exercise programs were better than no treatment (Waling et al., 2000). The exercise programs led to similar decreases in pain, indicating that the exact type of exercises may be of weak importance to achieve pain reduction (Waling et al., 2000). Two RCTs also looked at the efficacy of exercises as an add-on treatment in workers with upper extremity complaints. In the RCT by Omer et al., 50 workers with head, neck, shoulder, back, and wrist pain (most of them diagnosed as myofascial pain syndrome and CTS) were randomized into two groups: Group 1—mobilization, stretching, strengthening, and relaxation exercises 5 days a week for a period of 2 months, following a training course (education); or Group 2—training course only (Omer, Ozcan, Karan, & Ketenci, 2003/2004). The results showed that the program performed by Group 1 led to a higher reduction of pain and depression level in the short term as compared to Group 2. The long-term effect was not evaluated. In contrast, van den Heuvel et al. evaluated the effects of taking regular breaks and performing physical exercises for work-related neck and upper extremity disorders among computer workers and did not find any additional effect of the exercises (van Den Ende et al., 1996). In their study, 208 computer workers were randomized into a control group, one intervention group stimulated to take extra breaks, and one intervention group stimulated to perform exercises during the extra breaks (four physical exercises lasting 45 s) during an 8-week period. Intensity of performed exercises could have led to the differences in efficacy observed in these two studies.

Hagberg et al. evaluated whether isometric shoulder endurance was better than isometric shoulder strength training to reduce pain and perceived exertion and to increase shoulder function in 69 female industrial workers with nonspecific neck/shoulder pain (Hagberg, Harms-Ringdahl, Nisell, & Hjelm, 2000). Both training programs led to a significant decrease in pain. Finally, in an RCT using a crossover design, Sjögren et al. looked at the effects of a workplace physical exercise intervention on the perceived intensity of headache and the intensity of symptoms in the neck and shoulders. Fifty-three office workers reporting headache and neck and shoulder symptoms were allocated into one of the two treatment sequence groups: physical exercise intervention (15 weeks, progressive light resistance training and guidance on postural and movement control) followed by no intervention (15 weeks); or no intervention followed by physical exercise intervention. While the intervention led to a decrease in the intensity of headache and neck symptoms, it had no effect on shoulder symptoms. Based on the results of these RCTs, Verhagen et al., in their Cochrane review, concluded that there is conflicting evidence concerning the efficacy of exercises over no treatment or as an add-on treatment (Verhagen et al., 2006). No differences between various kinds of exercises were found.

Manual Therapy: Bang et al. evaluated the effect of manual therapy as an add-on treatment to exercises (Bang & Deyle, 2000). In their study, 52 workers diagnosed with RC syndrome were randomly assigned to the exercise group (supervised flexibility and strengthening exercises) or to the manual therapy group (same program with manual physical therapy). Subjects in both groups experienced significant decreases in pain and disability, but there was significantly more improvement in the manual therapy group. There is limited evidence for the efficacy of manual therapy for workers with RC syndrome as an add-on treatment to exercises (Verhagen et al., 2006). No evidence on manual therapy was found for other WRUEDs.

Ergonomics: Two RCTs evaluating the effects of ergonomic programs for workers with WRUED were found. First, Ketola et al. evaluated the effects of an intensive ergonomic approach and education on workstation changes and MSK disorders among workers who used a video display unit (Ketola et al., 2002). One hundred and twenty-five workers with symptoms in the neck, shoulders, or upper limb region were allocated to one of the three groups: intensive ergonomics (worksite visit by physiotherapists, workstation evaluation, and adjustments); ergonomic education (1-h training session in ergonomics); or reference (one-page leaflet). Conclusions were that, after 2 months, both the intensive ergonomics approach and education in ergonomics helped reduce MSK discomfort. The positive effects on discomfort were seen primarily for the shoulder, neck, and upper back areas. In an RCT by Lundblad, Elert, and Gerdle (1999), 97 female industrial workers with neck/shoulder complaints were randomized into one of the three groups: physiotherapy group (treatment according to an ergonomic program, 16 weeks); Feldenkrais group (education according to the Feldenkrais methodology, 16 weeks); or control group (no intervention). The ergonomic program had no effect at 1 year on neck and shoulder complaints and on disability. Furthermore, there was no difference between the Feldenkrais therapy (exercises) and the ergonomic program. Therefore, based on the results of these studies, there is conflicting evidence concerning the effectiveness of ergonomic programs over no treatment (Verhagen et al., 2006).

Three RCTs were found on the effects of computer keyboards with alternative geometry on workers with WRUED. First, Tittiranonda, Rempel, Armstrong, and Burastero (1999) compared the efficacy of a long-term (6-month) use of alternative geometry computer keyboards (three different keyboards were tested) or a placebo (standard keyboard as placebo) in computer users with CTS and wrist or forearm tendonitis. The use of two of the three types of alternative geometry computer keyboards led to an improving trend in pain severity and hand function following 6 months of use. Of note, a significant correlation was found between improvement of pain severity and greater satisfaction with the keyboards (Tittiranonda et al., 1999). Rempel et al. evaluated the effects of keyboard keyswitch design on computer users with hand paresthesias (Rempel, Tittiranonda, Burastero, Hudes, & So, 1999). Twenty computer users were assigned to one of the two groups for 12 weeks: a modified keyboard (looser keys with greater damping) or an unmodified keyboard. The use of the modified keyboard resulted in a significant reduction in pain. Finally, Ripat et al. randomized 68 symptomatic workers with WRUED to either a group receiving a commercially available ergonomic keyboard or a group receiving a modified version of the same keyboard designed to reduce activation force, vibration, and key travel (Ripat et al., 2006). At 6 months, both standard and ergonomic keyboard groups showed significantly reduced symptom severity and significantly improved functional status. Therefore, there is limited evidence that computer keyboards with altered force displacement characteristics or altered geometry are effective in reducing symptoms (Dick et al., 2011; Verhagen et al., 2006). Ergonomics will be further discussed later in the section on workplace interventions.

Graded Exposure to Pain-Related Fear: Some evidence suggests that pain-related fear influences the functional level of workers with WRUED (Huis 't Veld, Vollenbroek-Hutten, Groothuis-Oudshoorn, & Hermens, 2007; Karsdorp, Nijst, Goossens, & Vlaeyen, 2010). In studies performed on patients with low back pain (LBP) and neck pain, improved functional level has been demonstrated following interventions targeting catastrophic thinking and pain-related fear, also called graded exposure in vivo (GEXP) (Boersma et al., 2004; de Jong et al., 2008; Leeuw et al., 2007, 2008). While no RCT has, to our knowledge, evaluated the effect of GEXP in workers with WRUED, de Jong et al. evaluated this intervention in eight patients with WRUED reporting pain-related fear using a sequential single-case experimental phase design (de Jong, Vlaeyen, van Eijsden, Loo, & Onghena, 2012). The aim of GEXP was resumption of valued activities and restoration of a normal daily function, rather than pain reduction. Results showed that when GEXP was introduced, levels of pain catastrophizing and pain-related fear decreased significantly (de Jong et al., 2012). Clinically relevant improvements were also observed for pain and disability (de Jong et al., 2012). This study shows the potential of this intervention following WRUED. In conclusion, for the treatment of WRUED, exercises and ergonomic adjustments may be considered, despite the fact that the amount of evidence is still small (Staal et al., 2007). The lack of well-designed studies available for this population prevents from formulating more definite statements (Staal et al., 2007).

Return to Work

Outcomes of interest used in studies of WRUED have been highly inconsistent (Burton et al., 2009). Among them, work-related outcomes in WRUED have been relatively understudied (Baldwin & Butler, 2006). Because work outcomes do not necessarily correlate well with other health outcomes (Pransky, Loisel, & Anema, 2011), focusing specifically on RTW is essential in cases of WRUED. RTW has been defined and operationalized in many different ways (Schultz, Stowell, Feuerstein, & Gatchel, 2007). For example, cross-sectional dichotomous measures of RTW have been used in many studies, but these do not take into account recurrence of work absence after RTW (Dionne et al., 2007). Also, a worker may RTW, but not necessarily go back to the previous employer/job (Schultz et al., 2007). Other operationalizations of RTW have hence been proposed. For instance, Johnson, Baldwin, and Butler (1998) described four patterns of RTW for injured workers: RTW on first attempt, no RTW following no attempts, RTW after several attempts, and no RTW after several attempts. To this day, there is still no agreed upon taxonomy for RTW (Schultz et al., 2007). Furthermore, to add to the confusion, in studies attempting to identify predictors of occupational outcomes after injury, such as those affecting the upper extremity, the focus has mostly been on risk factors for occupational disability (e.g., sick leave, sickness absence), rather than on factors associated with going back to work (Schultz et al., 2007). Hence, in this section, we will present results of studies and reviews that include outcomes of work disability and RTW.

The Problem of Return to Work

In the last few decades, there has been an increasing number of compensation claims for WRUED (Baldwin & Butler, 2006). Similar to LBP, only a minority of workers with WRUED are absent from work for lengthy amounts of time, possibly 5 %, but this fraction of workers is associated with the greatest share of indemnity costs (Baldwin & Butler, 2006). Approximately one-third of workers with WRUED have been found to be at risk for prolonged work instability (Baldwin & Butler, 2006). WRUED, like LBP, is also characterized by recurrence in work absences (Baldwin & Butler, 2006). According to the results of a study by Baldwin and Butler (2006), most workers with WRUED RTW at least once, but they are even more susceptible to multiple work absences than workers with LBP. Among the group of workers who were off work at least once, 26 % of those presenting WRUED reported a second absence, while this percentage was 18 % for workers with LBP (Baldwin & Butler, 2006). Reviewing the literature shows that occupational disability and delays in RTW for WRUED are problematic, but a majority of workers eventually RTW (although they may present recurrent absences).

Predictors of Return to Work

On a theoretical and conceptual level, different models found in the literature show the potential influence of a great number of factors, spanning from the individual, to the workplace, to societal contexts, on RTW and occupational disability (Schultz et al., 2007). As an example, Loisel et al. visually presented what they call the “arena in work disability prevention,” a figure that highlights the multiple influences and interrelationships between aspects related to the workplace system, the legislative and insurance system, the healthcare system, and the worker’s personal system and coping (Loisel et al., 2005). The work disability problem is viewed from an individual and public health viewpoint. Work disability and failure to RTW are further regarded as multicausal (Briand, Durand, St-Arnaud, & Corbiere, 2008; Pransky et al., 2011), although the actual causal factors are yet to be identified.

On an empirical level, a limited number of studies have been conducted on predictors of RTW in workers with WRUED (Bot et al., 2007; Clay, Newstead, & McClure, 2010). Investigated factors have been classified in different ways. For example, Ijzelenberg et al. identified individual factors, work-related physical factors, as well as work-related psychosocial risk factors (Ijzelenberg, Molenaar, & Burdorf, 2004). Feuerstein et al. distinguished individual psychosocial variables, including job stress and satisfaction, from organizational psychosocial variables, encompassing co-worker support, for instance (Feuerstein, Shaw, Nicholas, & Huang, 2004). In a narrative review, Pomerance classified factors that delay or prevent RTW of workers with WRUED more generally as intrinsic or extrinsic to the worker (Pomerance, 2009). Inspired by these various conceptualizations and classifications, we present here findings regarding predictors of RTW in cases of WRUED on the individual, organizational, and system levels. However, we acknowledge that these categories are not mutually exclusive and are interrelated.

Individual-Level Factors: Individual-level factors include sociodemographic, injury-related, and psychosocial variables. Based on findings from Pomerance's (2009) review, women RTW up to 50 % later than men, while age has an unclear effect on RTW (Pomerance, 2009). Clay et al. recently published a systematic review on early prognostic determinants of RTW after acute orthopedic trauma resulting in upper or lower extremity injuries, some of which occurred during work (Clay, Newstead, & McClure, 2010). In this review, women were also at higher risk of prolonged work disability (Clay, Newstead, & McClure, 2010). The authors found that younger individuals, those with higher than average self-efficacy, and those with higher education are off work for a shorter time (Clay, Newstead, & McClure, 2010). Blue-collar workers and severely injured individuals were found to be at higher risk of prolonged work disability (Clay, Newstead, & McClure, 2010). Other individual-level factors that have been found to be associated with RTW include duration of work experience (Baldwin & Butler, 2006), pain attitudes (Clay, Newstead, Watson, & McClure, 2010), pain intensity (Feuerstein, Shaw, Lincoln, Miller, & Wood, 2003; Pomerance, 2009), behavioral factors (e.g., doctor shopping, recurrent absence from work), stress, coping skills, job satisfaction, and expectations (Clay, Newstead, Watson, et al., 2010; Pomerance, 2009). The role of individual factors in explaining RTW for workers with WRUED, especially individual psychosocial factors, however merits further study (Bongers et al., 2006).

Organizational-Level Factors: Organizational factors associated with RTW in workers with WRUED include physical, as well as psychosocial factors. Bot et al. conducted a prospective longitudinal study specifically looking at work-related physical and psychological workplace factors associated with sick leave in workers who consult their general practitioners for neck or upper extremity complaints (Bot et al., 2007). They found that heavy physical work increased the risk of sick leave, while prolonged sitting reduced sick leave in the subgroup of workers who worried a lot about their pain. Psychosocial workplace factors were not found to be related to sick leave in this study. According to the results of Burton et al.'s review, available studies indicate that there is strong evidence that workplace psychosocial factors, including beliefs, perceptions, and work organization, are associated with upper extremity disorders for numerous outcomes including symptom development and work absence (Burton et al., 2009). In Clay et al.'s systematic review (Clay, Newstead, & McClure, 2010), none of the included studies were found to have considered factors related to the work organization. The role of psychosocial work conditions, such as employer or co-worker support, in explaining RTW for workers with upper extremity disorders has also been given relatively little attention (Bongers et al., 2006).

System-Level Factors: System-level factors associated with RTW are related to healthcare and insurance systems, for instance. Although they may also be viewed as individual-level factors, compensation status and active litigation were found to be associated with delayed RTW in Pomerance's (2009) review. In Clay et al.'s review (Clay, Newstead, & McClure, 2010), workers not receiving compensation were also off work for a shorter time. The healthcare response (e.g., physician approach, stakeholder collaboration) is another example of system-level factors influencing RTW in workers with WRUED (Pomerance, 2009). Because they did not view compensation as a system-level factor, Clay et al. stated they did not find any studies on policy/system factors. Still, this indicates that further study is required (Clay, Newstead, & McClure, 2010).

Intervention and Prevention in the Workplace

Faced with the burden of WRUED on the personal and societal levels, a great number of interventions have been put forward in the broad healthcare field. Because multiple factors contribute to the onset of WRUED and their persistence over time, the interventions to put into place should target these different factors (Briand et al., 2008; Burton et al., 2009; Feuerstein & Harrington, 2006; Kennedy et al., 2010; Noonan & Wagner, 2010; Pransky, Robertson, & Moon, 2002; Staal et al., 2007). Based on a review, Kennedy et al. concluded that single interventions tended to offer no effects, hence suggesting that different types of interventions should be combined (Kennedy et al., 2010). Current evidence does not support providing purely biomedical or workplace interventions alone (Burton et al., 2009). A multimodal approach based on a biopsychosocial model is preferred (Burton et al., 2009). Although there is wide consensus that multiple types of interventions are needed, the actual ingredients to put together vary across authors and the literature focusing specifically on WRUED is still emerging (Burton et al., 2009; Loisel et al., 2005). This section will focus on workplace-based interventions and prevention. Dick et al. defined a workplace intervention as "any action at a worker's place of work to improve the outcome of an existing upper limb disorder" (Dick et al., 2011). Kennedy et al. defined occupational health and safety interventions as interventions carried out in the workplace or mandated by the employer and "designed to reduce or prevent MSK symptoms, signs, disorders, injuries, claims and lost time" (Kennedy et al., 2010).

Usual healthcare interventions do not routinely entail workplace interventions. Indeed, rehabilitation programs traditionally focus on worker-related interventions, while workplace interventions such as disability management programs instigated by employers and insurers include changes in the work environment (Kennedy et al., 2010), such as organizational policy changes and physical workplace adjustments (Baril & Berthelette, 2000). Rehabilitation programs do not usually involve the employers who are observers in the RTW process but, in disability management programs, the employers take charge (at least partially) of the occupational disability (Shrey, 1996). Nonetheless, in some workplaces, clinical interventions take place onsite (e.g., physical therapy clinics, Kennedy et al., 2010), while certain rehabilitation programs also include workplace visits. Moreover, previous reviews on the effectiveness of interventions to reduce symptoms or prevent WRUED have mostly focused on clinical rather than workplace interventions (Kennedy et al., 2010).

Like many articles found in the literature (Burton et al., 2009), published reviews often include a broader range of MSK disorders than just upper extremity disorders (Kennedy et al., 2010). In a 2009 systematic review of RCTs on the effectiveness of workplace interventions aiming at RTW, van Oostrom et al. only found one study of workers with WRUED (van Oostrom et al., 2009). Their overall conclusion for the six studies retained was that, in comparison to usual care or clinical interventions, workplace interventions including changes in workplace station, organization, and environment, as well as case management, are effective to reduce sickness absence, but not for improving health outcomes such as pain and symptoms (van Oostrom et al., 2009). In a content analysis of studies on RTW interventions for workers with various MSK conditions, Briand et al. reported that the essential components of RTW programs are centralized coordination, formal psychological and occupational interventions, changes in the workplace environment, contact between stakeholders, and interventions to promote concerted action between them (Briand et al., 2008).

Ergonomics

Ergonomics is probably the form of workplace intervention most often cited and studied in the literature specifically on WRUED. Nonetheless, there is great variety and confusion regarding the nature of ergonomics, terms used to refer to ergonomics, as well as content of ergonomics-related interventions (Loisel et al., 2005). For example, according to Dick et al., ergonomic training includes education sessions for workers and also more action-based training, both varying in length and intensity (Dick et al., 2011). As for ergonomic interventions, they include actions such as workstation assessments and adjustments (Dick et al., 2011). There has also been a call for ergonomics to go beyond posture and forces in order to consider aspects such as work styles, gender, and weight (Feuerstein & Harrington, 2006). In a recent systematic review, Dick et al. examined the effectiveness of workplace interventions for WRUED, mainly ergonomics, to prevent or reduce sickness absence, retain one's normal job, or prevent ill-health/retirement (Dick et al., 2011). In this review, upper limb disorders included CTS, nonspecific arm pain, extensor tenosynovitis, and lateral epicondylitis but excluded neck/shoulder pain. Based on their detailed analyses of 28 papers, the authors found limited evidence for the use of alternative keyboards to reduce CTS and tenosynovitis and lacking evidence for workplace interventions for epicondylitis (Dick et al., 2011). Similar findings were obtained in a systematic review on the use of specific keyboards with alternative force displacement of the keys or alternative geometry for workers with CTS (Verhagen et al., 2009). Another review by Burton et al. also found limited evidence for alternative mouse or keyboards to reduce pain in office workers and insufficient evidence for changes in equipment in the manufacturing industry (Burton et al., 2009). Studies on the effectiveness of arm supports showed moderate evidence of positive effects (Kennedy et al., 2010). Dick et al. concluded that there was moderate evidence that ergonomic work redesign targeting equipment or work organization does not reduce the incidence and prevalence of WRUED (Dick et al., 2011), although such interventions may improve worker comfort, which is non-negligible (Burton et al., 2009). Mixed results have indeed been reported for the effectiveness of ergonomic training and interventions (Dick et al., 2011). Also, according to Burton et al., giving too much attention to ergonomic interventions may send the message that work is the major cause of WRUED (Burton et al., 2009), which may be damaging for the worker because the epidemiology of the condition does not support such an affirmation. Furthermore, adopting a purely ergonomic approach to intervention is insufficient (Feuerstein & Harrington, 2006), although these forms of interventions have been by far the most prevalent. For example, Kennedy et al. found strong evidence that workstation adjustments alone are not effective (Kennedy et al., 2010). Integrating interventions addressing ergonomic and psychosocial factors, for instance, could be helpful in promoting return to regular work of workers having suffered an upper extremity injury (Shaw, Feuerstein, Lincoln, Miller, & Wood, 2001).

Work Organization and Other Interventions

Other workplace interventions have been discussed in the literature. For example, the potential role of case managers has been recommended to facilitate RTW following upper extremity injury

(Burton et al., 2009; Shaw et al., 2001). Case managers can help workers address barriers to their RTW (e.g., by obtaining workplace accommodations and engaging workers in active problem-solving) (Shaw et al., 2001). In their review, Bongers et al. found inconclusive evidence for a positive effect of task rotation, task enrichment, and added rest breaks on upper extremity disorders and, at the most, promising evidence for management engagement (Bongers et al., 2006). The need to individually screen each worker to identify problem areas in order to consequently target the best-fitting interventions has also been suggested (Noonan & Wagner, 2010). Other examples of interventions in the workplace include training programs for stress control, promoting physical activity, and offering wellness programs, but little is known of their effectiveness in WRUED (Pransky et al., 2002). Kennedy et al. found mixed evidence for the effectiveness of exercise programs, and exercise programs combined with ergonomics training (Kennedy et al., 2010). There was moderate evidence that biofeedback and job stress management training taken separately were not effective. The evidence was limited for rest breaks and insufficient for rest breaks combined with exercise. Modified work, taking the form of "light duties," or gradual RTW through increasing demands in performance and time on the job may allow workers to gradually resume their tasks and reintegrate into the workplace, hopefully reducing stress, anxiety, and other psychosocial factors that may prevent RTW (Noonan & Wagner, 2010). Individual-level and organizational-level interventions may act on worker stress, for example, and consequently help alleviate upper extremity symptoms (Bongers et al., 2006). Studies examining the effectiveness of other work interventions such as work organization are rather scarce. This has notably been justified by the methodological challenges they entail (Bongers et al., 2006).

Prevention

Preventive efforts need to address modifiable risk factors (Bongers et al., 2006; Staal et al., 2007). However, further work is needed in the area of prevention of WRUED. Overall, as a field, work disability prevention is emerging (Loisel et al., 2005). Compared to LBP, upper extremity disorders have received much less attention in work disability prevention (Loisel et al., 2005). The effectiveness of interventions aiming to prevent the development of WRUED, thought as *primary prevention*, has been largely understudied (Bongers et al., 2006). For instance, the evidence on the effectiveness of broad injury prevention programs and injury prevention programs with physical therapy was insufficient in a recent systematic review by Kennedy et al. examining the effectiveness of occupational health and safety interventions on upper extremity disorders in terms of symptoms, signs, disorders, injuries, claims, or lost time (mostly in office work) (Kennedy et al., 2010). Briand et al. described RTW interventions as *tertiary prevention*, aiming to reduce the consequences of work absence, while the goal of *secondary prevention* interventions is to avoid absence from work (Briand et al., 2008). In the literature addressing specifically the prevention of WRUED, distinctions between primary, secondary, and tertiary prevention measures have not been routinely made. Studies also often address more than one level of action. In Kennedy et al.'s review, some of the studies addressed only primary ($n=9$) or secondary prevention ($n=8$), 15 were a mix of both, two were a mix of secondary and tertiary prevention, and two others were a mix of primary, secondary, and tertiary prevention (Kennedy et al., 2010). Overall, the authors concluded that the level of evidence was mixed for the effectiveness of occupational health and safety interventions on upper extremity disorders outcomes, with medium- and high-quality studies having provided inconsistent results (Kennedy et al., 2010). Such pooled results do not allow to distinguish the effectiveness of primary, secondary, and tertiary prevention. Future studies related to prevention in cases of WRUED should clearly identify their level(s) of action in order to help develop knowledge in this area and identify the best targets of action to aim for in order to improve effectiveness of preventive efforts. For instance, Staal et al. suggested that because incapacitating WRUED only affect a minority of the working population, preventive efforts should only target high-risk groups or workers already presenting symptoms (Staal et al., 2007).

Stakeholder Involvement and Collaboration

In the last few decades, collaboration and teamwork have been highly promoted in fields such as healthcare and management. One of the underlying rationales for the promotion of interprofessional collaboration in health systems has been that it allows to better respond to the healthcare needs of people presenting with complex conditions (Oandasan et al., 2006). Literature on WRUED certainly is aligned with this affirmation, numerous authors having called for the coming together of different stakeholders, including from the workplace, in the management of WRUED. Contacts between stakeholders and concerted actions are essential components of RTW programs (Briand et al., 2008). Noonan and Wagner stated that RTW efforts necessitate involvement and communication among all stakeholders (Noonan & Wagner, 2010). Using an interdisciplinary approach for WRUED could allow to address the multiple factors that contribute to their persistence, but these types of interventions remain relatively uncommon (Feuerstein & Harrington, 2006). According to Feuerstein and Harrington, collaboration is needed between providers (e.g., ergonomists, medical and behavioral personnel, and the workplace), even though such processes may be challenging (Feuerstein & Harrington, 2006). For Pransky et al., building formal relations among stakeholders in the healthcare field, such as family physicians, occupational physicians, and occupational psychologists, and among managers, workers, and health providers could facilitate organizational changes related to work stress reduction, for instance (Pransky et al., 2002). In the same vein, going beyond biomedical treatment to address individual- and organizational-level psychosocial factors in a coordinated manner among all stakeholders could allow to influence work outcomes (Burton et al., 2009).

In a frequently cited systematic review on the effectiveness of workplace-based interventions for the RTW of workers presenting MSK or other painful conditions, Franche et al. found strong evidence that contacts between healthcare providers with the workplace reduced length of work disability duration (Franche et al., 2005). The evidence was moderate for the effectiveness of early contact with the worker by the workplace and presence of an RTW coordinator (Franche et al., 2005). For all of these interventions, there was moderate evidence of reduced costs associated with work disability but inconclusive results on sustainability of overall effects and for any effects on quality of life outcomes (Franche et al., 2005). Empirical research is nonetheless lacking in the area of WRUED.

Barriers to Workplace Interventions and Related Research

Relatively few studies have until now included workplace interventions for WRUED. One possible reason for this narrow knowledge base on the effects of workplace interventions may be the complexity of implementing at least some interventions (for instance, those requiring important physical changes in the workplace). Briand et al. suggested that interventions involving the work environment and concerted action among stakeholders required the most investment in energy, notably because establishing common ground in terms of work rehabilitation and its implementation may be a challenge (Briand et al., 2008). Actions and attitudes of management and co-workers appear as important factors for the success of workplace-based interventions for workers with MSK disorders (Loisel et al., 2005; Pransky et al., 2002). The lack of consideration for worker health and safety in many organizations is notably viewed as a barrier to prevention and effective management (Feuerstein & Harrington, 2006). Just gaining access to workplaces is not necessarily an easy task. As stated by Feuerstein and Harrington, “characteristics and realities of many workplaces make certain assessments and interventions either difficult to conduct or insensitive to the realities of the modern workplace" (Feuerstein & Harrington, 2006). The dynamic nature of the work, characterized by fluctuations in tasks, work areas, required work postures, or technological advances, is another barrier to the implementation of multifaceted interventions in the workplace (Feuerstein & Harrington, 2006). Changes within the insurance systems, such as workers' compensation boards, are also most likely needed (Feuerstein & Harrington, 2006). Often, at the center of the interventions for workers with WRUED, healthcare providers also need to support the idea of RTW as an integral part of the rehabilitation process (Noonan & Wagner, 2010). Nonoccupational health providers have been viewed as not sufficiently prepared and knowledgeable about workplace risk factors, which negatively impacts received care and preventive efforts (Feuerstein & Harrington, 2006; Pransky et al., 2002). Healthcare providers should, for example, be able to identify factors associated with WRUED such as stress, using specific worker inquiry (Pransky et al., 2002). However, tools to assist healthcare providers in determining, for instance, work readiness and restrictions, such as specific guidelines, are also lacking (Pomerance, 2009).

Although controlled laboratory studies certainly are essential to develop the knowledge base on the efficacy of workplace interventions for WRUED, pragmatic studies occurring in the actual workplaces are needed in order to fully assess the real-life applicability and effectiveness of the interventions. Using RCTs as a gold standard to judge the quality of studies may not be adapted to the occupational health field, because the latter mostly comprises observational studies (Dick et al., 2011). Many studies on RTW have been retrospective until now and hence offer lower levels of evidence (Pomerance, 2009). Researchers studying the effectiveness of workplace interventions are faced with a number of challenges related to study design, control, and outcome/variable measurement (Pransky et al., 2002). Quality of studies comparing the effects of interventions may be limited by the impossibility of blinding participants to intervention allocation (Dick et al., 2011). For example, in studies looking at the effectiveness of using alternative keyboards compared to standard keyboards on outcomes of CTS, the uniqueness of the alternative keyboards makes blinding impossible (Dick et al., 2011). In addition, much emphasis has been given to subjective variables in the literature, such as perceived pain intensity (Pomerance, 2009). Outcomes related to the workplace, such as absenteeism, presenteeism, and return to previous employment, are seldom examined (Dick et al., 2011). Further use of RCTs examining the effects of interventions addressing biomechanical, biobehavioral, psychological, and organizational components has nonetheless been recommended (Feuerstein & Harrington, 2006). Case–control studies could also take place in small- and medium-size organizations where large trials could not be possible (Pomerance, 2009). Finally, in 2006, Feuerstein and Harrington stated that the occupational rehabilitation field had yet to create effective and efficient interventions for workers with upper extremity disorders that are founded on an existing clinical and epidemiological knowledge base (Feuerstein & Harrington, 2006). To this day, the overall quality of studies reporting on interventions in the workplace such as ergonomics has been said to be rather poor (Dick et al., 2011; Verhagen et al., 2009). Further efforts to design and evaluate workplace interventions are indeed needed (Loisel et al., 2005), notably studies outside the office sector (Kennedy et al., 2010).

Conclusions

In this chapter, we showed that WRUEDs are common and associated with substantial pain and functional limitations. We also showed that they lead to productivity loss and a significant economic burden, despite efforts in prevention and RTW intervention strategies. Unfortunately, because the etiology of WRUEDs is multifactorial, effective treatment for workers suffering from WRUEDs remains a challenge. The low level of available evidence also prevented us from formulating more definite conclusions. Nonetheless, in the last few years, the number of well-designed studies specific to the treatment of WRUEDs has been on the rise. There is indeed evidence that some interventions, such as exercises and ergonomic adjustments, can be effective in reducing pain and disability following a WRUED. Stronger recommendations on the best clinical, workplace, and preventive interventions will hopefully be possible in the next few years.

References

Almekinders, L. C., & Temple, J. D. (1998). Etiology, diagnosis, and treatment of tendonitis: An analysis of the literature. *Medicine and Science in Sports and Exercise, 30*(8), 1183–1190.

Altman, R. D. (2010). Pharmacological therapies for osteoarthritis of the hand: A review of the evidence. *Drugs and Aging, 27*(9), 729–745.

American Academy of Orthopaedic Surgeons. (2011). *The burden of musculoskeletal diseases in the United States, prevalence, societal and economic cost*. Rosemont, IL: American Academy of Orthopaedic Surgeons.

Assmus, H., Antoniadis, G., Bischoff, C., Hoffmann, R., Martini, A. K., Preissler, P., et al. (2011). Cubital tunnel syndrome—A review and management guidelines. *Central European Neurosurgery, 72*(2), 90–98.

Baldwin, M. L., & Butler, R. J. (2006). Upper extremity disorders in the workplace: Costs and outcomes beyond the first return to work. *Journal of Occupational Rehabilitation, 16*(3), 303–323.

Bang, M. D., & Deyle, G. D. (2000). Comparison of supervised exercise with and without manual physical therapy for patients with shoulder impingement syndrome. *Journal of Orthopaedic and Sports Physical Therapy, 30*(3), 126–137.

Baril, R., & Berthelette, D. (2000). *Les composantes et les déterminants organisationnels des interventions de maintien de lien d'emploi en entreprises*. Montréal: Institut de recherche en santé et sécurité du travail.

Beasley, J. (2012). Osteoarthritis and rheumatoid arthritis: Conservative therapeutic management. *Journal of Hand Therapy, 25*(2), 163–171.

Bernard, B. P. (1997). *Musculoskeletal disorders (MSDs) and workplace factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*. Cincinnati, OH: U.S. Department of Health and Human Services.

Boersma, K., Linton, S., Overmeer, T., Jansson, M., Vlaeyen, J., & de Jong, J. (2004). Lowering fear-avoidance and enhancing function through exposure in vivo. A multiple baseline study across six patients with back pain. *Pain, 108*(1–2), 8–16.

Bongers, P. M., Ijmker, S., van den Heuvel, S., & Blatter, B. M. (2006). Epidemiology of work related neck and upper limb problems: Psychosocial and personal risk factors (part I) and effective interventions from a bio behavioural perspective (part II). *Journal of Occupational Rehabilitation, 16*(3), 279–302.

Bongers, P. M., Kremer, A. M., & ter Laak, J. (2002). Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist?: A review of the epidemiological literature. *American Journal of Industrial Medicine, 41*(5), 315–342.

Boocock, M. G., Collier, J. M., McNair, P. J., Simmonds, M., Larmer, P. J., & Armstrong, B. (2009). A framework for the classification and diagnosis of work-related upper extremity conditions: Systematic review. *Seminars in Arthritis and Rheumatism, 38*(4), 296–311.

Boocock, M. G., McNair, P. J., Larmer, P. J., Armstrong, B., Collier, J., Simmonds, M., et al. (2007). Interventions for the prevention and management of neck/upper extremity musculoskeletal conditions: A systematic review. *Occupational and Environmental Medicine, 64*(5), 291–303.

Bot, S. D., Terwee, C. B., van der Windt, D. A., van der Beek, A. J., Bouter, L. M., & Dekker, J. (2007). Work-related physical and psychosocial risk factors for sick leave in patients with neck or upper extremity complaints. *International Archives of Occupational and Environmental Health, 80*(8), 733–741.

Briand, C., Durand, M. J., St-Arnaud, L., & Corbiere, M. (2008). How well do return-to-work interventions for musculoskeletal conditions address the multicausality of work disability? *Journal of Occupational Rehabilitation, 18*(2), 207–217.

Brosseau, L., Wells, G. A., Tugwell, P., Egan, M., Wilson, K. G., Dubouloz, C. J., et al. (2008a). Ottawa panel evidence-based clinical practice guidelines for strengthening exercises in the management of fibromyalgia: Part 2. *Physical Therapy, 88*(7), 873–886.

Brosseau, L., Wells, G. A., Tugwell, P., Egan, M., Wilson, K. G., Dubouloz, C. J., et al. (2008b). Ottawa panel evidence-based clinical practice guidelines for aerobic fitness exercises in the management of fibromyalgia: Part 1. *Physical Therapy, 88*(7), 857–871.

Buckle, P., & Devereux, J. (1999). *Work-related neck and upper limb musculoskeletal disorders*. Luxembourg: European Agency for Safety and Health at Work.

Buckle, P. W., & Devereux, J. J. (2002). The nature of work-related neck and upper limb musculoskeletal disorders. *Applied Ergonomics, 33*(3), 207–217.

Burton, A. K., Kendall, N. A., Pearce, B. G., Birrell, L. N., & Bainbridge, L. C. (2009). Management of work-relevant upper limb disorders: A review. *Occupational Medicine, 59*(1), 44–52.

Carette, S., Moffet, H., Tardif, J., Bessette, L., Morin, F., Frémont, P., et al. (2003). Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: A placebo-controlled trial. *Arthritis and Rheumatism, 48*(3), 829–838.

Chard, M. D., Hazleman, R., Hazleman, B. L., King, R. H., & Reiss, B. B. (1991). Shoulder disorders in the elderly: A community survey. *Arthritis and Rheumatism, 34*(6), 766–769.

Clay, F. J., Newstead, S. V., & McClure, R. J. (2010). A systematic review of early prognostic factors for return to work following acute orthopaedic trauma. *Injury, 41*(8), 787–803.

Clay, F. J., Newstead, S. V., Watson, W. L., & McClure, R. J. (2010). Determinants of return to work following non life threatening acute orthopaedic trauma: A prospective cohort study. *Journal of Rehabilitation Medicine, 42*(2), 162–169.

Coombes, B. K., Bisset, L., & Vicenzino, B. (2009). A new integrative model of lateral epicondylalgia. *British Journal of Sports Medicine, 43*(4), 252–258.

Crawford, J. O., & Laiou, E. (2007). Conservative treatment of work-related upper limb disorders: A review. *Occupational Medicine, 57*(1), 4–17.

de Jong, J. R., Vangronsveld, K., Peters, M. L., Goossens, M. E., Onghena, P., Bulté, I., et al. (2008). Reduction of pain-related fear and disability in post-traumatic neck pain: A replicated single-case experimental study of exposure in vivo. *The Journal of Pain, 9*(12), 1123–1134.

de Jong, J. R., Vlaeyen, J. W., van Eijsden, M., Loo, C., & Onghena, P. (2012). Reduction of pain-related fear and increased function and participation in work-related upper extremity pain (WRUEP): Effects of exposure in vivo. *Pain, 153*(10), 2109–2118.

Dick, F. D., Graveling, R. A., Munro, W., & Walker-Bone, K. (2011). Workplace management of upper limb disorders: A systematic review. *Occupational Medicine, 61*(1), 19–25.

Dionne, C. E., Bourbonnais, R., Frémont, P., Rossignol, M., Stock, S. R., Nouwen, A., et al. (2007). Determinants of "return to work in good health" among workers with back pain who consult in primary care settings: A 2-year prospective study. *European Spine Journal, 16*(5), 641–655.

Ellenbecker, T. S., & Cools, A. (2010). Rehabilitation of shoulder impingement syndrome and rotator cuff injuries: An evidence-based review. *British Journal of Sports Medicine, 44*(5), 319–327.

Eubanks, J. D. (2010). Cervical radiculopathy: Nonoperative management of neck pain and radicular symptoms. *American Family Physician, 81*(1), 33–40.

Fabrizio, A. J. (2002). Work-related upper extremity injuries: Prevalence, cost and risk factors in military and civilian populations. *Work, 18*(2), 115–121.

Ferrante, M. A. (2012). The thoracic outlet syndromes. *Muscle and Nerve, 45*(6), 780–795.

Feuerstein, M., Callan-Harris, S., Hickey, P., Dyer, D., Armbruster, W., & Carosella, A. M. (1993). Multidisciplinary rehabilitation of chronic work-related upper extremity disorders. Long-term effects. *Journal of Occupational Medicine, 35*(4), 396–403.

Feuerstein, M., & Harrington, C. B. (2006). Secondary prevention of work-related upper extremity disorders: Recommendations from the Annapolis conference. *Journal of Occupational Rehabilitation, 16*(3), 401–409.

Feuerstein, M., Shaw, W. S., Lincoln, A. E., Miller, V. I., & Wood, P. M. (2003). Clinical and workplace factors associated with a return to modified duty in work-related upper extremity disorders. *Pain, 102*(1–2), 51–61.

Feuerstein, M., Shaw, W. S., Nicholas, R. A., & Huang, G. D. (2004). From confounders to suspected risk factors: Psychosocial factors and work-related upper extremity disorders. *Journal of Electromyography and Kinesiology, 14*(1), 171–178.

Franche, R. L., Cullen, K., Clarke, J., Irvin, E., Sinclair, S., & Frank, J. (2005). Workplace-based return-to-work interventions: A systematic review of the quantitative literature. *Journal of Occupational Rehabilitation, 15*(4), 607–631.

Gillen, M., Yen, I. H., Trupin, L., Swig, L., Rugulies, R., Mullen, K., et al. (2007). The association of socioeconomic status and psychosocial and physical workplace factors with musculoskeletal injury in hospital workers. *American Journal of Industrial Medicine, 50*(4), 245–260.

Grieco, A., Molteni, G., De Vito, G., & Sias, N. (1998). Epidemiology of musculoskeletal disorders due to biomechanical overload. *Ergonomics, 41*(9), 1253–1260.

Hagberg, M., Harms-Ringdahl, K., Nisell, R., & Hjelm, E. W. (2000). Rehabilitation of neck-shoulder pain in women industrial workers: A randomized trial comparing isometric shoulder endurance training with isometric shoulder strength training. *Archives of Physical Medicine and Rehabilitation, 81*(8), 1051–1058.

Harrington, J. M., Carter, J. T., Birrell, L., & Gompertz, D. (1998). Surveillance case definitions for work related upper limb pain syndromes. *Occupational and Environmental Medicine, 55*(4), 264–271.

Harrison, A. K., & Flatow, E. L. (2011). Subacromial impingement syndrome. *Journal of the American Academy of Orthopaedic Surgeons, 19*(11), 701–708.

Health and Safety Executive (HSE). (2002). *Upper limb disorders in the workplace*. Surrey, England: HMSO.

Heaver, C., Goonetilleke, K. S., Ferguson, H., & Shiralkar, S. (2011). Hand-arm vibration syndrome: A common occupational hazard in industrialized countries. *The Journal of Hand Surgery, European Volume, 36*(5), 354–363.

Helliwell, P. S., Bennett, R. M., Littlejohn, G., Muirden, K. D., & Wigley, R. D. (2003). Towards epidemiological criteria for soft-tissue disorders of the arm. *Occupational Medicine, 53*(5), 313–319.

Herin, F., Paris, C., Levant, A., Vignaud, M. C., Sobaszek, A., & Soulat, J. M. (2011). Links between nurses' organisational work environment and upper limb musculoskeletal symptoms: Independently of effort-reward imbalance! The ORSOSA study. *Pain, 152*(9), 2006–2015.

Hinton, R., Moody, R. L., Davis, A. W., & Thomas, S. F. (2002). Osteoarthritis: Diagnosis and therapeutic considerations. *American Family Physician, 65*(5), 841–848.

Huang, G. D., Feuerstein, M., & Sauter, S. L. (2002). Occupational stress and work-related upper extremity disorders: Concepts and models. *American Journal of Industrial Medicine, 41*(5), 298–314.

Huis 't Veld, R. M., Vollenbroek-Hutten, M. M., Groothuis-Oudshoorn, K. C., & Hermens, H. J. (2007). The role of the fear-avoidance model in female workers with neck-shoulder pain related to computer work. *Clinical Journal of Pain, 23*(1), 28–34.

Huisstede, B. M., Bierma-Zeinstra, S. M., Koes, B. W., & Verhaar, J. A. (2006). Incidence and prevalence of upper-extremity musculoskeletal disorders. A systematic appraisal of the literature. *BMC Musculoskeletal Disorders, 7*, 7.

Huisstede, B., Miedema, H. S., van Opstal, T., de Ronde, M. T., Verhaar, J. A., & Koes, B. W. (2008). Interventions for treating the radial tunnel syndrome: A systematic review of observational studies. *Journal of Hand Surgery. American Volume, 33*(1), 72–78.

Hume, P. A., Reid, D., & Edwards, T. (2006). Epicondylar injury in sport: Epidemiology, type, mechanisms, assessment, management and prevention. *Sports Medicine, 36*(2), 151–170.

IJmker, S., Huysmans, M. A., Blatter, M., van der Beek, A. J., van Mechelen, W., & Bongers, P. M. (2007). Should office workers spend fewer hours at their computer? A systematic review of the literature. *Occupational and Environmental Medicine, 64*(4), 211–222.

Ijzelenberg, W., Molenaar, D., & Burdorf, A. (2004). Different risk factors for musculoskeletal complaints and musculoskeletal sickness absence. *Scandinavian Journal of Work, Environment & Health, 30*(1), 56–63.

Ilyas, A. M. (2009). Nonsurgical treatment for de Quervain's tenosynovitis. *Journal of Hand Surgery. American Volume, 34*(5), 928–929.

Johnson, W. G., Baldwin, M. L., & Butler, R. J. (1998). Back pain and work disability: The need for a new paradigm. *Industrial Relations, 37*(1), 9–34.

Karasek, R. (2006). The stress-disequilibrium theory: Chronic disease development, low social control, and physiological de-regulation. *Medicina del Lavoro, 97*(2), 258–271.

Karsdorp, P. A., Nijst, S. E., Goossens, M. E., & Vlaeyen, J. W. (2010). The role of current mood and stop rules on physical task performance: An experimental investigation in patients with work-related upper extremity pain. *European Journal of Pain, 14*(4), 434–440.

Katz, J. N., Stock, S. R., Evanoff, B. A., Rempel, D., Moore, J. S., Fransblau, A., et al. (2000). Classification criteria and severity assessment in work-associated upper extremity disorders: Methods matter. *American Journal of Industrial Medicine, 38*(4), 369–372.

Kennedy, C. A., Amick, B. C., III, Dennerlein, J. T., Brewer, S., Catli, S., Williams, R., et al. (2010). Systematic review of the role of occupational health and safety interventions in the prevention of upper extremity musculoskeletal symptoms, signs, disorders, injuries, claims and lost time. *Journal of Occupational Rehabilitation, 20*(2), 127–162.

Ketola, R., Toivonen, R., Hakkanen, M., Luukkonen, R., Takala, E. P., & Viikari-Juntura, E. (2002). Effects of ergonomic intervention in work with video display units. *Scandinavian Journal of Work, Environment & Health, 28*(1), 18–24.

Krause, N., Burgel, B., & Rempel, D. (2010). Effort-reward imbalance and one-year change in neck-shoulder and upper extremity pain among call center computer operators. *Scandinavian Journal of Work, Environment & Health, 36*(1), 42–53.

Kromer, T. O., Tautenhahn, U. G., de Bie, R. A., Staal, J. B., & Bastiaenen, C. H. (2009). Effects of physiotherapy in patients with shoulder impingement syndrome: A systematic review of the literature. *Journal of Rehabilitation Medicine, 41*(11), 870–880.

Kuhn, J. E. (2009). Exercise in the treatment of rotator cuff impingement: A systematic review and a synthesized evidence-based rehabilitation protocol. *Journal of Shoulder and Elbow Surgery, 18*(1), 138–160.

Langevin, P., Roy, J. S., & Desmeules, F. (2012). Cervical radiculopathy: Study protocol of a randomised clinical trial evaluating the effect of mobilisations and exercises targeting the opening of intervertebral foramen [NCT01500044]. *BMC Musculoskeletal Disorders, 13*(1), 10.

Laulan, J., Fouquet, B., Rodaix, C., Jauffret, P., Roquelaure, Y., & Descatha, A. (2011). Thoracic outlet syndrome: Definition, aetiological factors, diagnosis, management and occupational impact. *Journal of Occupational Rehabilitation, 21*(3), 366–373.

Leeuw, M., Goossens, M. E., van Breukelen, G. J., de Jong, J. R., Heuts, P. H., Smeets, R. J., et al. (2008). Exposure in vivo versus operant graded activity in chronic low back pain patients: Results of a randomized controlled trial. *Pain, 138*(1), 192–207.

Leeuw, M., Houben, R. M., Severeijns, R., Picavet, H. S., Schouten, E. G., & Vlaeyen, J. W. (2007). Pain-related fear in low back pain: A prospective study in the general population. *European Journal of Pain, 11*(3), 256–266.

Loisel, P., Buchbinder, R., Hazard, R., Keller, R., Scheel, I., van Tulder, M., et al. (2005). Prevention of work disability due to musculoskeletal disorders: The challenge of implementing evidence. *Journal of Occupational Rehabilitation, 15*(4), 507–524.

Lundblad, I., Elert, J., & Gerdle, B. (1999). Randomized controlled trial of physiotherapy and Feldenkrais interventions in female workers with neck-shoulder complaints. *Journal of Occupational Rehabilitation, 9*(3), 179–194.

Macfarlane, G. J., Hunt, I. M., & Silman, A. J. (2000). Role of mechanical and psychosocial factors in the onset of forearm pain: Prospective population based study. *BMJ, 321*(7262), 676–679.

Marcus, D. A. (2009). Fibromyalgia: Diagnosis and treatment options. *Gender Medicine, 6*(Suppl. 2), 139–151.

Marshall, S., Tardif, G., & Ashworth, N. (2007). Local corticosteroid injection for carpal tunnel syndrome. *Cochrane Database of Systematic Reviews,* (2), CD001554.

Maund, E., Craig, D., Suekarran, S., Neilson, A., Wright, K., Brealey, S., et al. (2012). Management of frozen shoulder: A systematic review and cost-effectiveness analysis. *Health Technology Assessment, 16*(11), 1–264.

Mayer, J., Kraus, T., & Ochsmann, E. (2012). Longitudinal evidence for the association between work-related physical exposures and neck and/or shoulder complaints: A systematic review. *International Archives of Occupational and Environmental Health, 85*(6), 587–603.

Mccormack, R. R., Inman, R. D., Wells, A., Berntsen, C., & Imbus, H. R. (1990). Prevalence of tendinitis and related disorders of the upper extremity in a manufacturing workforce. *Journal of Rheumatology, 17*(7), 958–964.

Mease, P. (2005). Fibromyalgia syndrome: Review of clinical presentation, pathogenesis, outcome measures, and treatment. *Journal of Rheumatology. Supplement, 75*, 6–21.

Miedema, H. S., & Huisstede, B. M. (2009). Comment on: A framework for the classification and diagnosis of work-related upper extremity conditions: Systematic review. *Seminars in Arthritis and Rheumatism, 38*(5), 407–408.

Neviaser, A. S., & Neviaser, R. J. (2011). Adhesive capsulitis of the shoulder. *Journal of the American Academy of Orthopaedic Surgeons, 19*(9), 536–542.

Noonan, J., & Wagner, S. L. (2010). A biopsychosocial perspective on the management of work-related musculoskeletal disorders. *AAOHN Journal, 58*(3), 105–114.

O'Connor, D., Marshall, S., & Massy-Westropp, N. (2003). Non-surgical treatment (other than steroid injection) for carpal tunnel syndrome. *Cochrane Database of Systematic Reviews,* (1), CD003219.

Oandasan, I., Baker, G. R., Barker, K., Bosco, C., D'Amour, D., Jones, L., et al. (2006). *Teamwork in healthcare: Promoting effective teamwork in healthcare in Canada. Policy synthesis and recommendations*. Ottawa: Canadian Health Services Research Foundation.

Omer, S. R., Ozcan, E., Karan, A., & Ketenci, A. (2003/2004). Musculoskeletal system disorders in computer users: Effectiveness of training and exercise programs. *Journal of Back & Musculoskeletal Rehabilitation, 17*(1), 9–13.

Palmer, B. A., & Hughes, T. B. (2010). Cubital tunnel syndrome. *Journal of Hand Surgery. American Volume, 35*(1), 153–163.

Piligian, G., Herbert, R., Hearns, M., Dropkin, J., Landsbergis, P., & Cherniack, M. (2000). Evaluation and management of chronic work-related musculoskeletal disorders of the distal upper extremity. *American Journal of Industrial Medicine, 37*(1), 75–93.

Pomerance, J. (2009). Return to work in the setting of upper extremity illness. *Journal of Hand Surgery. American Volume, 34*(1), 137–141.

Povlsen, B., Belzberg, A., Hansson, T., & Dorsi, M. (2010). Treatment for thoracic outlet syndrome. *Cochrane Database of Systematic Reviews,* (1), CD007218.

Pransky, G. S., Loisel, P., & Anema, J. R. (2011). Work disability prevention research: Current and future prospects. *Journal of Occupational Rehabilitation, 21*(3), 287–292.

Pransky, G., Robertson, M. M., & Moon, S. D. (2002). Stress and work-related upper extremity disorders: Implications for prevention and management. *American Journal of Industrial Medicine, 41*(5), 443–455.

Punnett, L., & Wegman, D. H. (2004). Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology, 14*(1), 13–23.

Putz-Anderson, V. (1988). *Cumulative trauma disorders: A manual for musculoskeletal diseases of the upper limbs*. Cincinnati, OH: National Institute for Occupational Safety and Health.

Radhakrishnan, K., Litchy, W. J., O'Fallon, W. M., & Kurland, L. T. (1994). Epidemiology of cervical radiculopathy. A population-based study from Rochester, Minnesota, 1976 through 1990. *Brain, 117*, 325–335.

Rempel, D., Tittiranonda, P., Burastero, S., Hudes, M., & So, Y. (1999). Effect of keyboard keyswitch design on hand pain. *Journal of Occupational and Environmental Medicine, 41*(2), 111–119.

Ripat, J., Scatliff, T., Giesbrecht, E., Quanbury, A., Friesen, M., & Kelso, S. (2006). The effect of alternate style keyboards on severity of symptoms and functional status of individuals with work related upper extremity disorders. *Journal of Occupational Rehabilitation, 16*(4), 707–718.

Robertson, C., & Saratsiotis, J. (2005). A review of compressive ulnar neuropathy at the elbow. *Journal of Manipulative and Physiological Therapeutics, 28*(5), 345.

Rugulies, R., & Krause, N. (2008). Effort-reward imbalance and incidence of low back and neck injuries in San Francisco transit operators. *Occupational and Environmental Medicine, 65*(8), 525–533.

Schultz, I. Z., Stowell, A. W., Feuerstein, M., & Gatchel, R. J. (2007). Models of return to work for musculoskeletal disorders. *Journal of Occupational Rehabilitation, 17*(2), 327–352.

Seitz, A. L., McClure, P. W., Finucane, S., Boardman, N. D., III, & Michener, L. A. (2011). Mechanisms of rotator cuff tendinopathy: Intrinsic, extrinsic, or both? *Clinical Biomechanics, 26*(1), 1–12.

Shaw, W. S., Feuerstein, M., Lincoln, A. E., Miller, V. I., & Wood, P. M. (2001). Case management services for work related upper extremity disorders. Integrating workplace accommodation and problem solving. *AAOHN Journal, 49*(8), 378–389.

Shrey, D. E. (1996). Disability management in industry: The new paradigm in injured worker rehabilitation. *Disability and Rehabilitation, 18*(8), 408–414.

Siegrist, J. (1996). Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology, 1*(1), 27–41.

Silverstein, B., Viikari-Juntura, E., & Kalat, J. (2002). Use of a prevention index to identify industries at high risk for work-related musculoskeletal disorders of the neck, back, and upper extremity in Washington state, 1990–1998. *American Journal of Industrial Medicine, 41*(3), 149–169.

Sluiter, J. K., Rest, K. M., & Frings-Dresen, M. H. (2001). Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. *Scandinavian Journal of Work, Environment & Health, 27*(Suppl. 1), 1–102.

Staal, J. B., de Bie, R. A., & Hendriks, E. J. (2007). Aetiology and management of work-related upper extremity disorders. *Best Practice & Research. Clinical Rheumatology, 21*(1), 123–133.

Tittiranonda, P., Rempel, D., Armstrong, T., & Burastero, S. (1999). Effect of four computer keyboards in computer users with upper extremity musculoskeletal disorders. *American Journal of Industrial Medicine, 35*(6), 647–661.

Turek, S., Weinsten, S., & Buckwalter, J. (1994). *Turek's orthopedics: Principles and their application* (5th ed.). Philadelphia: Lippincott.

van Den Ende, C. H., Rozing, P. M., Dijkmans, B. A., Verhoef, J. A., Voogt-van der Harst, E. M., & Hazes, J. M. (1996). Assessment of shoulder function in rheumatoid arthritis. *Journal of Rheumatology, 23*(12), 2043–2048.

van den Heuvel, S. G., van der Beek, A. J., Blatter, B. M., & Bongers, P. M. (2006). Do work-related physical factors predict neck and upper limb symptoms in office workers? *International Archives of Occupational and Environmental Health, 79*(7), 585–592.

van der Windt, D. A., Koes, B. W., de Jong, B. A., & Bouter, L. M. (1995). Shoulder disorders in general practice: Incidence, patient characteristics, and management. *Annals of the Rheumatic Diseases, 54*(12), 959–964.

Van Eerd, D., Beaton, D., Cole, D., Lucas, J., Hogg-Johnson, S., & Bombardier, C. (2003). Classification systems for upper-limb musculoskeletal disorders in workers: A review of the literature. *Journal of Clinical Epidemiology, 56*(10), 925–936.

van Oostrom, S. H., Driessen, M. T., de Vet, H. C., Franche, R. L., Schonstein, E., Loisel, P., et al. (2009). Workplace interventions for preventing work disability. *Cochrane Database of Systematic Reviews,* (2), CD006955.

Verhagen, A. P., Karels, C., Bierma-Zeinstra, S. M., Burdorf, L., Feleus, A., Dahaghin, S., et al. (2006). Ergonomic and physiotherapeutic interventions for treating work-related complaints of the arm, neck or shoulder in adults. *Cochrane Database of Systematic Reviews,* (3), CD003471.

Verhagen, A. P., Karels, C. C., Bierma-Zeinstra, S. M., Burdorf, L. L., Feleus, A., Dahaghin, S. S., et al. (2009). Ergonomic and physiotherapeutic interventions for treating work-related complaints of the arm, neck or shoulder in adults. *Cochrane Database of Systematic Reviews,* (3), CD003471.

Verhagen, A. P., Karels, C., Bierma-Zeinstra, S. M., Feleus, A., Dahaghin, S., Burdorf, A., et al. (2007). Ergonomic and physiotherapeutic interventions for treating work-related complaints of the arm, neck or shoulder in adults. A Cochrane systematic review. *Europa Medicophysica, 43*(3), 391–405.

Waling, K., Sundelin, G., Ahlgren, C., & Jarvholm, B. (2000). Perceived pain before and after three exercise programs—A controlled clinical trial of women with work-related trapezius myalgia. *Pain, 85*(1–2), 201–207.

Webster, B. S., & Snook, S. H. (1994). The cost of compensable upper extremity cumulative trauma disorders. *Journal of Occupational Medicine, 36*(7), 713–717.

Werner, R. A., & Andary, M. (2002). Carpal tunnel syndrome: Pathophysiology and clinical neurophysiology. *Clinical Neurophysiology, 113*(9), 1373–1381.

Wierwille, L. (2012). Fibromyalgia: Diagnosing and managing a complex syndrome. *Journal of the American Academy of Nurse Practitioners, 24*(4), 184–192.

Winzeler, S., & Rosenstein, B. D. (1996). Occupational injury and illness of the thumb. Causes and solutions. *AAOHN Journal, 44*(10), 487–492.

Wolfe, F., Clauw, D. J., Fitzcharles, M. A., Goldenberg, D. L., Katz, R. S., Russell, A. S., et al. (2010). The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis Care & Research, 62*(5), 600–610.

Zakaria, D., Mustard, C., Robertson, J., MacDermid, J. C., Hartford, K., Clarke, J., et al. (2003). Identifying cumulative trauma disorders of the upper extremity in workers' compensation databases. *American Journal of Industrial Medicine, 43*(5), 507–518.

Zakaria, D., Robertson, J., MacDermid, J., Hartford, K., & Koval, J. (2002). Work-related cumulative trauma disorders of the upper extremity: Navigating the epidemiologic literature. *American Journal of Industrial Medicine, 42*(3), 258–269.

Lower Extremity Pain

5

Krista Howard, David March, Haseeb Ikram, Jenna Lorentsen, and Jeffrey Howard

Introduction

Musculoskeletal disorders (MSDs), including the back, neck, and upper and lower extremities, are debilitating conditions and, if not treated appropriately, can lead to poor occupational outcomes including reduced productivity, worker absenteeism, and long-term disability. Of these musculoskeletal regions, there is not as much research available on lower extremity injuries and disorders as compared to lumbar and upper extremity musculoskeletal conditions. According to the Bureau of Labor Statistics, of all nonfatal work injuries resulting in time away from work, back injuries account for 45.4 %, upper extremity injuries account for 25.5 %, and lower extremity injuries account for 7.2 % (Bureau of Labor and Statistics, 2011). Given the prevalence of injuries for these musculoskeletal regions, it is understandable why more research on prevalence, risk factors, and treatment outcomes is available for back and upper extremity MSDs. While lower extremity injuries are less prevalent, they are believed to be more debilitating due to the negative impact on mobility and quality of life (Bruchal, 1995).

The aim of this chapter is to provide a comprehensive overview of lower extremity musculoskeletal injuries involving the hip, knee, ankle, and foot. For each lower extremity region, the joint structure and general types of injuries or disorders will be described. Additionally, current research on the common risk factors for these specific region injuries, along with prevention measures within various occupations, will be discussed. Finally, research on various types of treatment options available for lower extremity musculoskeletal injuries and conditions will be outlined.

Lower Extremity Musculoskeletal Disorders

Research into the occupational causes of MSDs of the lower extremities has not advanced at the same pace as that of the upper extremities. However, recently, more attention is being given to investigating the influence of workplace factors

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on the development of MSDs of the lower extremities. Most of the previous research into workplace lower extremity MSDs has focused on traumatic injuries of the knee or hip. Of the epidemiologic research on nontraumatic lower extremity MSDs, osteoarthritis (OA) is most often the focus, likely due to OA's status as the most common joint disease. On the contrary, there is extremely limited research into occupational causes of foot and ankle disorders, and much of what has been done has pooled feet and ankles into a general "lower leg" category (D'Souza, Franzblau, & Werner, 2005). Of the research available, most has focused on certain job features that are considered to be risk factors for the development of MSDs (e.g., repetitive motion patterns, awkward or unnatural postures, high physical demand). The ergonomics of workstation and work instruments are also important factors to be considered in combination with undesirable occupational features. This section will describe the affected joint, highlight the common physical injuries for each joint, and will also present a selection of literature exploring workplace factors in the development of lower extremity MSDs.

Although results of epidemiologic studies have consistently indicated common workplace features in the development of MSDs, debate continues regarding the magnitude of their influence. Many epidemiologic studies utilize a cross-sectional design due to the relative ease of collecting data compared to more complicated case–control and cohort studies. However, the cross-sectional study design does not allow for investigation into the causal relationships between workplace factors and MSDs. As a consequence, certain intrinsic risk factors (e.g., body mass index) are difficult to account for due to an inability to analyze the temporal relationship between risk factor and outcome. Furthermore, operational definitions and exposure periods often vary across epidemiological studies, resulting in a variation of quantitative findings (Punnett & Wegman, 2004). Additionally, the outcome measures and operational definitions used often vary across studies. Some studies use administrative data, while others utilize self-report measures, with few requiring clinical examinations (Punnett & Wegman, 2004). As a result, the use of unstandardized outcome measures can lead to fluctuating prevalence rates for disorders across studies, leading to discrepancies in the literature. Attempts to adhere to standardized outcome measures and workplace factors could help rectify discrepancies across studies.

While the complex nature of epidemiological research on MSDs means that many studies will be limited in generalizability, they are nonetheless a valuable source of information. Design limitations do not mitigate the value of epidemiological studies as a means of evaluating the "real-world" impact of work factors, which are difficult to infer from the limited scope of laboratory experiments. The variety of designs and measures used in the literature reflect the complicated task of investigating the influence of work factors on MSDs. Even with limitations to generalizability, studies that only inform as to a specific occupational population contribute to the understanding of workplace MSDs for that, and similar, occupations. As the field continues to grow, and the methodology continues to evolve, the role of unique work factors on MSDs should clarify in ways that will positively affect the lives of a large segment of workers.

Foot and Ankle Injuries

The epidemiological research available for review on MSDs of the feet and/or ankle is extremely limited, most likely due to lower prevalence of musculoskeletal symptoms of the ankle and/or foot compared to that of the knee or hip. The ankle is a synovial hinge joint that connects the distal ends of the tibia and fibula to the talus bone in the foot. The bones are cushioned by cartilage and held together by the ligaments of the ankle that help provide the joint with support and the ability to move. The ankle joint is constantly in use, and it bears more weight than any other joint in the body (Fallat, Grimm, & Saracco, 1998), so it is particularly vulnerable to the risk of injury. As a result, ankle injuries constitute some of the most common injuries in emergency

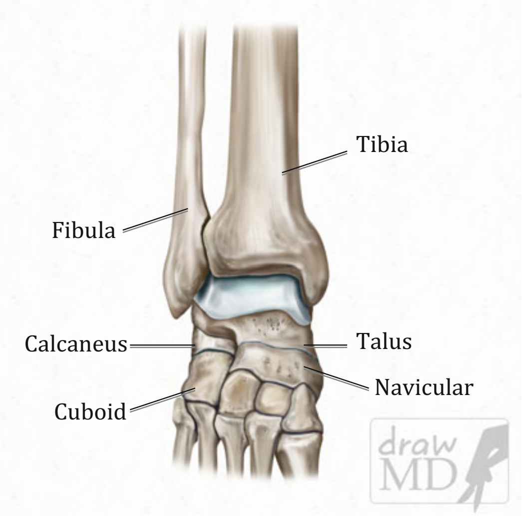

Fig. 5.1 The ankle

departments and clinics (Daly, Fitzgerald, Melton, & Llstrup, 1987) (Fig. 5.1).

The Achilles tendon connects the calf muscles to the calcaneus bone. It is the largest tendon in the body, and tapping this tendon typically results in the ankle jerk reflex. In the event of injury, patients often feel or hear a noise like a loud "pop." A rupture is usually caused by sudden force being exerted upon the tendon during strenuous physical activity and typically occurs when a patient is pushing off with his/her foot with force. Not all patients feel pain when the tendon ruptures (Gravlee, Hatch, & Galea, 2000). It is important to note that just because a patient retains the ability to plantarflex does not mean that a rupture is not present. Tendon rupture can be effectively diagnosed through clinical examination, but an ultrasound can provide confirmation (Maffulli, 1998).

The ligaments of the ankle are a source of mechanical stability and direct the motion of the joint. Sprains occur when these ligaments tear due to sudden stretching. Often times, ankle sprains are the result of suddenly "twisting" the ankle during sports or stepping off of an uneven surface. These injuries can usually be classified on the basis of physical examination by using the method of injury as a guide to determine the location of the sprain. Inversion and eversion sprains are the two main kinds of ankle sprains. Inversion trauma is responsible for 85 % of ankle sprains (Baumhauer, Alosa, Renström, Trevino, & Beynnon, 1995). This occurs when the foot is twisted inward and the lateral ligaments are stretched too far. Eversion sprains are a result of the foot being twisted outward causing the medial ligament to be stretched too far. Symptoms of a sprain include pain, swelling, and occasionally bruising around the area of injury. A high ankle sprain occurs when the syndesmotic ligament (the ligament above the joint) is injured as well. This kind of sprain can lead to chronic ankle instability (Taylor, Englehardt, & Bassett, 1992). There are three grades of ankle sprains. *Grade 1* sprains cause stretching of the ligament, and symptoms are usually limited to pain, tenderness, and swelling. *Grade 2* sprains cause a partial tear of the ligaments, and symptoms include pain, swelling, and local hemorrhage resulting in bruising. Patients can usually take a few steps but with considerable pain. *Grade 3* sprains result in a complete tear of the ligament(s) and present with significant swelling and the inability to support weight.

An ankle fracture is a common injury that usually has a low complication rate if managed carefully. Nearly five million ankle fractures occur every year in the United States alone (Daly et al., 1987). Some studies have shown a connection between ankle fractures and smoking and high body mass index (Honkanen, Tuppurainen, Kröger, Alhava, & Saarikoski, 1998; Valtola et al., 2002). Clinicians employ the Ottawa ankle rules to help determine whether or not a patient requires a series of X-rays to diagnose a possible bone fracture. The majority of ankle fractures affect the malleolus, which is the bony protrusion on each side of the ankle. These fractures can be broken down into three broad categories: unimalleolar, bimalleolar, and trimalleolar fractures (Court-Brown, McBirnie, & Wilson, 1998; Fallat et al., 1998). An unstable ankle fracture means that there are two or more sites of significant injury. Malleolar fractures tend to be stable if there is no contralateral or syndesmotic injury present. It is important to make sure that these injuries are isolated because medial malleolus fractures can often disturb lateral or posterior structures. Posterior malleolar fractures occur either as part of a pilon fracture or from an eversion force. These kinds of fractures rarely occur in isolation and are usually unstable injuries. Bimalleolar fractures incorporate fractures of both the lateral and medial malleoli. They are unstable and are usually the result of an eversion force. A trimalleolar fracture consists of bimalleolar fracture coupled with a posterior malleolus fracture. These types of fractures are unstable, occur with injuries that involve great force, and have a higher risk of complication.

A pilon fracture occurs when the talus is driven into the articular surface of the tibia by a very strong force. As a result of this force, the distal tibia bones are crushed, and injury is often present in other areas of the body as well. There are two broad categories for pilon fractures depending on the amount of force involved in the accident. The first category is a high-energy injury where the ankle suffers extreme force from something like a car accident. The second category is a low-energy injury where the ankle is compressed due to an activity like skiing.

The human foot is a complex structure that consists of 28 bones. The talus bone joins the foot to the leg. The calcaneus bone forms the heel of the foot and provides the attachment for the Achilles tendon. Plantar fasciitis is one of the most common disorders of the foot and is also known as plantar heel pain. Nearly one million patients complain of this disorder annually in the United States alone (Riddle & Schappert, 2004). Plantar fasciitis is caused by inflammation of the plantar fascia, the thick band of tissue on the bottom of the foot. Plantar fasciitis is usually diagnosed by clinical examination. The most common symptom is pain in the heel or sole of the foot. The pain is usually worse when walking, standing for long periods of time, or after intense physical activity. Possible risk factors may include obesity (Rano, Fallat, & Savoy-Moore, 2001) and reduced ankle dorsiflexion (Riddle, Pulisic, Pidcoe, & Johnson, 2003). Although heel spurs are frequently seen on the X-rays of plantar fasciitis patients (Yi et al., 2011), there is still some debate as to whether there is a correlation between heel spurs and the disorder. The majority of incidents occur in the group of people between the ages of 40 and 60. Plantar heel pain may be the result of other underlying disorders, including atrophy of the heel pad, rupture of plantar fascia, and sarcoidosis (Shaw, Holt, & Stevens, 1988).

Stress fractures are small cracks in a bone that are caused by the repeated application of stress or force. They occur in less than 1 % of the general population (Bennell & Brukner, 1997). Running on a hard surface, repeatedly jumping up and down, or suddenly undertaking an intense workout are examples of some activities that can cause stress fractures. Stress fractures are classified as being at “high risk” or “low risk” of complications depending on the location of the injury. They are usually diagnosed through a physical examination, and early diagnosis is imperative to help avoid further complications. Risk factors include low bone density (Myburgh, Hutchins, Fataar, Hough, & Noakes, 1990), history of a prior stress fracture (Milgrom et al., 1985), increased intensity of physical activity (Mäenpää, Soini, Lehto, & Belt, 2002), low levels of calcium intake, and a low level of physical fitness. Generally, women are at a higher risk for stress fractures than men (Banal et al., 2006). Preventative measures include a well-balanced diet, weight-bearing exercises that improve bone density, and proper training techniques.

Toe fractures are fairly common and account for nearly 9 % of the fractures treated by primary care physicians (Eiff & Saultz, 1993; Hatch & Rosenbaum, 1994). Studies have shown that over 60–75 % of these fractures involve the smaller toes (Schnaue-Constantouris, Birrer, Grisafi, & Dellacorte, 2002). Some common causes of toe fractures include stubbing a toe or a crushing injury caused by a falling object. Less common causes include hyperflexion and hyperextension. Symptoms include swelling, bruising, and throbbing pain. In the case of a displaced fracture, deformity of the toe is usually present. Patients may also complain of difficulty walking or comfortably fitting in shoes.

Occupational Causes of Foot and Ankle Injuries

Several studies have focused on occupational factors associated with the development of lower extremity MSDs. Oftentimes, these studies utilize self-reports to assess musculoskeletal symptoms, without assigning specific diagnoses (i.e., pain, discomfort, or fatigue). When referencing literature on MSDs of the foot or ankle, it is important to note that the lack of significant findings is not the consequence of a demonstrated lack of association, but a result of the sheer deficiency of studies in this area.

One type of foot injury, plantar fasciitis, which is inflammation of the plantar fascia on the bottom of the foot, has been examined within the context of occupational exposure. Investigating plantar fasciitis, Riddle et al. (2003) conducted a study by drawing participants from outpatient clinics. Participants were physician-diagnosed with plantar fasciitis prior to referral, after which time ankle dorsiflexion was measured using a goniometer. Other factors taken into account were time spent on feet and time spent jogging. Using multiple logistic regression modeling, these investigators found a significant association between plantar fasciitis diagnosis and time spent on the feet. However, time spent on the feet was dichotomized (majority or minority of the workday). Additional information about exact duration, time spent walking versus standing, type of surface, and participant footwear was not collected. Consequently, while these researchers present a correlation between standing and plantar fasciitis, conclusions are limited by the workplace factors not accounted for.

Ryan (1989) examined the association between time spent standing and musculoskeletal symptoms of the ankle or foot. Supermarket checkout workers were observed for 10-s intervals every 30 min, after which an activity profile was developed accounting for posture, activity, and department. Compared to other employees, checkout department workers stood the most and had the highest rates of foot and/or ankle symptoms. Although Ryan did not account for BMI, foot and/or ankle symptoms were associated with percent of time spent standing. However, floor surface and shoe design were not described, and these factors are known to affect prevalence of symptoms. Additionally, it should be noted that checkout workers were very young, and the majority were female, limiting the generalizability of these results.

Werner, Gell, Hartigan, Wiggerman, and Keyserling (2010) attempted to overcome the weaknesses seen in some earlier foot and ankle studies by determining the relative influence of floor surface, BMI, age, and work activity in contributing to foot and ankle disorders in assembly plant workers. These researchers also included shoe characteristics and foot biomechanics as independent variables, factors not accounted for in much of the earlier literature. Through self-report questionnaires, 24 % of assembly plant workers were diagnosed with a foot or ankle disorder. Participants with a foot or ankle disorder tended to be older, female, and longer-tenured workers. Previous medical issues such as osteoporosis, rheumatoid arthritis, and heel spurs were also associated with higher prevalence rates of foot or ankle disorders. Overall, results showed an increased risk of foot or ankle disorders associated with more time spent walking, whereby every 10 % of the day spent walking resulted in a 20 % increase in MSD risk. Higher metatarsal pressure was also associated with foot or ankle disorders when adjusted for BMI, time spent standing/walking, and previous medical issue. These results suggest that, when it comes to foot and ankle disorders, there is a complex interplay between a number of intrinsic and occupational factors at work.

The extant research on MSDs of the foot and ankle tend to find a relationship between disorder prevalence rates and time spent standing, higher BMI, and repeated impact (D'Souza et al., 2005). Although limitations exist throughout the literature, there is an undeniable trend across occupations and populations. Generalizability will continue to be an issue due to limitations inherent in this type of research; however, these results serve to influence both primary and secondary strategies for preventing foot and ankle disorders. Continued refinement of epidemiological research into the role of workplace factors in the development of MSDs of the feet and ankle will further clarify specific influences on prevalence rates.

Knee Injuries

The knee is the largest and most complex joint in the human body. It can be characterized as a modified hinge joint due to the fact that it allows both rotation and flexion while maintaining stability and control under an immense load (Goldblatt & Richmond, 2003). The joint connects the femur to the tibia and fibula through a series of muscles and is stabilized by several thick ligaments. The knee is surrounded by a synovial capsule containing synovial fluid that provides nourishment and lubrication to the joint. Inside the capsule, hyaline cartilage lines both sides of the joint allowing smooth traction. Between the bones lies a fibrocartilaginous c-shaped cushion called the meniscus which provides shock absorption, lubrication, nutrition, stability, and load transmission to the knee joint (Caldwell, Allen, & Fu, 1994). The patella (kneecap) gives significant mechanical leverage to the quadriceps muscles allowing knee extension and straightening as well as a connection between the thigh and shinbones (Fig. 5.2).

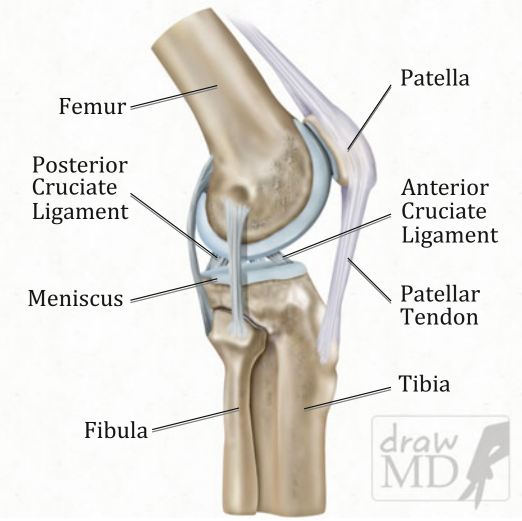

Fig. 5.2 The knee

Osteoarthritis (OA) is a common degenerative condition affecting the cartilage in the knee. OA is typically associated with both genetic factors and prolonged mechanical stress (Sandmark, Hogstedt, & Vingard, 2000). Another degenerative condition that affects the knee is bursitis, which is often associated with friction stress causes by repetitive kneeling (Okunribido, 2009).

A torn meniscus is a common injury that frequently occurs when a bent knee is twisted in an unnatural position. Those who participate in physical activity and sports have a high incidence of an acute injury where many sudden movements and cuts are performed. Acute meniscal tears can occur independently. However, the meniscus may also be injured alongside the rupture of a medial collateral ligament (MCL) and the rupture of the anterior cruciate ligament (ACL) (Keene, Bickerstaff, Rae, & Paterson, 1993; Nikolić, 1998). Chronic injury occurs in the elderly where the cartilage of the meniscus is worn down from overuse and degeneration over time. The peripheral (outer) section of meniscus has a higher healing rate, relative to the central meniscus, due to a better vascular supply and subsequently can be repaired (Metcalf & Barrett, 2004). Poor vascularity in the central meniscus requires surgical excision rather than repair (Henning, Lynch, & Clark, 1987).

The ACL is the most common ligament injured in the body that frequently requires surgery (Spindler & Wright, 2008; Vescovi & VanHeest, 2010). The ACL comprises a dense band of connective tissue that connects the femur to the tibia (Dodds & Arnoczky, 1994). The primary function of the ACL is to stabilize the range of motion of the knee by preventing extreme forward translation of the tibia from beneath the femur (Furman, Marshall, & Girgis, 1976). A ruptured ACL occurs when the knee undergoes a large traumatic force in a pivotal motion through both direct and indirect contact (Lin et al., 2012). However, the majority of ACL injuries occur in a noncontact fashion where no physical contact with the knee is involved (Agel, Arendt, & Bershadsky, 2005; Boden, Dean, Feagin, & Garrett, 2000; Feagin & Lambert, 1985). When the ligament is injured, a loss of functional stability occurs, as well as a shearing effect between the femur and tibia due to a lack of constraint by the ACL (DeMorat, Weinhold, Blackburn, Chudik, & Garrett, 2004; Lam et al., 2009; Maffulli, Binfield, & King, 2003). Injuries to the ACL range from micro-tears to complete tears and are classified I to III in severity (Kessler et al., 2008). The majority of ACL injuries are Grade III, where the ligament is completely torn and surgical intervention is required to restore proper function. Participants of high-risk sports account for the majority of torn ACLs where many rapid movements such as deceleration and pivoting take place (Pujol, Blanchi, & Chambat, 2007). Female athletes are more susceptible to an ACL tear than their male counterpart. However, the cause is not completely clear (Carson & Ford, 2011; Cowling & Steele, 2001; Ferrari, Bach, Bush-Joseph, Wang, & Bojchuk, 2001; Hewett, Myer, & Ford, 2001). Injuries to the ACL are also known to increase the risk of knee osteoarthritis occurring later in life (Lohmander, Englund, Dahl, & Roos, 2007; Lohmander, Östenberg, Englund, & Roos, 2004).

Like the ACL, the MCL is important in stabilization and works synergistically with the ACL to stabilize the knee against valgus (bent or twisted outward) stress and tibial translation (Baker & Shalvoy, 1996; Hull, Berns, Varma, & Patterson, 1996). Together, MCL and ACL ruptures account for 90 % of all knee ligament injuries in the young and active (Woo, Chan, & Yamaji, 1997). The typical source of MCL injury is through a direct blow to a bent knee which causes over stretching and subsequent trauma (Gibbs, 1994; Roberts & Stallard, 2000). Sudden pivoting and cutting motions can also indirectly injure the MCL as observed in those that play sports where valgus knee loading is common (Lorentzon, Wedrèn, & Pietilä, 1988; Najibi & Albright, 2005). MCL tears are graded on a scale of I to III in severity, and the general consensus is an MCL injury can be treated in a nonoperative fashion (Fetto & Marshall, 1978; Indelicato, 1983). However, a severe MCL injury may warrant surgical intervention (Edson, 2006; Lonergan & Taylor, 2002; Yoshiya, Kuroda, Mizuno, Yamamoto, & Kurosaka, 2005).

Occupational Causes of Knee Injuries

The literature regarding disorders of the knee tends to focus primarily on osteoarthritis (OA), bursitis, and meniscal lesions/tears. Although knee OA is the most frequently studied disorder of the knee, definitions of OA vary between studies, resulting in some variability across studies (D'Souza et al., 2005). A recent review of research on occupational knee disorders by Reid, Bush, Cummings, McMullin, and Durrani (2010) revealed that the epidemiology of these disorders can be dichotomized into intrinsic (e.g., age, BMI, previous injury) and extrinsic (e.g., occupational) factors. From this, these researchers hypothesized that personal and occupational factors may interact in a complementary manner to predispose individuals to knee disorders. Their review also showed that kneeling is the most often indicated occupational factor identified in knee disorder research and seen to contribute to OA, bursitis, and meniscal lesions. Additionally, squatting and heavy physical work are also often identified as contributing occupational factors to the development of MSDs of the knee.

Knee bursitis presents when inflammation of a bursa sac occurs. This inflammation is often caused by fluid retention, which causes swelling of the bursa sac, and a thickening of the bursa walls (Kivimaki, Riihimaki, & Hanninen, 1994). Knee bursitis is a common outcome in a number of occupations where kneeling or use of the knee as a tool is common (Reid et al., 2010). Using the knee as a tool creates a sudden impact stress, while kneeling for long periods creates a distribution of pressure throughout the knee. For example, carpet layers are noted as uniquely susceptible to knee bursitis as they spend a large amount of time on their knees. Carpet layers also use a tool known as a "knee kicker" for carpet stretching. A number of studies looking specifically at carpet layers have found the force created by knee kickers to be over four times greater than the individual's body weight (Bhattacharya, Mueller, & Putz-Anderson, 1985; Village, Morrison, & Leyland, 1993). In fact, knee bursitis is so common among carpet layers that it has become known as "carpet layer's knee" (Kivimaki et al., 1994).

While using the knee as a hammer-type tool is almost entirely unique to the carpet-laying occupation, there are a number of industries where long periods of time are spent kneeling or crawling, including coal mining, plumbing, and assorted carpentry occupations. A number of studies have shown an increase in knee and infrapatellar bursitis as a consequence of time spent kneeling (Partridge, Anderson, McCarthy, & Duthie, 1968; Tanaka et al., 2007; Thun et al., 1987). A review of the literature on occupational knee disorders by Jensen and Eenberg (1996) found an association between time spent kneeling and knee bursitis. While studies have shown a pattern of increased bursitis as a consequence of kneeling work, knee bursitis is a far less serious disorder than knee OA and is therefore not as prevalent in the literature.

Alternatively, knee OA is relatively well represented in the occupational MSD literature. Knee OA affects the cartilage of the knee, causing a loss of cartilage and a narrowing of the joint space. A number of studies have demonstrated a relationship between occupations requiring kneeling or squatting and knee osteoarthritis (Anderson & Felson, 1988; Kivimaki et al., 1994; Tanaka et al., 2007). Kivimaki et al. (1994) looked at the work habits of carpet and floor layers using video recordings while also observing painters as a referent group. Analysis of the recordings revealed that the floor and carpet layers spent 42 % of their workday kneeling on one of both knees, while the painters only spent 5 % of their time kneeling. X-ray examination revealed significantly more osteophytes in the carpet and floor layer group, which are often present in osteoarthritic joints. A case–control study by Cooper, McAlindon, Coggon, Egger, and Dieppe (1994) found that kneeling or squatting for more than 30 min a day significantly increased the risk of knee OA, while Coggon et al. (2000) found that kneeling or squatting for 1 h or getting up from a kneeling or squatting position 30 or more times were significantly associated with knee OA. Additionally, heavy physical work has been associated with knee OA. A study by Lau et al. (2000) matched patients with and without knee OA, confirming OA in diagnosed patients with radiographs. In this study, knee OA was associated with lifting more than 22 lb more than ten times per week in both men and women. Most studies do not list specific weights, but instead delineate workload into light, moderate, and heavy workloads, with definitions for each varying across study. A study by Kohatsu and Schurman (1990) used a self-report questionnaire of workload, finding that participants who reported having worked a job requiring a heavy workload were much more likely to present with knee OA. Anderson and Felson (1988) dichotomized participants by categorizing their occupations into those associated with and without high workload. Their results showed significantly higher prevalence of knee OA in the heavy workload subject group among both men and women. Diagnoses of knee OA were not prevalent among the younger age group, consistent with the development period necessary for chronic OA.

The difference in classifying knee OA between studies may help explain the reported discrepancies in prevalence rates among different studies (Yoshimura et al., 2004). Yoshimura et al. (2004) hypothesize that specific country location may influence the relationship between workplace factors and knee OA. Additionally, Teichtahl, Wluka, and Cicuttini (2003) suggest that future research should attempt to describe the biomechanical factors on knee OA, as well as whether these factors are an influence on risk, or alternatively, are outcomes of occupational factors. Regardless of classification inconsistencies, researchers consistently find a positive relationship between occupational factors, squatting, kneeling, and heavy physical workload and associated knee OA.

Even when compared to research on knee bursitis, the research on meniscal lesions is extremely sparse. A review of these studies by D’Souza et al. (2005) could not support the finding of an association between occupational factors and meniscal lesions. Kirkeskov and Eenberg (1996) point out that very few studies on meniscal lesions of the knee controlled for previous injury, sports participation, or the cause of a traumatic work injury. As such, there is insufficient data to say with confidence that kneeling or squatting influence the development of meniscal lesions. Future occupational studies examining meniscal lesions will need to control for these factors in order to allow for causal inferences.

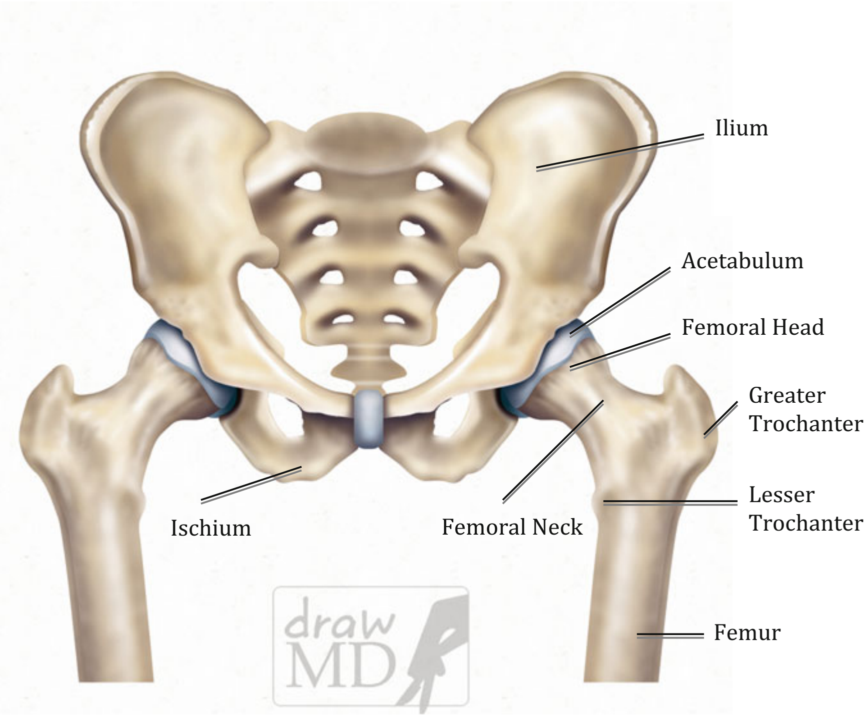

Fig. 5.3 The pelvis

The literature on knee OA shows a strong association between knee OA and squatting or bending. Knee bursitis has been seen to be caused by both kneeling and squatting across a variety of occupations. There is as yet not enough literature available to draw a conclusion regarding workplace factors influence on meniscal lesions. Generalizing these findings across occupations, locations, and genders is extremely difficult, as workplace biomechanics differ across these factors. Additionally, women are underrepresented in occupations requiring much kneeling or squatting, and men who are currently diagnosed with severe knee OA tend to avoid work requiring them to function in painful positions, potentially confounding prevalence rates. More detailed studies are needed to better understand the relationship between workplace factors and knee OA, bursitis, and meniscal lesions.

Hip Injuries

The hip is a ball and socket joint. The round head of the femoral bone articulates with the acetabulum, the cuplike cavity of the pelvis. The femoral head is lined with hyaline cartilage that assists in shock absorption, as well as giving lubricated traction to the joint. Several thick ligaments and the labrum firmly hold the femoral head in the acetabulum. The hip is stabilized by several groups of muscles that allow for a complex range of motions of the hip (Fig. 5.3).

A hip dislocation is a serious and painful injury that results from high-energy trauma. With enough force, the ball-shaped femoral head is displaced from the socket (acetabulum) in the pelvic bone. Dislocation can occur in sports injuries, industrial accidents, and most commonly in motor vehicle accidents (MVA) which account for 62–93 % of all hip dislocation injuries (Sah & Marsh, 2008). In MVA, dislocations commonly result in posterior dislocations of the right hip (Monma & Sugita, 2001; Sah & Marsh, 2008). This is due to the typical position of the driver's right hip in flexion and adduction. This position effectively increases the chance of a knee-thigh-hip complex impact against the dashboard (Rupp & Schneider, 2004). In a posterior dislocation, the limb is shortened, flexed, and internally rotated whereas in an anterior dislocation, the limb would be flexed externally (Chen et al., 2010). Posterior hip dislocations account for the majority of all hip dislocations, while the anterior dislocation is less commonly observed. Sciatic pain can also manifest as a secondary injury caused by hip dislocation. The sciatic nerve is the longest and thickest nerve in the human body. The nerve originates from the lower spine and runs through the pelvis and down the buttocks into the legs and feet. In a hip dislocation, the peroneal nerve component of the sciatic nerve may be stretched over the displaced femur head, causing pain and numbness (Clegg, Roberts, Greene, & Prather, 2010; Cornwall & Radomisli, 2000; Hillyard & Fox, 2003). The impingement also causes the injured to feel hypersensitive to touch in the lower extremity as well causes an impairment of motor functions (Hillyard & Fox, 2003).

A hip fracture is generally a break in the femoral neck of the femur. The majority of hip fractures occur from a simple fall (as observed in the elderly). However, a small percentage of younger individuals may suffer a hip fracture through a severe impact such as an MVA (Aschkenasy & Rothenhaus, 2006; Cummings, 1996; Keating & Aderinto, 2010; Melton Iii, 1996). The elderly are most susceptible to a hip fracture due to their increased loss of bone density. Furthermore, elderly women with osteoporosis have a higher incidence of fractures than elderly men because of their increased loss of bone mass (Cummings, 1996). Women who smoke also show a tendency to have an increased risk of hip fractures (Cornuz, Feskanich, Willett, & Colditz, 1999; Cummings et al., 1995).

There are three categories of hip fractures: intracapsular, intertrochanteric, and subtrochanteric. Femoral neck fractures (intracapsular fractures) occur inside the joint capsule. This type of fracture may result in partial or complete disunion of the round head from the rest of the femur. The Pipkin classification system is widely used to distinguish the severity of a intracapsular fracture and range from I to IV in severity (Iannacone, Dalsey, & Wood, 1994). In very severe cases, the blood supply may be disrupted, which then may result in avascular necrosis and osteonecrosis of the femur head (Harper, Barnes, & Gregg, 1991; Thuan & Marc). Poor blood circulation to the region creates further complications in healing and frequently leads to nonunion (Roshan & Ram, 2008).

Intertrochanteric (IT) fractures are designated as extracapsular, due to their occurrence outside of the joint capsule. IT fractures occur between the greater and lesser trochanter (large bump of the femur). Several classification systems exist. However, IT fractures are generally classified as either stable or unstable depending on the location, size, and number of bone fragments (Evans, 1949; Jensen, 1980; MacEachern & Heyse-Moore, 1983). A dependable vascular supply allows IT fractures to heal properly. However, other complications may arise. Misaligned healing and a shortening of the femur can occur because of competing forces from the surrounding muscle attachments (Bartonícek, Skála-Rosenbaum, & Douša, 2003; Haidukewych, Israel, & Berry, 2001; Olsson, Ceder, & Hauggaard, 2001).

Subtrochanteric fractures occur between the lower border of the lesser trochanter and 2.5 in. distally in the proximal portion of the femur (de Vries, Kloen, Borens, Marti, & Helfet, 2006; Shukla et al., 2007; Zuckerman, 1996). The subtrochanteric region is subjected to a high level of load-bearing stress and has a poor vascular supply that contributes to slower healing (de Vries et al., 2006; Guerra & Born, 1994). Subtrochanteric fractures are also subject to misalignment and deformities due to the strong forces of the muscular attachments on the femur (Shukla et al., 2007).

Trochanteric bursitis (hip bursitis) is the painful swelling of the bursa that superficially surrounds the trochanter region of the femur and is most commonly presented in the elderly. Many times, this injury is overlooked because of its close nature to other clinical conditions (Mulford, 2007). Micro-trauma from repeated overuse, complications in surgery, direct trauma, as well as a predisposition to other conditions contribute to the development of bursitis (Farmer, Jones, Brownson, Khanuja, & Hungerford, 2010).

Occupational Causes of Hip Injuries

The research on occupational hip disorders has mostly focused on OA of the hip, as well as general hip pain. Relative to research on knee OA, there is relatively little research done on occupational hip OA and even less research on general hip pain. Occupational research on hip OA suggests a relationship between development of hip OA and workplace biomechanical factors. In a review of the hip OA literature, Maetzel, Makela, Hawker, and Bombadier (1997) found an association between certain work factors and hip OA in men. This review did not include any studies examining hip OA in women. A more recent review by Schouten, de Bie, and Swain (2002) examined previous studies with strong methodology, finding a significant relationship between the development of hip OA and heavy lifting in both men and women. More recent studies have found correlations between heavy lifting exposure and hip OA, although what is considered "heavy lifting" varies across studies, and some studies simply extrapolate expected lifting exposure using only job title (D'Souza et al., 2005).

Hip pain has also been the focus of a small number of occupational studies. However, these studies tend to be extremely limited in their scope and often have a number of methodological flaws. Similar to the literature on the ankle and feet, the literature on the influence of work factors on hip disorders is extremely limited. Although patterns have emerged linking hip OA to certain workplace factors, further research is needed to fully understand the relationship between these factors and the development of MSDs of the hip.

Causes of Lower Extremity Injuries: Summary

Methodological inconsistencies limit the generalizability of studies on occupational factors' influence on the development of lower extremity MSDs. However, research has found relationships whereby heavy lifting predisposes workers to hip OA, squatting or kneeling influences the development of knee OA, and kneeling has been linked with knee bursitis. Future studies should attempt to standardize the diagnostic tools used, as well as the outcome measures. Many of the occupational studies on lower extremity pain and disorders focus on a single population in one occupational setting. Furthermore, many studies do not control for intrinsic variables like age, BMI, and previous injury. The inability to infer the causal relationship between factors like BMI and occupational exposure is a weakness of much of the reviewed research. However, this research remains useful in describing prevalence rates of disorders in certain occupations.

Treatment Modalities

When an individual has an injury of the lower extremity, there are many ways to treat the injury to ensure that the person is able to return to regular activities, including work. The best approach for assessing and treating patients with MSDs is through the biopsychosocial approach. This type of approach embraces a holistic perspective and includes treatment of the injury itself, along with any psychological or social factors that may impede the healing process. Treatment modalities used to treat musculoskeletal injuries can consist of pain management, exercise, and/or surgery. Pain management can involve medication or various forms of manipulation (i.e., stretching, chiropractics, ultrasound, etc.). It is important to prevent deconditioning of the muscles and joints. When medically approved, exercise is recommended to strengthen muscles and mobility. Surgery is typically a final option if other treatments fail to reduce pain and restore function. The following section will highlight various forms of treatment modalities for lower extremity injuries.

Pain Management

Manipulation, or manual therapy, is any activity or form of treatment that uses a hands-on process to get help the healing process associated with musculoskeletal injuries. Manipulation therapies can involve chiropractics, massage, ultrasound, and laser therapies (Finn & MacAirt, 1994). Ultrasound is one of the most common treatment options available for conditions of the soft tissue of the lower extremity. Ultrasound focuses on reducing edema to relieve pain and is used for managing musculoskeletal conditions, acute sports injuries, soft tissue injuries, muscle spasm, contusion, and pain (Shanks, Curran, Fletcher, & Thompson, 2010). Ultrasound is also usually used in conjunction with other forms of treatment. Antich (1982) conducted a study that compared four modalities of treatment: ice application, phonophoresis, ionotophoresis, and ultrasound with ice combination. When these were used to treat different knee extensor mechanism disorders, ultrasound with ice was the most effective treatment and was recommended most for decreasing pain and inflammation. When using ultrasound, other treatment modalities can be used, such as stretching and strengthening exercises, insoles and orthotics, heat and cold, and other physical therapy treatments (Shanks et al., 2010). Overall, ultrasound is found to be a highly beneficial treatment when used in the early stages of repairs and can result in stronger elastic scar tissue (Dyson, 1987).

Laser therapy is another medical intervention that uses light-emitting diodes that alter the function of cells during the healing process of an injury (Gworys, Gasztych, Puzder, Gworys, & Kujawa, 2012). Although there is limited research on laser therapy, it has been used to treat acute pain that is caused by osteoarthritis and tendon disorders. Because laser therapy is commonly used to treat knee OA and tendon disorders, most of the research available on laser treatment is focused on these disorders. When laser therapy is used to treat patients who have OA, there were significant improvements in function and pain relief in all the groups that received the therapy (Gworys et al., 2012). Tendon injuries are usually caused by overuse. When researching the effects of laser therapy on tendon overuse, it was found to decrease pain and slow down the strength reduction. Also, when it was used for injured tendons, it was found to help improve the function and strength of the fibers and the overall function of the tendon (Elwakil, 2007). This type of therapy is usually used in combination with stretching before the patient starts an exercise program (Ng & Chung, 2012).

Massage is a form of manipulation therapy that is used to relieve pain, rehabilitate injuries, and reduce stress in the injured patient. Massage is also effective for treating lymphedema (Casely-Smith, 2000). Massage therapy is rarely used alone; instead, it can be used in combination with compression, exercise, hot/cold application, etc. Lymphoedema is usually caused by inflammation of the lymphatic system, which often results from physical injury. Since it can cause a buildup of fluid in the limb, treatment usually consists of massage, compression, and exercise. One study was conducted to test the effects of these three modalities together, and it found that the combination of massage, compression, and exercise helped to decreased inflammation and increase mobility, resulting in improvement in quality of life and return to work (Casely-Smith, 2000).

Exercise

Exercise is considered as one of the most common treatment recommendations for lower extremity injuries. Physical therapists can incorporate different modalities (such as those mentioned earlier), along with other forms of treatment, such as water-based therapy and specific exercise techniques. Most exercise programs are the most effective for hip and knee problems because these are the most common lower extremity injuries (Roddy, Zhang, & Doherty, 2005).

Water-based therapy, also called hydrotherapy, is commonly used for older patients but can also be used for younger patients who are unable to participate in a regular exercise program. Hydrotherapy uses aerobic techniques for which the patients are able to use swimming, weights, and stairs to relieve pain and gain their normal function back. It has also been effective to produce significant reductions in pain and improvement in physical function. When used in conjunction with land-based therapy, greater improvements are reported (Harmer, Naylor, Crosbie, & Russell, 2009).

Lower limb exercises are important components to a rehabilitation program when it comes to treating injuries and OA. With most lower extremity injuries affecting the knee and hip, the majority of strengthening exercises developed focus on the knee and hip joints, and they incorporate walking or cycling and flexibility exercises (Bennell, Hunt, Wrigley, Hunter, & Hinman, 2007).

Hip and knee injuries are not only the most common, but they can also influence one another's function. For example, when someone is suffering from OA of the knee or other injuries associated with the knee, hip abductor and adductor strengthening exercises may influence how the knee joint loads, improve function, and reduce the symptoms that are involved in the arthritis. It is important to note that these exercises can be used for both hip and knee injuries because a lot of movements are based around the hip and, the stronger it is, the more stability we have in our lower extremity as a whole (Chang et al., 2005). Other exercises that can be used to strengthen the hip are flexion and extension exercises involving the gluteal muscles and hip flexors. These exercises are important to improve the strength and stability of the hip. For the knee, one can increase quadriceps strength with leg extensions, the hamstrings with leg curls, and squats and lunges for the whole lower extremity.

With lower leg injuries, it is always important to incorporate the knee, calf, and ankle exercise because they all play a part in each other's functions. For example, calf-raising exercises just focus on the calves, but there are ankle exercises that work both the ankle and the calves that can be used in rehabilitation treatments. These exercises consist of dorsiflexion (that works the anterior tibialis), plantar flexion (that works the posterior tibialis and soleus), eversion, and inversion that help to strengthen these muscles, as well as other muscles that are involved in movement of the ankle.

Although not as common as the other injuries, when an individual sustains a foot injury, lower leg exercises can be used. In fact, foot intrinsics and extrinsics can be used along with other forms of treatment discussed earlier in this section. Home-based exercises that include walking and jogging for cardiovascular health can be supplemented with these other forms of treatment to provide optimal results (McCarthy et al., 2004).

Because it is invasive, surgery is never the "go-to" for an injury unless the condition is severe or unless all other forms of treatment fail. Surgery can be used to repair an injured site or to replace a damaged joint due to arthritic causes, such as knee and hip arthroplasty, which are the most common types of surgery for the lower extremity. Microsurgery is used to salvage tissue that has suffered trauma. For example, if an individual suffers from an injury that damages a muscle, instead of amputation they would be able to receive a tissue transfer. Most of these types of surgeries are multistaged, but once it is final the patient is able to function almost normally and can return to work efficiently (Korompilias, Lykissas, Vekris, Beris, & Soucacos, 2008).

Arthroplasty is a very common joint replacement surgery typically used for knee or hip OA or injuries. When a person receives a total hip or knee arthroplasty, the arthritic joint is replaced or remodeled (with other forms of tissues) in order to relieve pain, restore range of motion, and increase muscular strength (Benum, Aamodt, & Haugan, 2004). Related to arthroplasty, hip and knee replacement surgeries replace the arthritic joint with a prosthetic that can act as a normal weight-bearing joint and allow for normal movement of the joint. This is also used to reduce pain and disability (Leopold, 2009). Although surgery has been used to relieve pain and restore mobility in patients, it is important to keep in mind that other forms of treatment and rehabilitation should be used first.

Other considerations to be made when treating patients with occupational lower extremity injuries involve psychosocial factors that can interfere with the treatment process. In particular, the pain experience has been found to intensify with the presence of psychopathology, which can perpetuate the individual's sense of disability. Accurately assessing the psychopathology of the patient is a fundamental component crucial for treating the chronic pain condition.

Within chronic pain populations, three major psychiatric disorders prevail: mood disorders, anxiety disorders, and substance use disorders. Furthermore, as the pain experience becomes more chronic, emotional factors can exacerbate the suffering and disability (Gatchel, 1996).

Research has shown that depression, anxiety, and substance use disorders have a direct impact on the treatment outcomes. Depression and anxiety have been linked to poor work-return rates following treatment for musculoskeletal injuries (Corbiere, Sullivan, Stanish, & Adams, 2007; Lloyd, Waghorn, & McHugh, 2008; Richmond et al., 2009; Watson, Booker, Morres, & Main, 2004). Substance abuse, in particular, is found to be a main risk factor in failure to return to work for patients with occupational MSDs (Dersh et al., 2007; Kidner, Mayer, & Gatchel, 2009; MacLaren, Gross, Sperry, & Boggess, 2006).

The biopsychosocial approach to understanding the pain condition takes into account not only the physiological injury but also how various psychosocial factors interact in a dynamic nature which can exacerbate the pain condition and often deter the progress of treatment. It is through a comprehensive evaluation, including a full assessment of psychological and social factors, that the appropriate treatment plan can be developed for the individual chronic pain patient.

Summary and Conclusion

MSDs that can be caused by genetic factors or injury are associated with worker absenteeism, decreased productivity, and long-term disability. Most of the research on prevalence, risk factors, and treatment modalities for occupational MSDs has focused on individuals with lumbar disorders, and limited research has been devoted to understanding occupational lower extremity injuries. This chapter reviewed the specific lower extremity joints and the common disorders associated with the joints. Additionally, this chapter provided a review of the known risk factors for the development of lower extremity disorders, along with prevention and intervention strategies aimed at reducing the prevalence of these types of musculoskeletal injuries. Because research on lower extremity disorders is limited and because the methodological approach to investigating these types of injuries is not standardized, it is difficult to "pin-point" true risk factors for the development of lower extremity injuries.

Using the biopsychosocial model to assess and treat patients with MSDs has been shown to be an effective way to reduce pain and to improve function and psychosocial factors that enable patients to return to regular activities. Various treatment modalities were highlighted in this chapter. Treatments involving manipulation, exercise, and surgery focus on the injury itself. However, it is well known in pain research literature that psychological and social factors also play a part in the healing process. Through multidisciplinary treatment approaches, individuals with lower extremity MSDs are more likely to regain function and improve their quality of life.

References

Agel, J., Arendt, E. A., & Bershadsky, B. (2005). Anterior cruciate ligament injury in National Collegiate Athletic Association basketball and soccer a 13-year review. *The American Journal of Sports Medicine, 33*(4), 524–531.

Anderson, J., & Felson, D. (1988). Factors associated with osteoarthritis of the knee in the first national health and nutrition examination survey (HANES I). *American Journal of Epidemiology, 128*, 179–189.

Antich, T. J. (1982). Phonophoresis: The principles of the ultrasonic driving force and efficacy in treatment of common orthopaedic diagnoses. *Journal of Orthopaedic & Sports Physical Therapy, 4*(2), 99–102.

Aschkenasy, M. T., & Rothenhaus, T. C. (2006). Trauma and falls in the elderly. *Emergency Medicine Clinics of North America, 24*(2), 413–432.

Baker, C. L., Jr., & Shalvoy, R. M. (1996). Treatment of acute and chronic injuries to the medial structures of the knee. *Operative Techniques in Sports Medicine, 4*(3), 166–173.

Banal, F., Etchepare, F., Rouhier, B., Rosenberg, C., Foltz, V., Rozenberg, S., et al. (2006). Ultrasound ability in early diagnosis of stress fracture of metatarsal bone. *Annals of the Rheumatic Diseases, 65*(7), 977.

Bartonícek, J., Skála-Rosenbaum, J., & Douša, P. (2003). Valgus intertrochanteric osteotomy for malunion and nonunion of trochanteric fractures. *Journal of Orthopaedic Trauma, 17*(9), 606–612.

Baumhauer, J. F., Alosa, D. M., Renström, P. A. F. H., Trevino, S., & Beynnon, B. (1995). A prospective study of ankle injury risk factors. *The American Journal of Sports Medicine, 23*(5), 564–570.

Bennell, K. L., & Brukner, P. D. (1997). Epidemiology and site specificity of stress fractures. *Clinics in Sports Medicine, 16*(2), 179–196.

Bennell, K., Hunt, M., Wrigley, T., Hunter, D., & Hinman, R. (2007). The effects of hip strengthening on knee load, pain, and function in people with knee osteoarthritis: A protocol for a randomized, single-blind controlled trial. *BMC Musculoskeletal Disorders, 8*, 121–130.

Benum, P., Aamodt, A., & Haugan, K. (2004). Uncemented custom femoral components in hip arthroplasty. A prospective clinical study. *Orthopaedic Proceedings, 86*, 76–81.

Bhattacharya, A., Mueller, M., & Putz-Anderson, V. (1985). Traumatogenic factors affecting the knees of carpet installers. *Applied Ergonomics, 16*, 243–250.

Boden, B. P., Dean, G. S., Feagin, J. A., Jr., & Garrett, W. E., Jr. (2000). Mechanisms of anterior cruciate ligament injury. *Orthopedics, 23*(6), 573.

Bruchal, L. C. H. (1995). *Occupational knee disorders: An overview*. London: Taylor & Francis.

Bureau of Labor and Statistics. (2011). *Nonfatal occupational injuries and illnesses requiring days away from work, 2010* (Publication no. http://www.bls.gov/iif/oshcdnew.htm, http://www.bls.gov/iif/oshcdnew.htm).

Caldwell, G. L., Jr., Allen, A. A., & Fu, F. H. (1994). Functional anatomy and biomechanics of the meniscus. *Operative Techniques in Sports Medicine, 2*(3), 152–163.

Carson, D. W., & Ford, K. R. (2011). Sex differences in knee abduction during landing. *Sports Health: A Multidisciplinary Approach, 3*(4), 373–382.

Casely-Smith, J. (2000). Changes in the microcirculation at the superficial and deeper levels in lymphoedema: The effects and results of massage, compression, exercise and benzopyrones on these levels during treatment. *Clinical Hemorheology and Microcirculation, 23*(2–4), 335–343.

Chang, A., Hayes, K., Dunlop, D. D., Song, J., Hurwitz, D., Cahue, S., et al. (2005). Hip abduction moment and protection against medial tibiofemoral osteoarthritis progression. *Arthritis and Rheumatism, 52*(11), 3515–3519.

Chen, W., Su, Y., Zhang, Y., Zhang, Q., Zheng, Z., & Pan, J. (2010). Unusual combination of posterior femoral head dislocation with anterior and posterior wall fractures in the ipsilateral acetabulum. *Orthopedics, 33*(6), 440.

Clegg, T. E., Roberts, C. S., Greene, J. W., & Prather, B. A. (2010). Hip dislocations—Epidemiology, treatment, and outcomes. *Injury, 41*(4), 329–334.

Coggon, D., Croft, P., Kellingray, S., Barrett, D., McLaren, M., & Cooper, C. (2000). Occupational physical activities and osteoarthritis of the knee. *Arthritis and Rheumatism, 43*(7), 1443–1449.

Cooper, C., McAlindon, T., Coggon, D., Egger, P., & Dieppe, P. (1994). Occupational activity and osteoarthritis of the knee. *Annals of Rheumatic Disease, 53*, 90–93.

Corbiere, M., Sullivan, M. J., Stanish, W. D., & Adams, H. (2007). Pain and depression in injured workers and their return to work: A longitudinal study. *Canadian Journal of Behavioural Science, 39*(1), 23–31.

Cornuz, J., Feskanich, D., Willett, W. C., & Colditz, G. A. (1999). Smoking, smoking cessation, and risk of hip fracture in women. *The American Journal of Medicine, 106*(3), 311–314.

Cornwall, R., & Radomisli, T. E. (2000). Nerve injury in traumatic dislocation of the hip. *Clinical Orthopaedics and Related Research, 377*, 84–91.

Court-Brown, C. M., McBirnie, J., & Wilson, G. (1998). Adult ankle fractures-an increasing problem? *Acta Orthopaedica, 69*(1), 43–47.

Cowling, E. J., & Steele, J. R. (2001). Is lower limb muscle synchrony during landing affected by gender? Implications for variations in ACL injury rates. *Journal of Electromyography and Kinesiology, 11*(4), 263–268.

Cummings, S. R. (1996). Treatable and untreatable risk factors for hip fracture. *Bone, 18*(3 Suppl. 1), S165–S167.

Cummings, S. R., Nevitt, M. C., Browner, W. S., Stone, K., Fox, K. M., Ensrud, K. E., et al. (1995). Risk factors for hip fracture in white women. *New England Journal of Medicine, 332*(12), 767–774.

D'Souza, J. C., Franzblau, A., & Werner, R. A. (2005). Review of epidemiological studies on occupational factors and lower extremity musculoskeletal and vascular disorders and symptoms. *Journal of Occupational Rehabilitation, 15*(2), 129–165.

Daly, P. J., Fitzgerald, R. H., Melton, L. J., & Llstrup, D. M. (1987). Epidemiology of ankle fractures in Rochester, Minnesota. *Acta Orthopaedica, 58*(5), 539–544.

de Vries, J. S., Kloen, P., Borens, O., Marti, R. K., & Helfet, D. L. (2006). Treatment of subtrochanteric nonunions. *Injury, 37*(2), 203–211.

DeMorat, G., Weinhold, P., Blackburn, T., Chudik, S., & Garrett, W. (2004). Aggressive quadriceps loading can induce noncontact anterior cruciate ligament injury. *The American Journal of Sports Medicine, 32*(2), 477–483.

Dersh, J., Mayer, T. G., Gatchel, R. J., Towns, B., Theodore, B. R., & Polatin, P. (2007). Psychiatric comorbidity in chronic disabling occupational spinal disorders has minimal impact on functional restoration socioeconomic outcomes. *Spine, 32*(17), 1917–1925.

Dodds, J. A., & Arnoczky, S. P. (1994). Anatomy of the anterior cruciate ligament: A blueprint for repair and reconstruction. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 10*(2), 132–139.

Dyson, M. (1987). Mechanisms involved in therapeutic ultrasound. *Physiotherapy, 73*(3), 116–120.

Edson, C. J. (2006). Conservative and postoperative rehabilitation of isolated and combined injuries of the medial collateral ligament. *Sports Medicine and Arthroscopy Review, 14*(2), 105–110.

Eiff, M., & Saultz, J. (1993). Fracture care by family physicians. *American Board of Family Practice, 6*, 179–181.

Elwakil, T. F. (2007). An in-vivo experiment evaluation of He-Ne laser photostimulation in healing Achilles tendons. *Lasers in Medical Science, 22*(1), 53–59.

Evans, E. M. (1949). The treatment of trochanteric fractures of the femur. *Journal of Bone and Joint Surgery. British Volume, 31*(2), 190–203.

Fallat, L., Grimm, D. J., & Saracco, J. A. (1998). Sprained ankle syndrome: Prevalence and analysis of 639 acute injuries. *The Journal of Foot and Ankle Surgery, 37*(4), 280–285.

Farmer, K. W., Jones, L. C., Brownson, K. E., Khanuja, H. S., & Hungerford, M. W. (2010). Trochanteric bursitis after total hip arthroplasty: Incidence and evaluation of response to treatment. *The Journal of Arthroplasty, 25*(2), 208–212.

Feagin, J., Jr., & Lambert, K. (1985). Mechanism of injury and pathology of anterior cruciate ligament injuries. *The Orthopedic Clinics of North America, 16*(1), 41.

Ferrari, J. D., Bach, B. R., Jr., Bush-Joseph, C. A., Wang, T., & Bojchuk, J. (2001). Anterior cruciate ligament reconstruction in men and women: An outcome analysis comparing gender. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 17*(6), 588–596.

Fetto, J. F., & Marshall, J. L. (1978). Medial collateral ligament injuries of the knee: A rationale for treatment. *Clinical Orthopaedics and Related Research, 132*, 206.

Finn, A. M., & MacAirt, J. (1994). A survey of the work practices of physiotherapists in the community. *Irish Journal of Medical Sciences, 163*, 61–64.

Furman, W., Marshall, J., & Girgis, F. (1976). The anterior cruciate ligament. A functional analysis based on postmortem studies. *The Journal of Bone and Joint Surgery. American Volume, 58*(2), 179.

Gatchel, R. J. (1996). Psychological disorders and chronic pain: Cause and effect relationships. In R. J. Gatchel & D. C. Turk (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (pp. 33–52). New York: Guilford.

Gibbs, N. (1994). Common rugby league injuries. *Sports Medicine, 18*(6), 438–450.

Goldblatt, J. P., & Richmond, J. C. (2003). Anatomy and biomechanics of the knee. *Operative Techniques in Sports Medicine, 11*(3), 172–186.

Gravlee, J. R., Hatch, R., & Galea, A. (2000). Achilles tendon rupture: A challenging diagnosis. *The Journal of the American Board of Family Practice, 13*(5), 371–373.

Guerra, J. J., & Born, C. T. (1994). The management of traumatic subtrochanteric fractures. *Operative Techniques in Orthopaedics, 4*(2), 116–121.

Gworys, K., Gasztych, J., Puzder, A., Gworys, P., & Kujawa, J. (2012). Influence of various laser therapy methods on knee joint pain and function in patients with knee osteoarthritis. *Medsport Press, 14*(3), 269–277.

Haidukewych, G. J., Israel, T. A., & Berry, D. J. (2001). Reverse obliquity fractures of the intertrochanteric region of the femur. *The Journal of Bone and Joint Surgery, 83*(5), 643–650.

Harmer, A. R., Naylor, J. M., Crosbie, J., & Russell, T. (2009). Land-based versus water-based rehabilitation following total knee replacement: A randomized, single-blind trial. *Arthritis Care and Research, 61*(2), 184–191.

Harper, W., Barnes, M., & Gregg, P. (1991). Femoral head blood flow in femoral neck fractures. An analysis using intra-osseous pressure measurement. *Journal of Bone and Joint Surgery. British Volume, 73-B*(1), 73–75.

Hatch, R. L., & Rosenbaum, C. I. (1994). Fracture care by family physicians. A review of 295 cases. *The Journal of Family Practice, 38*(3), 238.

Henning, C. E., Lynch, M. A., & Clark, J. R. (1987). Vascularity for healing of meniscus repairs. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 3*(1), 13–18.

Hewett, T. E., Myer, G. D., & Ford, K. R. (2001). Prevention of anterior cruciate ligament injuries. *Current Women's Health Reports, 1*(3), 218.

Hillyard, R. F., & Fox, J. (2003). Sciatic nerve injuries associated with traumatic posterior hip dislocations. *The American Journal of Emergency Medicine, 21*(7), 545–548.

Honkanen, R., Tuppurainen, M., Kröger, H., Alhava, E., & Saarikoski, S. (1998). Relationships between risk factors and fractures differ by type of fracture: A population-based study of 12192 perimenopausal women. *Osteoporosis International, 8*(1), 25–31.

Hull, M. L., Berns, G. S., Varma, H., & Patterson, H. A. (1996). Strain in the medial collateral ligament of the human knee under single and combined loads. *Journal of Biomechanics, 29*(2), 199–206.

Iannacone, W. M., Dalsey, R. M., & Wood, J. B., Jr. (1994). Fractures of the femoral head. *Operative Techniques in Orthopaedics, 4*(2), 104–110.

Indelicato, P. A. (1983). Non-operative treatment of complete tears of the medial collateral ligament of the knee [article]. *Journal of Bone and Joint Surgery. American Volume, 65*(3), 323–329.

Jensen, J. S. (1980). Classification of trochanteric fractures. *Acta Orthopaedica, 51*(1–6), 803–810.

Jensen, L., & Eenberg, W. (1996). Occupation as a risk factor for knee disorders. *Scandinavian Journal of Work, Environment and Health, 22*, 165–175.

Keating, J., & Aderinto, J. (2010). (v) The management of intracapsular fracture of the femoral neck. *Orthopaedics and Trauma, 24*(1), 42–52.

Keene, G. C. R., Bickerstaff, D., Rae, P. J., & Paterson, R. S. (1993). The natural history of meniscal tears in anterior cruciate ligament insufficiency. *The American Journal of Sports Medicine, 21*(5), 672–679.

Kessler, M., Behrend, H., Henz, S., Stutz, G., Rukavina, A., & Kuster, M. (2008). Function, osteoarthritis and activity after ACL-rupture: 11 years follow-up results of conservative versus reconstructive treatment. *Knee Surgery, Sports Traumatology, Arthroscopy, 16*(5), 442–448.

Kidner, C. L., Mayer, T. G., & Gatchel, R. J. (2009). Higher opioid doses predict poorer functional outcome in patients with chronic disabling occupational musculoskeletal disorders. *Journal of Bone and Joint Surgery, 91*(4), 919–927.

Kirkeskov, J., & Eenberg, W. (1996). Occupation as a risk for knee disorders. *Scandinavian Journal of Work, Environment and Health, 22*, 165–175.

Kivimaki, J., Riihimaki, H., & Hanninen, K. (1994). Knee disorders in carpet and floor layers and painters. *Scandinavian Journal of Work, Environment and Health, 26*, 97–101.

Kohatsu, N., & Schurman, D. (1990). Risk factors for the development of osteoarthritis of the knee. *Clinical Orthopaedics and Related Research, 261*, 242–246.

Korompilias, A., Lykissas, M., Vekris, M., Beris, A., & Soucacos, P. (2008). Microsurgery for lower extremity injuries. *International Journal of the Care of the Injured, 39S*, 103–108.

Lam, M.-H., Fong, D., Yung, P., Ho, E., Chan, W.-Y., & Chan, K.-M. (2009). Knee stability assessment on anterior cruciate ligament injury: Clinical and biomechanical approaches. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology, 1*(1), 1–9.

Lau, E., Cooper, C., Lam, D., Chan, V., Tsang, K., & Sham, A. (2000). Factors associated with osteoarthritis of the hip and knee in Hong Kong Chinese: Obesity, joint injury and occupation activities. *American Journal of Epidemiology, 12*, 855–862.

Leopold, S. S. (2009). Minimally invasive total knee arthroplasty for osteoarthritis. *The New England Journal of Medicine, 360*, 1749–1758.

Lin, C.-F., Liu, H., Gros, M. T., Weinhold, P., Garrett, W. E., & Yu, B. (2012). Biomechanical risk factors of non-contact ACL injuries: A stochastic biomechanical modeling study. *Journal of Sport and Health Science, 1*(1), 36–42.

Lloyd, C., Waghorn, G., & McHugh, C. (2008). Musculoskeletal disorders and comorbid depression: Implications for practice. *Australian Occupational Therapy Journal, 55*, 23–29.

Lohmander, L. S., Englund, P. M., Dahl, L. L., & Roos, E. M. (2007). The long-term consequence of anterior cruciate ligament and meniscus injuries osteoarthritis. *The American Journal of Sports Medicine, 35*(10), 1756–1769.

Lohmander, L., Östenberg, A., Englund, M., & Roos, H. (2004). High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. *Arthritis & Rheumatism, 50*(10), 3145–3152.

Lonergan, K. T., & Taylor, D. C. (2002). Medial collateral ligament injuries of the knee: An evolution of surgical reconstruction. *Techniques in Knee Surgery, 1*(2), 137–145.

Lorentzon, R., Wedrèn, H., & Pietilä, T. (1988). Incidence, nature, and causes of ice hockey injuries. A three-year prospective study of a Swedish elite ice hockey team. *The American Journal of Sports Medicine, 16*(4), 392–396.

Ly, T. V. & Swiontkowski, M. F. (2008). Treatment of femoral neck fractures in young adults. *Journal of Bone and Joint Surgery, 90*, 2254–2266.

MacEachern, A., & Heyse-Moore, G. (1983). Stable intertrochanteric femoral fractures. A misnomer? *Journal of Bone and Joint Surgery. British Volume, 65*(5), 582–583.

MacLaren, J. E., Gross, R. T., Sperry, J. A., & Boggess, J. T. (2006). Impact of opioid use on outcomes of functional restoration. *The Clinical Journal of Pain, 22*(4), 392–398.

Mäenpää, H., Soini, I., Lehto, M., & Belt, E. (2002). Insufficiency fractures in patients with chronic inflammatory joint diseases. *Clinical and Experimental Rheumatology, 20*(1), 77.

Maetzel, A., Makela, M., Hawker, G., & Bombadier, C. (1997). Osteoarthritis of the hip and knee and mechanical occupational exposure—A systematic overview of the evidence. *Journal of Rheumatology, 24*, 1599–1607.

Maffulli, N. (1998). The clinical diagnosis of subcutaneous tear of the Achilles tendon a prospective study in 174 patients. *The American Journal of Sports Medicine, 26*(2), 266–270.

Maffulli, N., Binfield, P. M., & King, J. B. (2003). Articular cartilage lesions in the symptomatic anterior cruciate ligament-deficient knee. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 19*(7), 685–690.

McCarthy, C. J., Millis, P. M., Pullen, R., Richardson, G., Hawkins, N., Roberts, C. R., et al. (2004). Supplementation of a home-based exercise programme with a class-based programme for people with osteoarthritis of the knees: A randomized controlled trial and health economic analysis. *Health Technology Assessment, 8*(46), 1–61.

Melton Iii, L. J. (1996). Epidemiology of hip fractures: Implications of the exponential increase with age. *Bone, 18*(3 Suppl. 1), S121–S125.

Metcalf, M. H., & Barrett, G. R. (2004). Prospective evaluation of 1485 meniscal tear patterns in patients with stable knees. *The American Journal of Sports Medicine, 32*(3), 675–680.

Milgrom, C., Giladi, M., Stein, M., Kashtan, H., Margulies, J., Chisin, R., et al. (1985). Stress fractures in military recruits. A prospective study showing an unusually high incidence. *Journal of Bone and Joint Surgery. British Volume, 67*(5), 732–735.

Monma, H., & Sugita, T. (2001). Is the mechanism of traumatic posterior dislocation of the hip a brake pedal injury rather than a dashboard injury? *Injury, 32*(3), 221–222.

Mulford, K. (2007). Greater trochanteric bursitis. *The Journal for Nurse Practitioners, 3*(5), 328–332.

Myburgh, K. H., Hutchins, J., Fataar, A. B., Hough, S. F., & Noakes, T. D. (1990). Low bone density is an etiologic factor for stress fractures in athletes. *Annals of Internal Medicine, 113*(10), 754.

Najibi, S., & Albright, J. P. (2005). The use of knee braces, part 1: Prophylactic knee braces in contact sports. *The American Journal of Sports Medicine, 33*(4), 602–611.

Ng, G. Y., & Chung, P. Y. (2012). Effects of therapeutic laser and passive stretching program for treating tendon overuse. *Photomedicine and Laser Surgery, 30*(3), 155–159.

Nikolić, D. K. (1998). Lateral meniscal tears and their evolution in acute injuries of the anterior cruciate ligament of the knee arthroscopic analysis. *Knee Surgery, Sports Traumatology, Arthroscopy, 6*(1), 26–30.

Okunribido, O. (2009). Lower limb MSD: Scoping work to help inform advice and research planning. In *HSE books: Health and Safety Executive* (Vol. BB706, pp. 1–69). Norwich: Crown.

Olsson, O., Ceder, L., & Hauggaard, A. (2001). Femoral shortening in intertrochanteric fractures. A comparison between the Medoff sliding plate and the compression hip screw. *Journal of Bone and Joint Surgery. British Volume, 83*(4), 572–578.

Partridge, R., Anderson, S., McCarthy, M., & Duthie, J. (1968). Rheumatic complaints among workers in iron foundries. *Annals of the Rheumatic Diseases, 27*, 441–453.

Pujol, N., Blanchi, M. P. R., & Chambat, P. (2007). The incidence of anterior cruciate ligament injuries among competitive Alpine skiers a 25-year investigation. *The American Journal of Sports Medicine, 35*(7), 1070–1074.

Punnett, L., & Wegman, D. (2004). Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology, 14*, 13–23.

Rano, J. A., Fallat, L. M., & Savoy-Moore, R. T. (2001). Correlation of heel pain with body mass index and other characteristics of heel pain. *The Journal of Foot and Ankle Surgery, 40*(6), 351–356.

Reid, C., Bush, P., Cummings, N., McMullin, D., & Durrani, S. (2010). A review of occupational knee disorders. *Journal of Occupational Rehabilitation, 20*, 489–501.

Richmond, T. S., Amsterdam, J. D., Guo, W., Ackerson, T., Gracias, V., Robinson, K. M., et al. (2009). The effect of post-injury depression on return to pre-injury function: A prospective cohort study. *Psychological Medicine, 39*(10), 1709–1720.

Riddle, D., Pulisic, M., Pidcoe, P., & Johnson, R. (2003). Risk factors for plantar fasciitis: A matched case–control study. *Journal of Bone and Joint Surgery, 85*, 872–877.

Riddle, D. L., & Schappert, S. M. (2004). Volume of ambulatory care visits and patterns of care for patients diagnosed with plantar fasciitis: A national study of medical doctors. *Foot & Ankle International, 25*(5), 303.

Roberts, D. M., & Stallard, T. C. (2000). Emergency department evaluation and treatment of knee and leg injuries. *Emergency Medicine Clinics of North America, 18*(1), 67–84.

Roddy, E., Zhang, W., & Doherty, M. (2005). Aerobic walking or strengthening exercise for osteoarthritis of the knee? A systematic review. *Annals of Rheumatic Diseases, 64*, 544–548.

Roshan, A., & Ram, S. (2008). The neglected femoral neck fracture in young adults: Review of a challenging problem. *Clinical Medicine & Research, 6*(1), 33–39.

Rupp, J. D., & Schneider, L. W. (2004). Injuries to the hip joint in frontal motor-vehicle crashes: Biomechanical and real-world perspectives. *The Orthopedic Clinics of North America, 35*(4), 493–504, vii.

Ryan, G. (1989). The prevalence of musculoskeletal symptoms in supermarket workers. *Ergonomics, 32*, 359–371.

Sah, A. P., & Marsh, E. (2008). Traumatic simultaneous asymmetric hip dislocations and motor vehicle accidents. *Orthopedics, 31*(6), 613.

Sandmark, H., Hogstedt, C., & Vingard, E. (2000). Primary osteoarthritis of the knee in men and women as a result of lifelong physical load from work. *Scandinavian Journal of Work, Environment and Health, 26*(1), 20–25.

Schnaue-Constantouris, E. M., Birrer, R. B., Grisafi, P. J., & Dellacorte, M. P. (2002). Digital foot trauma: Emergency diagnosis and treatment. *The Journal of Emergency Medicine, 22*(2), 163–170.

Schouten, J., de Bie, R., & Swain, G. (2002). An update on the relationship between occupational factors and arthritis of the hip and knee. *Current Opinion in Rheumatology, 14*, 89–92.

Shanks, P., Curran, M., Fletcher, P., & Thompson, R. (2010). The effectiveness of therapeutic ultrasound for musculoskeletal conditions of the lower limb: A literature review. *The Foot, 20*, 133–139.

Shaw, R. A., Holt, P. A., & Stevens, M. B. (1988). Heel pain in sarcoidosis. *Annals of Internal Medicine, 109*(8), 675–677.

Shukla, S., Johnston, P., Ahmad, M. A., Wynn-Jones, H., Patel, A. D., & Walton, N. P. (2007). Outcome of traumatic subtrochanteric femoral fractures fixed using cephalo-medullary nails. *Injury, 38*(11), 1286–1293.

Spindler, K. P., & Wright, R. W. (2008). Anterior cruciate ligament tear. *New England Journal of Medicine, 359*(20), 2135–2142.

Tanaka, S., Halperin, W., Smith, A., Lee, S., Luggen, M., & Hess, E. (2007). Skin effects of occupational kneeling. *American Journal of Industrial Medicine, 8*, 341–349.

Taylor, D. C., Englehardt, D. L., & Bassett, F. H. (1992). Syndesmosis sprains of the ankle. The influence of heterotopic ossification. *The American Journal of Sports Medicine, 20*(2), 146–150.

Teichtahl, A., Wluka, A., & Cicuttini, F. (2003). Abnormal biomechanics: A precursor or result of knee osteoarthritis? *British Journal of Sports Medicine, 37*, 289–290.

Thun, M., Tanaka, S., Smith, A., Halperin, W., Lee, S., Luggen, M., et al. (1987). Morbidity from repetitive knee trauma in carpet and floor layers. *British Journal of Industrial Medicine, 44*, 611–620.

Valtola, A., Honkanen, R., Kröger, H., Tuppurainen, M., Saarikoski, S., & Alhava, E. (2002). Lifestyle and other factors predict ankle fractures in perimenopausal women: A population-based prospective cohort study. *Bone, 30*(1), 238–242.

Vescovi, J. D., & VanHeest, J. L. (2010). Effects of an anterior cruciate ligament injury prevention program on performance in adolescent female soccer players.

Scandinavian Journal of Medicine & Science in Sports, 20(3), 394–402.

Village, J., Morrison, J., & Leyland, A. (1993). Biomechanical comparison of carpet-stretching devices. *Ergonomics, 36*, 899–909.

Watson, P. J., Booker, C. K., Morres, L., & Main, C. J. (2004). Returning the chronically unemployed with low back pain to employment. *European Journal of Pain, 8*(4), 359–369.

Werner, R., Gell, N., Hartigan, A., Wiggerman, N., & Keyserling, W. (2010). Risk factors for plantar fasciitis among assembly plant workers. *Physical Medicine and Rehabilitation, 2*, 110–116.

Woo, S. L. Y., Chan, S. S., & Yamaji, T. (1997). Biomechanics of knee ligament healing, repair and reconstruction. *Journal of Biomechanics, 30*(5), 431–439.

Yi, T. I., Lee, G. E., Seo, I. S., Huh, W. S., Yoon, T. H., & Kim, B. R. (2011). Clinical characteristics of the causes of plantar heel pain. *Annals of Rehabilitation Medicine, 35*(4), 507–513.

Yoshimura, N., Nishioka, S., Kinoshita, H., Hori, N., Nishioka, T., Ryujin, M., et al. (2004). Risk factors for knee osteoarthritis in Japanese women: Heavy weight, previous joint injuries, and occupational activities. *The Journal of Rheumatology, 31*, 157–162.

Yoshiya, S., Kuroda, R., Mizuno, K., Yamamoto, T., & Kurosaka, M. (2005). Medial collateral ligament reconstruction using autogenous hamstring tendons technique and results in initial cases. *The American Journal of Sports Medicine, 33*(9), 1380–1385.

Zuckerman, J. D. (1996). Hip fracture. *New England Journal of Medicine, 334*(23), 1519–1525.

6

Chronic Widespread Pain and Fibromyalgia Syndrome

Akiko Okifuji and Bradford D. Hare

Overview

Chronic widespread pain (CWP) is defined as musculoskeletal pain in multiple locations that represents generalized body pain. Fibromyalgia syndrome (FMS) is a subset of CWP, characterized with CWP, hyperalgesia, and a host of other functional and mood disturbances, such as fatigue, poor sleep, cognitive problems, depression, and anxiety (Wolfe et al., 1990). Conventionally, CWP and FMS have been treated as overlapping yet somewhat separate illness entities, resulting in two lines of research literature. In this chapter, we will provide a critical review on the disability issues of people with CWP, which include people with FMS. We will include information from research investigating FMS, CWP, or both. Thus, it will be helpful to first present how each condition is conceptualized and assessed.

History of FMS Assessment

Although much of research and public attention to FMS started to rise in the 1980s, it is not a new illness entity. The first published description of FMS appeared in the mid 1800s in Germany. A cluster of FMS-like symptoms were collectively labeled as "Muskelschwiele" (muscle callus), which was considered as severe muscle tenderness associated with rheumatism (Simons, 1975). In the early 1900s, Stockman (1904) described patients whose primary complaints consisted of hyperalgesia to pressure and worsening of pain in response to physical activities, and he considered the condition to be "muscular rheumatism." Around the same time, the term "fibrositis" was introduced by an English physician by the name of Gowers (1904), reflecting the thinking of the time that it was an inflammatory disorder in the connective tissues. Later research disconfirmed the presence of the inflammatory process in FMS, yet we had to wait another 80 years before the field accepted the more etiologically neutral term fibromyalgia, literally meaning pain in the muscles, tendons, and ligaments (Yunus, Masi, Calabro, Miller, & Feigenbaum, 1981).

By the 1970s, the term fibrosis had attained the unfortunate reputation of a "wastebasket diagnosis" for anyone with pain and fatigue with no known objective pathology. Furthermore, the lack of precision for clinically describing the phenomenon, and the random applications of various terms to describe FMS, resulted in the inclusion of a heterogeneous group of pain phenomena. These problems seriously undermined the scientific understanding of the disorder and the development of therapy approaches.

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The first classification criteria were developed by Kraft and his associates in 1966 (Kraft, Johnson, & LaBan, 1968). Interestingly, the criteria did not include the presence of CWP, but consisted of a "jump sign" (a behaviorally exaggerated flinching response to pressure), vasomotor instability of affected regions, delayed analgesic response to deep, aching pain, and what they referred to as "fibrocystic nodules," a ropey consistency of affected muscles. However, the clinical validity of these criteria was never established, and their application was limited. In 1972, Smythe (1972) took an approach to define the syndrome as a disorder of diffuse pain and stiffness, focusing primarily upon the typical clinical presentations of FMS. In addition to diffuse pain and stiffness, the criteria specified the symptoms onset following a minor injury and included generalized hyperalgesia, sleep disturbance with morning fatigue, and stiffness (see Table 6.1). Additionally, the criteria introduced some exclusion criteria to help rule out other rheumatologic pain conditions. In the late 1980s, Yunus, Masi, and Aldag (1989) extended Smythe's criteria into a more elaborate set of diagnostic criteria based upon a study comparing 63 FMS patients with 32 patients with rheumatoid arthritis and 30 healthy people (see Table 6.1). These criteria yielded over 90 % sensitivity and specificity against clinically office-based diagnosed FMS. Subsequently, the classification criteria for FMS were rapidly evolving in the 1970s and 1980s. The clinically based classification criteria also stimulated a proliferation of FMS research. However, unfortunately, the application of these criteria was not consistent across studies. It was therefore difficult to integrate the findings from multiple studies (Raspe & Croft, 1995).

Table 6.1 History of FMS classification criteria

- Smythe (1972): diagnostic criteria from clinical studies

  Obligatory criteria

  1. Subjective aching of 3 months or longer
  2. Subjective stiffness of 3 months or longer
  3. Local point tenderness
  4. Point tenderness in two other sites
  5. Normal ESR, SGOT, rheumatoid factor, ANF, muscle enzymes, and sacroiliac films

  Minor criteria

  1. Chronic fatigue
  2. Emotional distress
  3. Poor sleep
  4. Morning stiffness

- Smythe (1979): criteria

  History of widespread pain of 3 months or longer

  Tenderness at 12 of 14 specified sites

  Disturbed sleep with morning fatigue and stiffness

  Normal ESR, SGOT, rheumatoid factor, ANF, muscle enzymes, and sacroiliac films

- Yunus (1989): criteria

  Diagnosis of primary fibromyalgia syndrome requires major or minor criteria plus obligatory criteria

  Obligatory criteria

  1. Presence of pain or stiffness or both, at 4 or more anatomic sites for 3 months or longer
  2. Exclusion of an underlying condition which may be responsible for the overall features of fibromyalgia

  Major criteria

  Presence of 2 or more of 6 historical variables, plus 4 or more of 14 specified tender points

  Minor criteria

  Presence of 3 or more the 6 historical variables, plus 2 or more tender points

In order to move towards more systematic, empirically driven criteria to classify FMS, a multicenter study (Wolfe et al., 1990) was conducted in the late 1980s, involving approximately 300 patients with FMS and 285 control subjects. The essential point of this study was to delineate factors that could, with good sensitivity and specificity, differentiate FMS patients from people with other chronic pain conditions. Of course, the study was not free from the circular logic problem of FMS diagnosis when trying to determine the eligibility of study patients to define the very disorder of those patients. The multicenter study (Wolfe et al., 1990) dealt with this by defining the 300 FMS patients by the "usual" clinical method that each participating practitioner had been using. Based upon the results, the American College of Rheumatology (ACR) criteria were suggested. FMS patients should present (1) a history of widespread pain of 3 months or longer and (2) the presence of pain responses to at least 11 of 18 designated tender points (TPs).

Table 6.2 ACR criteria for classification of FMS

1. Presence of widespread pain for at least 3 months. Pain must be present in all of the body quadrants and axial skeletal area
2. Presence of pain in at least 11 of 18 tender points on digital palpation with approximately 4 kg force. Tender points are located in 9 bilateral sites as described below
Occiput: At the suboccipital muscle insertions
Low cervical: At the anterior aspects of the intertransverse spaces at C5–C7
Trapezius: At the midpoint of the upper boarder
Supraspinatus: At origins, above the scapula spine near the medial boarder
Second rib: At the second costochondral junctions, just lateral to the junctions on upper surfaces
Lateral epicondyle: At 2 cm distal to the epicondyles
Gulteal: In upper outer quadrants of buttocks in anterior fold of muscle
Greater trochanter: Posterior to the trochanteric prominence
Knee: At the medial fat proximal to the joint line

Adopted from Wolfe et al. (1990)

The locations of the TPs are described in Table 6.2 and drawn in Fig. 6.1.

The validity of the ACR criteria, just like the validity of the previously recommended criteria, is difficult to evaluate due to the absence of an absolute "gold standard" for diagnosing FMS, and this leads to a "logic dead end." The diagnosis is further complicated by the fact that FMS frequently co-occurs with other functional disorders that also are characterized by the symptoms commonly associated with FMS, such as fatigue, sleep disorder, and mood disturbance. Furthermore, since these problems are also common in other chronic pain conditions, they did not show enough discriminating power to be included into the ACR classification criteria. As a result, this exclusion of common clinical complaints has made many wonder how valid the ACR criteria really are (Clauw & Crofford, 2003; Goldenberg, 1999). It is generally granted that the ACR criteria were developed to improve consistency in defining study population. However, the ACR criteria seem to be rarely used in clinical practice. The agreement between FMS classification by the ACR criteria and clinical diagnosis is only modest, with a kappa coefficient of about .5 (Katz, Wolfe, & Michaud, 2006). There are not many disease entities showing such a discrepancy in the diagnostic approach between research and clinical practices.

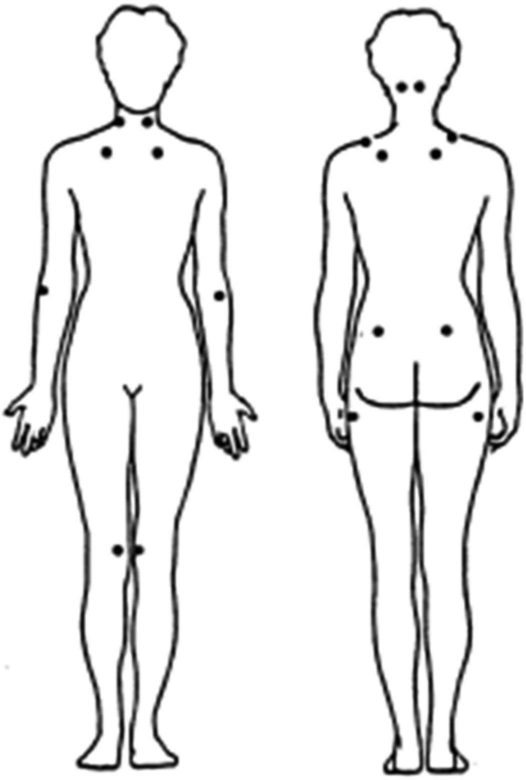
Fig. 6.1 ACR designated tender points

Although the TP criteria may correspond to the commonly observed hyperalgesic response to experimentally induced noxious stimuli (Clauw, Arnold, & McCarberg, 2011), there is no clear answer as to what painful TPs actually represent. The number of painful TPs (TP counts) is only moderately correlated with clinical pain report (Pamuk, Yesil, & Cakir, 2006), and TPs are generally related to the indices suggestive of psychosocial distress (McCarberg et al., 2003; Wolfe, 1997). In order to respond to the aforementioned criticisms, another multicenter study was recently conducted (Wolfe et al., 2010), yielding the preliminary new diagnostic criteria for FMS. The new criteria quantify CWP and the severity of commonly presented symptoms, but no longer require positive TP counts (see Table 6.2).

Table 6.3 New fibromyalgia diagnostic criteria

Criteria that must be met:			
1. Other disorders that would explain the pain must be ruled out			
2. Symptoms must be present for minimum of 3 months at the stable level			
3. Widespread pain index (WPI) and symptom severity scale (SS) levels must be greater than specified as below			
WPI: Areas where the patient complain of pain (score 0–19)			
Shoulder girdle left	Shoulder girdle right	Upper arm left	Upper arm right
Lower arm left	Lower arm right	Hip left	Hip right
Upper leg left	Upper leg right	Lower leg left	Lower leg right
Jaw left	Jaw right	Chest	Abdomen
Upper back	Lower back	Neck	
SS: (sum of severity scores of 3 symptoms and other somatic symptoms)			
Severity and symptoms	Fatigue	Waking unrefreshed	Cognitive symptoms
0: No problem			
1: Slight or mild problems, generally mild or intermittent			
2: Moderate, considerable problems, often present and/or at a moderate level			
3: Severe, pervasive, continuous, light-disturbing problems			
Levels of other somatic symptoms[a]:			
0 = No symptoms			
1 = Few symptoms			
2 = A moderate number of symptoms			
3 = A great deal of symptoms			

Adopted from Wolfe et al. (2010)

[a] There is a long list of somatic symptoms that can be included (see Wolfe et al. (2010) for details)

The symptoms include fatigue, unrefreshed wakening in the morning, and cognitive symptoms. The clinician is also required to rate the extensiveness of somatic complaints. It is important to note that the authors emphasize that the new criteria are not meant to replace the 1990 ACR criteria, but to complement it as a clinical classification tool. Nonetheless, the new criteria are likely to make the integrating CWP and FMS research easier and more meaningful. We have yet to see the data emerging based upon this new FMS classification. Thus, for this chapter, all research data of FMS patients are based upon the 1990 ACR criteria (see Table 6.3).

CWP Assessment

Research has used a range of methods to determine the presence of CWP. The determination of CWP requires two parameters of pain: chronicity and multiplicity of pain locations. Typical chronicity is defined as the presence of pain for 3 months or longer. The "widespreadness," on the other hand, has been defined in various ways. Some used simple descriptions such as "pain all over" or "multiple pain sites." The two most common standardized methods are the ACR criterion of CWP (see above) and Manchester method (MacFarlane, Croft, Schollum, & Silman, 1996). The Manchester method is more stringent than the ACR method, requiring at least two areas of pain in each limb.

Because the assessment of CWP relies on self-report, often without clinical examination, it is assumed that many of these patients meet the diagnostic criteria for FMS although the degree of such overlap is often not reported. Thus, in this chapter, when the study is only measuring CWP, unless specified, it should be assumed that the sample is likely a mix of patients with CWP but do not meet FMS criteria and patients with both CWP and FMS.

Epidemiology

There is more information about the prevalence of CWP than FMS because CWP can be assessed in a large sample set via survey or interview, whereas FMS requires a physical examination for confirmation based upon the 1990 ACR criteria. The population survey data of 2,000–4,000 community samples in various countries (UK, Sweden, Norway, Israel) revealed a range of prevalence at 4.2–18 %(Abusdal, Hagen, & Bjorndal, 1997; Bergman et al., 2001; Buskila, Abramov, Biton, & Neumann, 2000; Croft, Rigby, Boswell, Schollum, & Silman, 1993; Hunt, Silman, Benjamin, McBeth, & Macfarlane, 1999; Lindell, Bergman, Petersson, Jacobsson, & Herrstrom, 2000; Papageorgiou, Silman, & Macfarlane, 2002). The recent US data with 10,291 community residents (Hardt, Jacobsen, Goldberg, Nickel, & Buchwald, 2008a) yielded a rate of 3.6 % CWP prevalence. The variability in the prevalence rates is at least partially due to the assessment methods each study used. Gerdle et al. (2008) used two methods of assessing CWP: (1) the 1990 ACR CWP criteria and (2) criteria requiring the presence of pain in the spinal region and contralateral limb pain. Of their 7,637 community samples in Sweden, CWP based upon the ACR criteria was reported to be 4.8 % whereas 7.4 % prevalence was attained with the other criteria.

The prevalence rates of FMS also vary across studies, ranging from .7 to 11 % (Forseth & Gran, 1992; Hardt, Jacobsen, Goldberg, Nickel, & Buchwald, 2008b; Prescott et al., 1993; Toda, 2007; Wolfe, Ross, Anderson, Russell, & Hebert, 1995). White, Nielson, Harth, Ostbye, and Speechley (2002) screened 3,395 community residents and found 100 people meeting the FMS criteria (3 %). The National Arthritis Data Working Group has recently estimated that up to five million Americans suffer from this condition (Lawrence et al., 2008).

Although the rates differ across the studies, they consistently report that CWP/FSM is more common in females and have an increased rate with age. The prevalence of CWP/FMS also seems to increase in medical populations, particularly when the condition involves pain. The questionnaire study of 522 patients in the inpatient internal medicine ward with various medical conditions (Buskila et al., 2001) revealed 21 % CWP and 15 % FMS rates. Among 2,730 US workers who were disabled due to work-related injury, 32 % reported CWP (Mayer, Towns, Neblett, Theodore, & Gatchel, 2008). A subsequent study with 449 disabled workers showed a similar rate of CWP (33.9 %), with over two-thirds of those patients also qualifying for FMS. A recent study with 130 chronic back pain patients reported the presence of widespread pain in 28 % of these patients (Nordeman, Gunnarsson, & Mannerkorpi, 2012). These numbers far exceed the prevalence rate in the general public.

Very little is known about the occupational association for the development of CWP/FMS. However, certain occupations may have a higher prevalence of CWP. For example, 14.4 % of 643 female home-care workers reported CWP (Lundberg & Gerdle, 2002), a high-end range of the prevalence reported in the general population studies. Another occupation of interest is military personnel who are often exposed to extremely volatile physical and psychosocial situations. Interviews with veterans of the first Gulf War (Forman-Hoffman et al., 2007) yielded the rate of CWP in18 % of deployed military and 24 % of deployed national guard personnel, significantly greater than nondeployed military (9 %) and national guard (13 %) personnel. Similarly, post-deployment examination of 429 veterans from the Operation Enduring Freedom and Operation Iraqi Freedom yielded a CWP rate of 29 % (Helmer et al., 2009).

Pathophysiology

The etiology of FMS/CWP is unknown. There are several factors, however, that may underlie these conditions. This line of research has been mostly conducted with FMS patients, yielding the potential involvement of both peripheral and central pain modulation, neuroendocrine dysfunction, and dysregulation of the stress system.

Peripheral hypothesis: Earlier studies have suggested that peripheral abnormality in muscles may play a role in FMS. For example, localized hypoxia (Bengtsson & Henriksson, 1989) and metabolic abnormality (Sprott et al., 2000) in the affected areas have been observed in FMS patients. FMS patients may exhibit significantly lower levels of adenosine triphosphate and phosphocreatine based upon the P-31 magnetic resonance spectroscopic analysis of their muscles (Park, Phothimat, Oates, Hernanz-Schulman, & Olsen, 1998), suggesting the presence of muscle weakness and fatigability, possibly associated with metabolic dysfunction of the muscle. However, research has failed to support any electrodiagnostic evidence of ongoing denervation (Durette, Rodriquez, Agre, & Silverman, 1991) or of increased muscle sympathetic nerve discharge (Elam, Johansson, & Wallin, 1992) in FMS. There is also no microscopic evidence of definitive pathology in the muscle tissues of FMS patients (Drewes, Andreasen, Schroder, Hogsaa, & Jennum, 1993). Thus, the pathophysiological involvement of the peripheral abnormality is, at best, inconclusive at this time. The diffuse nature of the pain in this population also provides questionable credibility for the peripheral abnormality hypothesis. Nevertheless, some (Staud, 2011) argue that the potential involvement may occur via forming a peripheral chemical environment that leads to local sensitization, which may contribute to central pain sensitivity.

Central hypothesis: In contrast to the investigation of the peripheral mechanism, research has yielded consistent evidence suggesting the dysregulated central pain modulatory system in FMS. FMS patients exhibit enhanced pain response to various types of experimentally induced noxious stimulation (Arroyo & Cohen, 1993; Gibson, Littlejohn, Gorman, Helme, & Granges, 1994; Kosek & Hansson, 1997; Lautenbacher, Rollman, & McCain, 1994; Petzke, Clauw, Ambrose, Khine, & Gracely, 2003). An imaging study also showed that FMS patients achieved a comparable degree of cortical activation, relative to healthy people, in response to noxious stimuli but at a significantly lower severity of the stimuli (Gracely, Petzke, Wolf, & Clauw, 2002), also suggesting the presence of centrally dysregulated pain modulation in FMS.

FMS patients may also be associated with dysfunction in the endogenous inhibitory system of pain. Attenuated descending noxious inhibitory controls (DNIC) in FMS patients, but not in chronic low back pain patients, were found (Julien, Goffaux, Arsenault, & Marchand, 2005). Significantly reduced DNIC in FMS, relative to healthy people, has recently been reported, and the effects seem to be independent of depression (Normand et al., 2011). Furthermore, FMS patients show increased "windup" (WU) sensitivity (i.e., abnormally heightened temporal summation of pain) and maintain the WU sensitivity (Staud, Price, Robinson, Mauderli, & Vierck, 2004), suggesting the increased excitability of spinal cord neurons related to central sensitization.

Neuroendocrine hypothesis: Another hypothesis regarding the mechanism underlying FMS comes from the studies showing that FMS is related to low levels of serotonin in the plasma (Wolfe, Russell, Vipraio, Ross, & Anderson, 1997), serum (Ernberg, Voog, Alstergren, Lundeberg, & Kopp, 2000), chronic fatigue syndrome (CFS) concentration (Russell, Vaeroy, Javors, & Nyberg, 1992), transfer ratio of tryptophan (Norregaard, Bulow, Mehlsen, & Danneskiold-Samsoe, 1994), and reuptake site density (Russell et al., 1992). FMS may also be associated with disturbance in the dopamine regulation. FMS patients show an increased prolactin response to a buspirone challenge test, suggesting altered sensitivity in dopamine receptors in these patients (Malt, Olafsson, Aakvaag, Lund, & Ursin, 2003). An imaging study, using positron emission tomography tracing L-DOPA uptake, suggests that FMS may be related to the disrupted presynaptic dopamine activity (Wood et al., 2007).

The results from these studies suggest a possibility of the abnormal levels of these neurotransmitters associated with FMS. However, our current understanding of how exactly these neurotransmitters are involved in FMS is limited. Large individual variations in the neurotransmitter levels are present within a group of FMS patients. Clinical correlates of the neurotransmitter levels are also largely unknown. Indeed, the correlations of the serotonin level and depression symptoms in FMS patients were in the reverse direction from the expected in one study (Wolfe, Russell, et al., 1997).

Stress system hypothesis: Given that stress is one of the most prominent aggravating factors for FMS (Okifuji & Turk, 2002), dysregulation of the stress system may be involved in FMS. In general, research supports the notion that FMS may be related to abnormal functioning of the sympatho-adrenal system and hypothalamic-pituitary adrenergic (HPA) axis. FMS patients show altered baseline catecholamines compared to healthy individuals, independent of depression (Hamaty et al., 1989; Loevinger, Muller, Alonso, & Coe, 2007). FMS is also associated with abnormalities of reactivity of the HPA axis, such as abnormal adrenocorticotropic hormone (ACTH) response to exogenous corticotropin releasing hormone (CRH)-induced hypoglycemia and blunted cortisol response (Adler, Kinsley, Hurwitz, Mossey, & Goldenberg, 1999; Crofford et al., 1994). FMS patients also show disturbed heart rate variability (Cohen et al., 2000; Lerma et al., 2011). Compared to healthy people, FMS people show hyporeactive sympatho-adrenal and hypothalamic-pituitary response to exercise (Kadetoff & Kosek, 2010; van Denderen, Boersma, Zeinstra, Hollander, & van Neerbos, 1992). Overall, these studies suggest that FMS is associated with a hyperactive sympathetic activity with hyporeactive response to stress (Di Franco, Iannuccelli, & Valesini, 2010; Martinez-Lavin, 2007). This seemingly paradoxical response may result from chronic hyperstimulation of the beta-adrenergic receptors, leading to receptor desensitization and downregulation (Martinez-Lavin, 2007).

In addition, there may be some genetic components for these abnormalities. A recent study comparing 97 FMS patients to 59 healthy people (Xiao, He, & Russell, 2011) found a specific function-altering beta-adrenergic gene polymorphism in FMS patients, implicating genetic vulnerability in at least some FMS patients. A series of studies investigating gene expression in response to exercise (Light et al., 2012; Light, White, Hughen, & Light, 2009) also demonstrated a significant increase in gene expression of adrenergic molecular receptors in response to exercise, as well as at rest, in FMS patients compared to healthy controls.

Phenomenology of FMS/CWP

FMS/CWP is not lethal or progressive. However, the condition can be quite debilitating, and patients with FMS/CWP report severely compromised quality of life (QOL). QOL is a multifactorial, multilevel concept. In FMS/CWP, not only do disease-related factors determine the QOL, but a number of other psychosocial, environmental, and socioeconomic factors are involved. FMS/CWP seems to significantly influence and interact with those various factors, compromising the QOL for patients with FMS/CWP. For example, a large community survey, investigating comorbid mood disorders in various chronic illnesses (Gadalla, 2008), found that FMS and CFS, which often overlapped, had the highest comorbidity of mood disorders (27 % and 37 %, respectively). Community residents with CWP also seem to have higher comorbid chronic fatigue and mood disturbance (Kato, Sullivan, Evengard, & Pedersen, 2006).

An in-depth interview of eight people with CWP revealed a significant decrement in their ability to manage time in their daily lives due to tasks taking longer and disrupted routines (Richardson, Ong, & Sim, 2008). Natvig, Bruusgaard, and Eriksen (2001) compared 281 chronic back pain patients with widespread pain to 222 back pain patients without CWP and found that the former reported a significant reduction in the QOL, as well as poorer mood. Among people with chronic pain due to work-related injury, those with comorbid CWP/FMS tend to report greater psychosocial stress (Howard et al., 2010). Recently, Nordeman et al. (2012) reported that patients with CWP in the primary care setting exhibited significantly poorer physical functioning, greater pain and fatigue, and more severe mood disturbance than other patients in the practice.

There is little question that FMS/CWP adversely impacts patients' lives. FMS patients tend to report a lowered sense of physical well-being, greater long-term health concerns (Ejlertsson, Eden, & Leden, 2002; Wolfe, Anderson, et al., 1997a), and increased healthcare utilization (Bombardier & Buchwald, 1996; White, Speechley, Harth, & Ostbye, 1999). FMS seems to be a compounding factor in disability associated with other disease conditions, such as systemic lupus erythematosus (SLE) (Middleton, McFarlin, & Lipsky, 1994). Furthermore, FMS patients tend to rate their QOL as significantly more compromised, compared to other chronically ill patients (Burckhardt, Clark, & Bennett, 1993).

Work-Related Issues and FMS/CWP

Work Disability

Given the multiple symptoms, including chronic fatigue, pain, mood disturbance, and poor sleep, it should perhaps not be surprising that many FMS/CWP patients find it difficult to maintain their productivity at the workplace (Bennett, Jones, Turk, Russell, & Matallana, 2007). Work disability is prevalent in FMS/CWP. Bombardier and Buchwald (1996) reported that 35 % of FMS patients, and over 50 % of FMS patients with concurrent CFS, were unable to be gainfully employed due to their illness. Other studies (De Girolama, 1991; Penrod et al., 2004; Wolfe, Anderson, et al., 1997b) report that work disability due to FMS is found in 9–24 % of FMS patients.

In a study of 91 FMS patients from the community rheumatology clinics (Penrod et al., 2004), 78 % of the patients worked prior to their problems with FMS, whereas 44 % continued to work. Nine percent of the patients reported that they had retired due to FMS, and 16 % were on disability due to FMS. Estimated loss of work time per year due to FMS on average was over 12 weeks. A survey comparison between 136 FMS patients and 152 "clinic controls" (patients recruited from various outpatient clinics) (Al-Allaf, 2007) showed that FMS was associated with greater work dysfunction. Loss of work secondary to the health condition was reported by 47 % of FMS patients and 14 % of clinic controls.

Even when patients are gainfully employed, their productivity and attendance are likely to be adversely impacted by their pain conditions. Accumulated evidence suggests that people with chronic pain, including CWP and FMS, tend to have greater work disability and associated costs for work loss. The data from 31 large self-insured companies in the USA (L. A. White et al., 2008) showed that 8,513 employees with FMS and 7,260 employees with osteoarthritis (OA) missed 30 and 26 days, respectively, per year compared to 10 days in the 7,260 control employees. The cost incurred due to work disability was $2,913 for FMS, $2,537 for OA, and $1,359 for the control subjects (2005 dollars). Winkelmann et al. (2011) surveyed FMS patients in Germany and France and found that, on average, they missed 32 days (France) and 25 days (Germany) of work due to FMS. White and her colleagues, in their systematic examination of 100 FMS patients drawn from the larger community sample, reported 31 % of FMS patients were "work disabled," whereas 11 % of CWP and 2 % of general controls reported work disability (White et al., 1999). In this study, 65 % of FMS patients, 29 % of CWP subjects, and 9 % of controls reported that they needed to reduce work hours. The leading symptoms that limited work were reported to be pain (87 %), fatigue (80 %), weakness (73 %), and cognitive problems (51 %). In Spain (Rivera, Esteve-Vives, Vallejo, & Rejas, 2011), 68 % of 301 FMS patients reported to have temporary work disability, with the average missing work of 44 days per year. Also, veterans with CWP have a higher likelihood of disability (Forman-Hoffman et al., 2007): Odds ratios of those with CWP to have Veteran's Administration (VA) disability was 3.14; VA compensation was 2.89; and unemployment due to health problems of greater than 3 months was 7.8.

In a small sample of FMS patients, with the mean age of 43, Martinez, Ferraz, Sato, and Atra (1995) reported that 30 % of their patients had reduced their work hours, and 65 % had a reduction in their family income. A report by Assefi, Coy, Uslan, Smith, and Buchwald (2003) estimates that approximately one-half of patients with FMS lost a job due to the hardship associated with FMS. Even for those currently employed, many patients reduced their working hours (mean hours: 41–45 h per week prior to the FMS onset vs. 31–32 h per week currently). This is not to say that FMS patients willingly terminate their employment. Results from the narrative interview (Liedberg & Henriksson, 2002) indicate that FMS patients consider their work role to be an important part of their self-images. However, patients carefully review the work environment, such as the physical demands of work, the requirement for physical movement, and the opportunity to move around when they evaluate their ability to stay at work. In addition to their physical ability to perform tasks, comorbid conditions, such as fatigue and compromised ability to concentrate, may significantly interfere with certain occupational requirements. Moreover, the availability of psychosocial support at work seems essential. Many FMS patients feel that others do not understand their pain and suffering for their "invisible" illness. Acceptance of their frequent leaves for visiting healthcare providers may also influence their sense of well-being at work.

It is important to note that although FMS is considered as a pain disorder, other symptoms are also important in how occupationally disabled patients perceive themselves. The comparison between working and nonworking FMS patients (Henriksson & Liedberg, 2000) demonstrates that fatigue, irritability, and gastrointestinal discomfort were significant discriminating variables, whereas the two groups did not differ in age, duration of symptoms, number of pain locations, or pain-free time periods. It should also be noted that human resource data (Kleinman et al., 2009), examining the financial burden of illness to the employer, compared various work-related costs among people with FMS, people with OA, and people without FMS (in 2008 dollars). The average costs for short-term disability were $1,706 for FMS, $1,247 for OA, and $263 for non-FMS employees. Both employee groups of FMS and OA showed a greater amount of annual cost associated with sick leave ($582 and $514, respectively), compared to the controls ($329).

Disability Compensation Issues

The difficulty in maintaining gainful employment may lead FMS patients to apply for financial compensation for their disability. The prevalence of receiving financial compensation for their condition varies greatly from study to study. In one study, 55 % of their patients reported to be receiving either temporary or permanent disability compensation (Martinez et al., 1995). In a multicenter study, Wolfe, Anderson, et al. (1997b) found that approximately 15 % of FMS patients receive compensation from Social Security Disability, and an additional 10 % receive other types of financial compensation for disability. The results from a recent Internet survey (Bennett et al., 2007) reported that 20 % of the respondents have a history of filing for disability claims. In a small Swiss study with 48 FMS patients who were followed for 2 years (Noller & Sprott, 2003), 19 % of the patients applied for disability pension. Of course, it is difficult to integrate the results on the disability compensation issues across different countries because of the differences in the entitlement benefit system, laws and regulations governing the disability system, economical strength, and labor market. For example, only a small fraction of disability compensation is provided for FMS in the USA, whereas in Canada, McCain, Cameron, and Kennedy (1989) reported that 9 % of all disability compensation was paid for FMS. The situation, however, may change with a new ruling by the Social Security Administration in July 2012, to be discussed next.

Social Security Disability of FMS in the USA

The Social Security Administration has recently published a ruling providing guidance for the determination of disability claims for FMS patients (Social Security Administration, 2012). Previously, the subjective nature of FMS complaints and the lack of established etiology and pathology made the disability evaluation of FMS patients a difficult challenge. In the new ruling, the medically determinable impairment (MDI) of FMS is now established by appropriate medical evidence gathered by a licensed physician. The evaluation must include the history and physical examination. Treatment notes must be consistent with the diagnosis of FMS and indicate the course of the severity of disease, including the assessment of physical strength and functional abilities for at least 1 year prior to determination. The two sets of criteria acceptable for the diagnosis are the 1990 ACR classification criteria for FMS (Wolfe et al., 1990) and the 2010 ACR preliminary diagnostic criteria (Wolfe et al., 2010). Evidence from "other acceptable medical sources, such as psychologists" may be used in the determination to evaluate the "severity and functional effects of fibromyalgia" or if the person may have another MDI (p. 43643).

Once the MDI of FMS is established, the severity of impairment and whether it prevents the person from work must be determined based upon (a) person's work activity, (b) severity level of MDI, (c) medical comparability of the person's impairment with the items in the listing of impairments, and (d) residual functional capacity. Given the newness of the ruling, we cannot ascertain whether the new guidance will change the prevalence of the compensated disability in FMS.

Factors Affecting Loss or Reduction in Work

A number of factors affect a person's ability to maintain gainful employment. They are not necessarily all clinical factors. Non-clinical factors such as economical trends, physical demands of the job, regional variation in the job market, availability of job accommodations, marketability of patients' skills, extent of wage potential or replacement if job needs to be changed, and financial incentives all influence the likelihood of FMS/CWP patients staying in the workplace. Once out of the job market, finding an employer may be particularly difficult for patients who have a long history of chronic pain, especially if their job skills are predicated on high degrees of physical exertion. Given the fast-paced changes in technology, some skills can become outdated quickly, even for white-collared workers, thus requiring additional training.

The economic, political, and administrative factors notwithstanding, there are several clinical factors that seem to adversely impact employment and work productivity for FMS/CWP patients. Chronicity of the pain condition, for example, seems to play a role in increasing work disability. In the aforementioned study by White et al. (2002) with 100 FMS patients, the rates of claiming total disability and receiving disability pension were 21 % and 20 % at baseline, and increased to 35 % and 30 %, respectively, over the next 3 years.

The severity of the condition may also be a factor. A recent multicenter study with 203 FMS patients (Chandran et al., 2012) divided those patients into three severity levels, based upon the total score of the *Fibromyalgia Impact Questionnaire* (Burckhardt, Clark, & Bennett, 1991) that has extensively been used to measure the symptom severity and disability associated with FMS. Almost all of those in the mild range ($n = 21$) were currently homemakers working outside of the home, whereas this fell to 41 % for those in the severe range ($n = 33$). Over one-half of the severe range group (54 %) reported to have missed work at least 1 day in the past 4 weeks, whereas 14 % of the mild range group reported any days missed. The aforementioned epidemiological study of mood comorbidity in chronic illness (Gadalla, 2008) suggests that the presence of mood disorder may also be a risk factor for work disability among people with chronic medical conditions; the comorbid mood disorder seems to at least double the risk of short-term disability and may be an additional MDI.

Mannerkorpi and Gard (2012) identified three aspects of work demands: physical, psychosocial, and organizational demands to be critical. In order to best address how FMS patients can maintain their gainful employment, their coping resources to manage all three demands must be present. In their in-depth interview of 27 working FMS patients, limited physical capacity and increased stress were listed as top factors hindering continued work. Thus, modification of one aspect does not necessarily lead to a desirable outcome. For example, simply shortening work days (e.g., from 8 to 4 h a day) does not help much if the psychosocial work demand is unaddressed, as it would maintain the level of stress. Sallinen, Kukkurainen, Peltokallio, and Mikkelsson (2010) also identified four types of work-related concerns from interviewing 20 female FMS workers: mental confusion, coping with fluctuating symptoms, being "in-between" ability to work and disability, and being on the edge of exhaustion. When people are unsuccessful in addressing these concerns, their ability to maintain gainful employment seems to falter over time.

Functional Disability

Functional disability is a significant problem for both CWP and FMS, but particularly in FMS. Functional disability associated with FMS may be comparable in degree to other chronic illnesses, such as rheumatoid arthritis (Martinez et al., 1995) and spondyloarthropathy (Heikkila, Ronni, Kautiainen, & Kauppi, 2002). Others have shown that FMS patients claim a greater degree of perceived disability compared to CWP patients (K. P. White et al., 1999) and spinal cord injury patients (Cardol et al., 2002). In the community sample, having a CWP would significantly predict the likelihood of having low level of physical activity in the future (McBeth, Nicholl, Cordingley, Davies, & Macfarlane, 2010). Functional limitations in CWP/FMS are also observed in performance-based functional testing. Waehrens, Amris, and Fisher (2010) evaluated 50 women with CWP and found their motor and processing skills needed for activities of daily living (ADL) to be significantly reduced. Their subsequent study (Amris, Waehrens, Jespersen, Bliddal, & Danneskiold-Samsoe, 2011) included a larger sample (257 females with CWP) and specified those who met the criteria for FMS ($n = 199$). The majority of their sample (97 %) exhibited a significantly compromised level of ADL motor skills, with FMS patients showing greater impairment than CWP-only patients. Interestingly, these two studies failed to find meaningful association between performance-based, objective physical functioning, and self-reported disability.

The discrepancy between subjectively perceived disability and objective indices of functional disability has also been reported by others. Turk, Okifuji, Starz, and Sinclair (1996) found that the relationships between pain and perceived disability, and between pain and observed physical functioning, were significant, whereas there was no association between observed physical functioning and self-reported disability. These results suggest that FMS is associated with an inability to perceive accurately one's physical ability. Similar results have been reported by others (Hidding et al., 1994). Furthermore, although it is reasonable to point to the severity of illness as a primary determinant of disability, self-reported disability seems fairly independent of disease severity (Hawley, Wolfe, & Cathey, 1988). One potential factor accounting for the discrepancy may be fear of physical activity and related avoidance. For example, Vlaeyen, Kole-Snijders, Boeren, and van Eek (1995) state that the fear that physical activity may aggravate pain leads to further excessive guarding and avoidance of functional activity, leading to further deconditioning and disability in chronic pain patients. The vicious cycle of fear, deactivation, and disability may provide a feedback to patients' beliefs about their physical ability and, thus, these patients may underestimate their ability to perform physical tasks.

A study reporting the results from the comprehensive assessment of 233 FMS patients (Turk, Robinson, & Burwinkle, 2004) indicates that approximately 39 % of their patients showed a high level of fear about engaging in activity. Those with a high level of fear reported significantly greater perceived disability, pain, and mood disturbance. However, their physical performance, while they performed less on treadmill testing and other physical tasks assessing strength and flexibility, did not differ from those with the low level of fear. Another study by de Gier, Peters, and Vlaeyen (2003) has shown that FMS patients with a high level of fear for physical activity exhibited lower tolerance and endurance for the physical task. However, the effect disappeared when pain intensity was taken into consideration. The result is at variance with the multiple studies testing low back patients (e.g., Al-Obaidi, Nelson, Al-Awadhi, & Al-Shuwaie, 2000) showing that fear is not a solely function of pain. The authors speculate that the experimental demand of the physical task was perhaps not threatening enough to create a significant level of fear avoidance in their patients. Further research may clarify this point.

Exercise intolerance is also frequently noted for FMS/CWP patients. At times, this creates a clinical challenge when the treatment plan includes activating physical therapy. Research investigating the baseline level of physical conditioning for FMS patients, however, has yielded conflicting results. Some studies showed a below-average level of aerobic conditioning in the majority of FMS patients (Jacobsen & Holm, 1992; Mannerkorpi, Burckhardt, & Bjelle, 1994), although others report that FMS patients' aerobic capacity does not differ significantly from age-matched healthy individuals (even though FMS patients consistently rate the exercise as more demanding; Nielens, Boisset, & Masquelier, 2000; Norregaard et al., 1994). FMS patients consistently exhibit a significantly lower degree of muscle strength and endurance than do healthy people (Norregaard et al., 1994) and chronic myofascial pain patients (Jacobsen & Holm, 1992). The experience of severe post-exertional pain is common in FMS patients, especially the majority who also have comorbid CFS (Bennett, Cook, Clark, Burckhardt, & Campbell, 1997). In general, patients experience pain during the exercise but, upon termination of the activity, pain dissipates but will recur about 24–48 h later. Such delayed onset muscle/joint pain/soreness (DOMS) is common in FMS and may cause patients to drop out of an activation-oriented program or fail to adhere with the regimen (Sarzi-Puttini, Buskila, Carrabba, Doria, & Atzeni, 2008).

Relatively little is known about the factors contributing to the significant decline in functional ability in FMS patients. Mood disturbance, such as depression and anxiety, is significantly related to self-reported disability (Kurtze, Gundersen, & Svebak, 1999; Sherman, Turk, & Okifuji, 2000; White et al., 2002). Lifestyle of patients may also impact their self-evaluation of their disability. FMS patients who smoke tend to report higher degree of functional disability than those who did not smoke, and there seems to be a positive relationship between body mass index and self-reported disability (Yunus, Arslan, & Aldag, 2002). Obesity also seems to be related to poor physical strength and flexibility (Okifuji, Donaldson, Barck, & Fine, 2010). There is suggestive support that pain sensitivity for TPs may be associated with disability. However, as will be discussed later, subjective disability may not necessarily correspond with objective findings.

Healthcare Utilization

FMS/CWP can be costly from the health services perspectives. As we reviewed above, work disability is pervasive in FMS/CWP and healthcare costs tend to be correlated with work disability (Penrod et al., 2004). Wolfe, Anderson, et al. (1997a) conducted the first multicenter study of the healthcare utilization of FMS patients in seven healthcare centers. On average, FMS patients had one hospitalization every 3 years and approximately 10 outpatient visits per year. The mean annual cost for outpatient care, medications, and hospitalization was $2,274 (1996 dollars). The regression analysis revealed that the annual cost was related to the number of comorbidities, perceived disability, and perceived severity of FMS. In Canada (Dobkin et al., 2003), FMS patients reported to have had seven physician visits in the 6 months prior to the study. The regression analysis revealed that the number of physician visits was mostly related to younger age and greater number of comorbid symptoms. Moreover, the healthcare costs of FMS patients are greater than those without chronic pain. The data from the healthcare plan database (Berger, Dukes, Martin, Edelsberg, & Oster, 2007) reveal that FMS patients' total annual medical expenditures were nearly three times as much as compared to people without FMS ($9,573 vs. $3,291). Medication costs were also significantly greater for FMS individuals ($4,247) than for controls ($822).

We reviewed earlier that the severity of FMS may impact work disability. It also seems to impact healthcare costs. In the study by Chandran and colleagues (2012), the average annual healthcare costs of the FMS patients in the severe group were nearly twice as much as those in the mild and moderate levels ($9,310 vs. $4,854, $5,662, respectively). Healthcare costs for FMS appeared to be about the same range with other chronic pain conditions. Employment-based large sample studies, that compared employees with FMS, OA, and non-FMS patients, suggest that both employees with FMS and OA both utilize significantly greater healthcare resources. For example, in reviewing the large database of employees using private insurance, White et al. (2008) found that the annual healthcare costs are $7,286 for FMS employees, $8,625 for OA employees, and $3,915 for control employees (2005 dollars). Similarly, from the aforementioned human resource data, Kleinman et al. (2009) report the annual healthcare costs of $8,452 for FMS employees, $11,253 for OA employees, and $4,013 for non-FMS employees (2008 dollars). Furthermore, the healthcare cost of a pain condition appears to rise if FMS co-occurs with the pain condition. Using the retrospective analysis of a large administrative healthcare claim data, Silverman et al. (2009) have report that, although annual healthcare costs for employees with FMS and rheumatoid arthritis (RA) are comparable ($10,911 for FMS, $10,716 for RA), those with both conditions nearly doubled the cost ($19,359) (all in 2004 dollars).

The results from another study suggest that the healthcare cost for FMS may be rapidly climbing. Based upon the claim data of a Fortune 100 manufacturer, Robinson et al. (2003) compared the annual medical, pharmaceutical, and work-loss cost between FMS claimants and randomly selected claimants. The comparison revealed that the cost for the FMS claimants was substantially greater ($5,945) than that of the others ($2,486). When the figure was recalculated only for the employed claimants, FMS employees incurred a cost of $7,776 per year.

Does Pain Treatment Help Them Return to Work?

Our review thus far suggests that work disability is common in FMS/CWP, incurring large costs related to work- and healthcare-related disability. An important and related question is whether work disability changes as a function of successful treatment. This is a difficult question particularly because there is no universally effective treatment for FMS/CWP. A wide range of treatment modalities have been tried to treat FMS. The review of FMS treatment would be too extensive and beyond the scope of the present chapter. Interested readers may refer to other review papers (Clauw, 2008; Hassett & Williams, 2011). Briefly, research suggests that certain treatment modalities may benefit some FMS/CWP patients. Clinical benefit may result from using three classes of medications for some FMS patients: low-dose tricyclic compounds (Arnold, Keck, & Welge, 2000), serotonin-norepinephrine reuptake inhibitors (Geisser, Palmer, Gendreau, Wang, & Clauw, 2010), and anticonvulsant drugs (Arnold et al., 2008). However, the general consensus is that, given the complexity of the disorder, any unimodal approach has limited benefit, and symptoms need to be treated with multimodal biopsychosocial approaches (Clauw, 2008). For both FMS and CWP patients, such approaches should include education, activation exercise, and cognitive-behavioral therapy (Hassett & Williams, 2011). However, in general, individual variability in treatment response is large. Furthermore, very few studies focus on work disability as a potential outcome.

Straube et al. (2011) examined the four published clinical trials (total $n=2{,}757$) evaluating the efficacy of pregabalin at various daily dosages

(150, 300, 450, 600 mg) for assessing the treatment effect on self-reported work disability, as indicated by missed work in the previous week. Group comparisons by dose (and placebo) showed no significant difference in reducing the missed work days. However, those patients who "responded" to treatment (i.e., significant pain reduction of at least 30 %) showed significant reduction in missed work (2.1 to 1.1 days per week for those reporting 30–50 % pain reduction, 2.0 to .97 days per week for those reporting greater than 50 % pain reduction).

Lemstra and Olszynski (2005) compared the outcomes of a 6-week multimodal activating rehabilitation program to standard medical care for treating FMS and found that the former group improved on a broad range of pain and related areas, yet most patients did not change their work status. Although a greater number of patients in the rehabilitation group went back to work (12 %) than did the patients in the standard medical care (3 %), the difference was not statistically significant. Others (Skouen, Grasdal, & Haldorsen, 2006) suggest that a high intensity of rehabilitation may be needed to improve work disability for FMS/CWP patients. In their study, they compared disabled CWP patients (on sick leave for 3 months) who underwent "light" rehabilitation involving a few hours of treatment, intensive 4-week daily multimodal rehabilitation program, and standard medical care. For CWP women who underwent the intensive treatment, when compared to women undergoing standard medical care, the estimated work absence was 207 fewer missed days over 54 months.

Similarly, functional restoration programs for people with musculoskeletal pain following a work-related injury with or without CWP (Mayer et al., 2008) showed no difference in the rate of return to work 1 year after the treatment (86 % vs. 88 %). However, the subsequent study (Howard et al., 2010) showed that when FMS patients were treated as a separated category from CWP only, FMS patients seemed to show significantly lower rates of return to work, as well as work retention. Clearly, this area of inquiry is quite young and more research is needed before we developed a better understanding of how treatment may help work disability associated with FMS/CWP. As we noted previously, there are a number of non-clinical factors involved in the return-to-work issues, and research should take those non-clinical factors into account in interpreting the results. Patient factors, such as the level of disability, duration, and financial status, may also play a role. Their satisfaction with return to work may also be influenced by multiple factors relevant to the quality and quantity of work. Finally, the effects of treatment on work productivity for those who maintain their employment should reflect another important factor in assessing work disability in this population.

Summary and Conclusions

The literature provides overwhelming support that FMS/CWP, although not lethal, is a disabling pain disorder that disrupts patients' daily lives and work capacities. Many patients with these conditions leave the work force due to pain and associated problems. FMS/CWP patients miss many days of work because of pain, and the cost associated with their absence may be twice as high as those workers without FMS/CWP. The rate of unemployment among war veterans with CWP is also alarmingly high. Despite the prevalence and severity of the work disability among these patients, surprisingly little has been done to delineate risk factors as well as to evaluate the effects of treatment on the various parameters of work disability. Limited evidence suggests that chronicity and severity of pain, mood disturbance, and ability to cope with work demands may play an important role. Once we have a better understanding of risk factors, we should be able to develop a strategy that can be incorporated into the overall treatment plan.

Several studies indicate that smoking and obesity may also significantly contribute to functional disability. These two factors are generally related to a sedentary lifestyle, which may mediate the relationship. Given that physical activation is typically an important part of the treatment for these patients, researchers and clinicians may need to pay close attention to patients' lifestyle issues in order to evaluate their disability status. It should also be highlighted that many factors associated with work disability are not necessarily clinical features of FMS/CWP. For example, patients who are able to maintain employment often succeed in modifying the work demands to match their physical and coping resources. Collaboration between employers and healthcare providers may be needed to assure that patients can keep working with productive and satisfactory outcomes.

How work disability associated with FMS/CWP will interact with the recent change in the disability determination by the Social Security Administration is unknown at this early point in time. Internet postings of various sources focusing on this issue for FMS suggest that, generally, the change seems to be welcomed as it may provide the legitimacy to the disorder itself. However, it could increase the claims and thereby influence the financial disincentives for staying employed. Finally, it is important to keep in mind that there is a heterogeneity of FMS/CWP patients. Clinical presentations and treatment responses widely differ across patients. How patients adapt and cope with their FMS varies greatly across individuals. Cognitive appraisals of their plight, how patients' pain complaints are handled at home and at work, expectation of how physical activities affects their pain, and the availability of environmental resources to accommodate any changes that their FMS/CWP requires, all seem to have an impact on the patients' adaptation. Further research investigating these factors in relation to disability will help us better understand and manage this complex, debilitating pain disorder.

References

Abusdal, U. G., Hagen, K. B., & Bjorndal, A. (1997). Self-reported chronic muscle pain among women in Oslo. *Tidsskrift for den Norske Lægeforening, 117*(11), 1606–1610.

Adler, G. K., Kinsley, B. T., Hurwitz, S., Mossey, C. J., & Goldenberg, D. L. (1999). Reduced hypothalamic-pituitary and sympathoadrenal responses to hypoglycemia in women with fibromyalgia syndrome. *American Journal of Medicine, 106*(5), 534–543.

Al-Allaf, A. W. (2007). Work disability and health system utilization in patients with fibromyalgia syndrome. *Journal of Clinical Rheumatology, 13*(4), 199–201.

Al-Obaidi, S. M., Nelson, R. M., Al-Awadhi, S., & Al-Shuwaie, N. (2000). The role of anticipation and fear of pain in the persistence of avoidance behavior in patients with chronic low back pain. *Spine (Phila Pa 1976), 25*(9), 1126–1131.

Amris, K., Waehrens, E. E., Jespersen, A., Bliddal, H., & Danneskiold-Samsoe, B. (2011). Observation-based assessment of functional ability in patients with chronic widespread pain: A cross-sectional study. *Pain, 152*(11), 2470–2476.

Arnold, L. M., Keck, P. E., Jr., & Welge, J. A. (2000). Antidepressant treatment of fibromyalgia. A meta-analysis and review. *Psychosomatics, 41*(2), 104–113.

Arnold, L. M., Russell, I. J., Diri, E. W., Duan, W. R., Young, J. P., Jr., Sharma, U., et al. (2008). A 14-week, randomized, double-blinded, placebo-controlled monotherapy trial of pregabalin in patients with fibromyalgia. *The Journal of Pain, 9*(9), 792–805.

Arroyo, J. F., & Cohen, M. L. (1993). Abnormal responses to electrocutaneous stimulation in fibromyalgia [see comments]. *Journal of Rheumatology, 20*(11), 1925–1931.

Assefi, N. P., Coy, T. V., Uslan, D., Smith, W. R., & Buchwald, D. (2003). Financial, occupational, and personal consequences of disability in patients with chronic fatigue syndrome and fibromyalgia compared to other fatiguing conditions. *Journal of Rheumatology, 30*(4), 804–808.

Bengtsson, A., & Henriksson, K. G. (1989). The muscle in fibromyalgia–A review of Swedish studies. *Journal of Rheumatology. Supplement, 19*, 144–149.

Bennett, R. M., Cook, D. M., Clark, S. R., Burckhardt, C. S., & Campbell, S. M. (1997). Hypothalamic-pituitary-insulin-like growth factor-I axis dysfunction in patients with fibromyalgia. *Journal of Rheumatology, 24*(7), 1384–1389.

Bennett, R. M., Jones, J., Turk, D. C., Russell, I. J., & Matallana, L. (2007). An internet survey of 2,596 people with fibromyalgia. *BMC Musculoskeletal Disorders, 8*, 27.

Berger, A., Dukes, E., Martin, S., Edelsberg, J., & Oster, G. (2007). Characteristics and healthcare costs of patients with fibromyalgia syndrome. *International Journal of Clinical Practice, 61*(9), 1498–1508.

Bergman, S., Herrstrom, P., Hogstrom, K., Petersson, I. F., Svensson, B., & Jacobsson, L. T. (2001). Chronic musculoskeletal pain, prevalence rates, and sociodemographic associations in a Swedish population study. *Journal of Rheumatology, 28*(6), 1369–1377.

Bombardier, C. H., & Buchwald, D. (1996). Chronic fatigue, chronic fatigue syndrome, and fibromyalgia. Disability and health-care use. *Medical Care, 34*(9), 924–930.

Burckhardt, C. S., Clark, S. R., & Bennett, R. M. (1991). The fibromyalgia impact questionnaire: Development and validation. *Journal of Rheumatology, 18*(5), 728–733.

Burckhardt, C. S., Clark, S. R., & Bennett, R. M. (1993). Fibromyalgia and quality of life: A comparative analysis. *Journal of Rheumatology, 20*(3), 475–479.

Buskila, D., Abramov, G., Biton, A., & Neumann, L. (2000). The prevalence of pain complaints in a general population in Israel and its implications for utilization of health services. *Journal of Rheumatology, 27*(6), 1521–1525.

Buskila, D., Neumann, L., Odes, L. R., Schleifer, E., Depsames, R., & Abu-Shakra, M. (2001). The prevalence of musculoskeletal pain and fibromyalgia in patients hospitalized on internal medicine wards. *Seminars in Arthritis and Rheumatism, 30*(6), 411–417.

Cardol, M., de Jong, B. A., van den Bos, G. A., Beelem, A., de Groot, I. J., & de Haan, R. J. (2002). Beyond disability: Perceived participation in people with a chronic disabling condition. *Clinical Rehabilitation, 16*(1), 27–35.

Chandran, A., Schaefer, C., Ryan, K., Baik, R., McNett, M., & Zlateva, G. (2012). The comparative economic burden of mild, moderate, and severe fibromyalgia: Results from a retrospective chart review and cross-sectional survey of working-age U.S. adults. *Journal of Managed Care Pharmacy, 18*(6), 415–426.

Clauw, D. J. (2008). Pharmacotherapy for patients with fibromyalgia. *Journal of Clinical Psychiatry, 69*(Suppl 2), 25–29.

Clauw, D. J., Arnold, L. M., & McCarberg, B. H. (2011). The science of fibromyalgia. *Mayo Clinic Proceedings, 86*(9), 907–911.

Clauw, D. J., & Crofford, L. J. (2003). Chronic widespread pain and fibromyalgia: What we know, and what we need to know. *Best Practice & Research. Clinical Rheumatology, 17*(4), 685–701.

Cohen, H., Neumann, L., Shore, M., Amir, M., Cassuto, Y., & Buskila, D. (2000). Autonomic dysfunction in patients with fibromyalgia: Application of power spectral analysis of heart rate variability. *Seminars in Arthritis and Rheumatism, 29*(4), 217–227.

Crofford, L. J., Pillemer, S. R., Kalogeras, K. T., Cash, J. M., Michelson, D., Kling, M. A., et al. (1994). Hypothalamic-pituitary-adrenal axis perturbations in patients with fibromyalgia. *Arthritis and Rheumatism, 37*(11), 1583–1592.

Croft, P., Rigby, A. S., Boswell, R., Schollum, J., & Silman, A. (1993). The prevalence of chronic widespread pain in the general population. *Journal of Rheumatology, 20*(4), 710–713.

de Gier, M., Peters, M. L., & Vlaeyen, J. W. (2003). Fear of pain, physical performance, and attentional processes in patients with fibromyalgia. *Pain, 104*(1–2), 121–130.

De Girolama, G. (1991). Epidemiology and social costs of low back pain and fibromyalgia. *Clinical Journal of Pain, 7*(Suppl 1), S1–S7.

Di Franco, M., Iannuccelli, C., & Valesini, G. (2010). Neuroendocrine immunology of fibromyalgia. *Annals of the New York Academy of Sciences, 1193*, 84–90.

Dobkin, P. L., De Civita, M., Abrahamowicz, M., Bernatsky, S., Schulz, J., Sewitch, M., et al. (2003). Patient-physician discordance in fibromyalgia. *Journal of Rheumatology, 30*(6), 1326–1334.

Drewes, A. M., Andreasen, A., Schroder, H. D., Hogsaa, B., & Jennum, P. (1993). Pathology of skeletal muscle in fibromyalgia: A histo-immuno-chemical and ultra-structural study. *British Journal of Rheumatology, 32*(6), 479–483.

Durette, M. R., Rodriquez, A. A., Agre, J. C., & Silverman, J. L. (1991). Needle electromyographic evaluation of patients with myofascial or fibromyalgic pain. *American Journal of Physical Medicine and Rehabilitation, 70*(3), 154–156.

Ejlertsson, G., Eden, L., & Leden, I. (2002). Predictors of positive health in disability pensioners: A population-based questionnaire study using Positive Odds Ratio. *BMC Public Health, 2*, 20.

Elam, M., Johansson, G., & Wallin, B. G. (1992). Do patients with primary fibromyalgia have an altered muscle sympathetic nerve activity? *Pain, 48*(3), 371–375.

Ernberg, M., Voog, U., Alstergren, P., Lundeberg, T., & Kopp, S. (2000). Plasma and serum serotonin levels and their relationship to orofacial pain and anxiety in fibromyalgia. *Journal of Orofacial Pain, 14*(1), 37–46.

Forman-Hoffman, V. L., Peloso, P. M., Black, D. W., Woolson, R. F., Letuchy, E. M., & Doebbeling, B. N. (2007). Chronic widespread pain in veterans of the first Gulf War: Impact of deployment status and associated health effects. *The Journal of Pain, 8*(12), 954–961.

Forseth, K. O., & Gran, J. T. (1992). The prevalence of fibromyalgia among women aged 20–49 years in Arendal, Norway. *Scandinavian Journal of Rheumatology, 21*(2), 74–78.

Gadalla, T. (2008). Association of comorbid mood disorders and chronic illness with disability and quality of life in Ontario, Canada. *Chronic Diseases in Canada, 28*(4), 148–154.

Geisser, M. E., Palmer, R. H., Gendreau, R. M., Wang, Y., & Clauw, D. J. (2010). A pooled analysis of two randomized, double-blind, placebo-controlled trials of milnacipran monotherapy in the treatment of fibromyalgia. *Pain Practice, 11*(2), 120–131.

Gerdle, B., Bjork, J., Coster, L., Henriksson, K., Henriksson, C., & Bengtsson, A. (2008). Prevalence of widespread pain and associations with work status: A population study. *BMC Musculoskeletal Disorders, 9*, 102.

Gibson, S. J., Littlejohn, G. O., Gorman, M. M., Helme, R. D., & Granges, G. (1994). Altered heat pain thresholds and cerebral event-related potentials following painful CO2 laser stimulation in subjects with fibromyalgia syndrome. *Pain, 58*(2), 185–193.

Goldenberg, D. L. (1999). Fibromyalgia syndrome a decade later: What have we learned? *Archives of Internal Medicine, 159*(8), 777–785.

Gowers, W. (1904). Lumbago: Its lessons and analogues. *British Medical Journal, 1*, 117–121.

Gracely, R. H., Petzke, F., Wolf, J. M., & Clauw, D. J. (2002). Functional magnetic resonance imaging evidence of augmented pain processing in fibromyalgia. *Arthritis and Rheumatism, 46*(5), 1333–1343.

Hamaty, D., Valentine, J. L., Howard, R., Howard, C. W., Wakefield, V., & Patten, M. S. (1989). The plasma endorphin, prostaglandin and catecholamine profile of patients with fibrositis treated with cyclobenzaprine and placebo: A 5-month study. *Journal of Rheumatology. Supplement, 19*, 164–168.

Hardt, J., Jacobsen, C., Goldberg, J., Nickel, R., & Buchwald, D. (2008). Prevalence of chronic pain in a representative sample in the United States. *Pain Medicine, 9*(7), 803–812.

Hassett, A. L., & Williams, D. A. (2011). Non-pharmacological treatment of chronic widespread musculoskeletal pain. *Best Practice & Research. Clinical Rheumatology, 25*(2), 299–309.

Hawley, D. J., Wolfe, F., & Cathey, M. A. (1988). Pain, functional disability, and psychological status: A 12-month study of severity in fibromyalgia. *Journal of Rheumatology, 15*(10), 1551–1556.

Heikkila, S., Ronni, S., Kautiainen, H. J., & Kauppi, M. J. (2002). Functional impairment in spondyloarthropathy and fibromyalgia. *Journal of Rheumatology, 29*(7), 1415–1419.

Helmer, D. A., Chandler, H. K., Quigley, K. S., Blatt, M., Teichman, R., & Lange, G. (2009). Chronic widespread pain, mental health, and physical role function in OEF/OIF veterans. *Pain Medicine, 10*(7), 1174–1182.

Henriksson, C., & Liedberg, G. (2000). Factors of importance for work disability in women with fibromyalgia. *Journal of Rheumatology, 27*(5), 1271–1276.

Hidding, A., van Santen, M., De Klerk, E., Gielen, X., Boers, M., Geenen, R., et al. (1994). Comparison between self-report measures and clinical observations of functional disability in ankylosing spondylitis, rheumatoid arthritis and fibromyalgia. *Journal of Rheumatology, 21*(5), 818–823.

Howard, K. J., Mayer, T. G., Neblett, R., Perez, Y., Cohen, H., & Gatchel, R. J. (2010). Fibromyalgia syndrome in chronic disabling occupational musculoskeletal disorders: Prevalence, risk factors, and posttreatment outcomes. *Journal of Occupational and Environmental Medicine, 52*(12), 1186–1191.

Hunt, I. M., Silman, A. J., Benjamin, S., McBeth, J., & Macfarlane, G. J. (1999). The prevalence and associated features of chronic widespread pain in the community using the 'Manchester' definition of chronic widespread pain. *Rheumatology (Oxford), 38*(3), 275–279.

Jacobsen, S., & Holm, B. (1992). Muscle strength and endurance compared to aerobic capacity in primary fibromyalgia syndrome. *Clinical and Experimental Rheumatology, 10*(4), 419–420.

Julien, N., Goffaux, P., Arsenault, P., & Marchand, S. (2005). Widespread pain in fibromyalgia is related to a deficit of endogenous pain inhibition. *Pain, 114*(1–2), 295–302.

Kadetoff, D., & Kosek, E. (2010). Evidence of reduced sympatho-adrenal and hypothalamic-pituitary activity during static muscular work in patients with fibromyalgia. *Journal of Rehabilitation Medicine, 42*(8), 765–772.

Kato, K., Sullivan, P. F., Evengard, B., & Pedersen, N. L. (2006). Chronic widespread pain and its comorbidities: A population-based study. *Archives of Internal Medicine, 166*(15), 1649–1654.

Katz, R. S., Wolfe, F., & Michaud, K. (2006). Fibromyalgia diagnosis: A comparison of clinical, survey, and American College of Rheumatology criteria. *Arthritis and Rheumatism, 54*(1), 169–176.

Kleinman, N., Harnett, J., Melkonian, A., Lynch, W., Kaplan-Machlis, B., & Silverman, S. L. (2009). Burden of fibromyalgia and comparisons with osteoarthritis in the workforce. *Journal of Occupational and Environmental Medicine, 51*(12), 1384–1393.

Kosek, E., & Hansson, P. (1997). Modulatory influence on somatosensory perception from vibration and heterotopic noxious conditioning stimulation (HNCS) in fibromyalgia patients and healthy subjects. *Pain, 70*(1), 41–51.

Kraft, G. H., Johnson, E. W., & LaBan, M. M. (1968). The fibrositis syndrome. *Archives of Physical Medicine and Rehabilitation, 49*(3), 155–162.

Kurtze, N., Gundersen, K. T., & Svebak, S. (1999). Quality of life, functional disability and lifestyle among subgroups of fibromyalgia patients: The significance of anxiety and depression. *British Journal of Medical Psychology, 72*(Pt 4), 471–484.

Lautenbacher, S., Rollman, G. B., & McCain, G. A. (1994). Multi-method assessment of experimental and clinical pain in patients with fibromyalgia. *Pain, 59*(1), 45–53.

Lawrence, R. C., Felson, D. T., Helmick, C. G., Arnold, L. M., Choi, H., Deyo, R. A., et al. (2008). Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. *Arthritis and Rheumatism, 58*(1), 26–35.

Lemstra, M., & Olszynski, W. P. (2005). The effectiveness of multidisciplinary rehabilitation in the treatment of fibromyalgia: a randomized controlled trial. *Clinical Journal of Pain, 21*(2), 166–174.

Lerma, C., Martinez, A., Ruiz, N., Vargas, A., Infante, O., & Martinez-Lavin, M. (2011). Nocturnal heart rate variability parameters as potential fibromyalgia biomarker: Correlation with symptoms severity. *Arthritis Research and Therapy, 13*(6), R185.

Liedberg, G. M., & Henriksson, C. M. (2002). Factors of importance for work disability in women with fibromyalgia: An interview study. *Arthritis and Rheumatism, 47*(3), 266–274.

Light, A. R., Bateman, L., Jo, D., Hughen, R. W., Vanhaitsma, T. A., White, A. T., et al. (2012). Gene expression alterations at baseline and following moderate exercise in patients with chronic fatigue syndrome and fibromyalgia syndrome. *Journal of Internal Medicine, 271*(1), 64–81.

Light, A. R., White, A. T., Hughen, R. W., & Light, K. C. (2009). Moderate exercise increases expression for sensory, adrenergic, and immune genes in chronic fatigue syndrome patients but not in normal subjects. *The Journal of Pain, 10*(10), 1099–1112.

Lindell, L., Bergman, S., Petersson, I. F., Jacobsson, L. T., & Herrstrom, P. (2000). Prevalence of fibromyalgia and chronic widespread pain. *Scandinavian Journal of Primary Health Care, 18*(3), 149–153.

Loevinger, B. L., Muller, D., Alonso, C., & Coe, C. L. (2007). Metabolic syndrome in women with chronic pain. *Metabolism, 56*(1), 87–93.

Lundberg, G., & Gerdle, B. (2002). Tender point scores and their relations to signs of mobility, symptoms, and disability in female home care personnel and the prevalence of fibromyalgia syndrome. *Journal of Rheumatology, 29*(3), 603–613.

MacFarlane, G. J., Croft, P. R., Schollum, J., & Silman, A. J. (1996). Widespread pain: Is an improved classification possible? *Journal of Rheumatology, 23*(9), 1628–1632.

Malt, E. A., Olafsson, S., Aakvaag, A., Lund, A., & Ursin, H. (2003). Altered dopamine D2 receptor function in fibromyalgia patients: A neuroendocrine study with buspirone in women with fibromyalgia compared to female population based controls. *Journal of Affective Disorders, 75*(1), 77–82.

Mannerkorpi, K., Burckhardt, C. S., & Bjelle, A. (1994). Physical performance characteristics of women with fibromyalgia. *Arthritis Care and Research, 7*(3), 123–129.

Mannerkorpi, K., & Gard, G. (2012). Hinders for continued work among persons with fibromyalgia. *BMC Musculoskeletal Disorders, 13*, 96.

Martinez, J. E., Ferraz, M. B., Sato, E. I., & Atra, E. (1995). Fibromyalgia versus rheumatoid arthritis: A longitudinal comparison of the quality of life. *Journal of Rheumatology, 22*(2), 270–274.

Martinez-Lavin, M. (2007). Biology and therapy of fibromyalgia. Stress, the stress response system, and fibromyalgia. *Arthritis Research and Therapy, 9*(4), 216.

Mayer, T. G., Towns, B. L., Neblett, R., Theodore, B. R., & Gatchel, R. J. (2008). Chronic widespread pain in patients with occupational spinal disorders: Prevalence, psychiatric comorbidity, and association with outcomes. *Spine (Phila Pa 1976), 33*(17), 1889–1897.

McBeth, J., Nicholl, B. I., Cordingley, L., Davies, K. A., & Macfarlane, G. J. (2010). Chronic widespread pain predicts physical inactivity: Results from the prospective EPIFUND study. *European Journal of Pain, 14*(9), 972–979.

McCain, G. A., Cameron, R., & Kennedy, J. C. (1989). The problem of long-term disability payments and litigation in primary fibromyalgia: The Canadian perspective. *Journal of Rheumatology. Supplement, 19*, 174–176.

McCarberg, B., Barkin, R. L., Wright, J. A., Cronan, T. A., Groessl, E., & Schmidt, S. M. (2003). Tender points as predictors of distress and the pharmacologic management of fibromyalgia syndrome. *American Journal of Therapy, 10*(3), 176–192.

Middleton, G. D., McFarlin, J. E., & Lipsky, P. E. (1994). The prevalence and clinical impact of fibromyalgia in systemic lupus erythematosus [see comments]. *Arthritis and Rheumatism, 37*(8), 1181–1188.

Natvig, B., Bruusgaard, D., & Eriksen, W. (2001). Localized low back pain and low back pain as part of widespread musculoskeletal pain: Two different disorders? A cross-sectional population study. *Journal of Rehabilitation Medicine, 33*(1), 21–25.

Nielens, H., Boisset, V., & Masquelier, E. (2000). Fitness and perceived exertion in patients with fibromyalgia syndrome. *Clinical Journal of Pain, 16*(3), 209–213.

Noller, V., & Sprott, H. (2003). Prospective epidemiological observations on the course of the disease in fibromyalgia patients. *Journal of Negative Results in Biomedicine, 2*, 4.

Nordeman, L., Gunnarsson, R., & Mannerkorpi, K. (2012). Prevalence and characteristics of widespread pain in female primary health care patients with chronic low back pain. *Clinical Journal of Pain, 28*(1), 65–72.

Normand, E., Potvin, S., Gaumond, I., Cloutier, G., Corbin, J. F., & Marchand, S. (2011). Pain inhibition is deficient in chronic widespread pain but normal in major depressive disorder. *Journal of Clinical Psychiatry, 72*(2), 219–224.

Norregaard, J., Bulow, P. M., Mehlsen, J., & Danneskiold-Samsoe, B. (1994). Biochemical changes in relation to a maximal exercise test in patients with fibromyalgia. *Clinical Physiology, 14*(2), 159–167.

Okifuji, A., Donaldson, G. W., Barck, L., & Fine, P. G. (2010). Relationship between fibromyalgia and obesity in pain, function, mood, and sleep. *The Journal of Pain, 11*(12), 1329–1337.

Okifuji, A., & Turk, D. C. (2002). Stress and psychophysiological dysregulation in patients with fibromyalgia syndrome. *Applied Psychophysiology and Biofeedback, 27*(2), 129–141.

Pamuk, O. N., Yesil, Y., & Cakir, N. (2006). Factors that affect the number of tender points in fibromyalgia and chronic widespread pain patients who did not meet the ACR 1990 criteria for fibromyalgia: Are tender points a reflection of neuropathic pain? *Seminars in Arthritis and Rheumatism, 36*(2), 130–134.

Papageorgiou, A. C., Silman, A. J., & Macfarlane, G. J. (2002). Chronic widespread pain in the population: A seven year follow up study. *Annals of the Rheumatic Diseases, 61*(12), 1071–1074.

Park, J. H., Phothimat, P., Oates, C. T., Hernanz-Schulman, M., & Olsen, N. J. (1998). Use of P-31 magnetic resonance spectroscopy to detect metabolic abnormalities in muscles of patients with fibromyalgia. *Arthritis and Rheumatism, 41*(3), 406–413.

Penrod, J. R., Bernatsky, S., Adam, V., Baron, M., Dayan, N., & Dobkin, P. L. (2004). Health services costs and their determinants in women with fibromyalgia. *Journal of Rheumatology, 31*(7), 1391–1398.

Petzke, F., Clauw, D. J., Ambrose, K., Khine, A., & Gracely, R. H. (2003). Increased pain sensitivity in fibromyalgia: Effects of stimulus type and mode of presentation. *Pain, 105*(3), 403–413.

Prescott, E., Kjoller, M., Jacobsen, S., Bulow, P. M., Danneskiold-Samsoe, B., & Kamper-Jorgensen, F.

(1993). Fibromyalgia in the adult Danish population: I. A prevalence study. *Scandinavian Journal of Rheumatology, 22*(5), 233–237.

Raspe, H., & Croft, P. (1995). Fibromyalgia. *Baillieres Clinical Rheumatology, 9*(3), 599–614.

Richardson, J. C., Ong, B. N., & Sim, J. (2008). Experiencing and controlling time in everyday life with chronic widespread pain: A qualitative study. *BMC Musculoskeletal Disorders, 9*, 3.

Rivera, J., Esteve-Vives, J., Vallejo, M. A., & Rejas, J. (2011). Factors associated with temporary work disability in patients with fibromyalgia. *Rheumatology International, 31*(11), 1471–1477.

Robinson, R. L., Birnbaum, H. G., Morley, M. A., Sisitsky, T., Greenberg, P. E., & Claxton, A. J. (2003). Economic cost and epidemiological characteristics of patients with fibromyalgia claims. *Journal of Rheumatology, 30*(6), 1318–1325.

Russell, I. J., Michalek, J. E., Vipraio, G. A., Fletcher, E. M., Javors, M. A., & Bowden, C. A. (1992). Platelet 3H-imipramine uptake receptor density and serum serotonin levels in patients with fibromyalgia/fibrositis syndrome [see comments]. *Journal of Rheumatology, 19*(1), 104–109.

Russell, I. J., Vaeroy, H., Javors, M., & Nyberg, F. (1992). Cerebrospinal fluid biogenic amine metabolites in fibromyalgia/fibrositis syndrome and rheumatoid arthritis. *Arthritis and Rheumatism, 35*(5), 550–556.

Sallinen, M., Kukkurainen, M. L., Peltokallio, L., & Mikkelsson, M. (2010). Women's narratives on experiences of work ability and functioning in fibromyalgia. *Musculoskeletal Care, 8*(1), 18–26.

Sarzi-Puttini, P., Buskila, D., Carrabba, M., Doria, A., & Atzeni, F. (2008). Treatment strategy in fibromyalgia syndrome: Where are we now? *Seminars in Arthritis and Rheumatism, 37*(6), 353–365.

Sherman, J. J., Turk, D. C., & Okifuji, A. (2000). Prevalence and impact of posttraumatic stress disorder-like symptoms on patients with fibromyalgia syndrome. *Clinical Journal of Pain, 16*(2), 127–134.

Silverman, S., Dukes, E. M., Johnston, S. S., Brandenburg, N. A., Sadosky, A., & Huse, D. M. (2009). The economic burden of fibromyalgia: Comparative analysis with rheumatoid arthritis. *Current Medical Research and Opinion, 25*(4), 829–840.

Simons, D. G. (1975). Muscle pain syndromes–Part I. *American Journal of Physical Medicine, 54*(6), 289–311.

Skouen, J. S., Grasdal, A., & Haldorsen, E. M. (2006). Return to work after comparing outpatient multidisciplinary treatment programs versus treatment in general practice for patients with chronic widespread pain. *European Journal of Pain, 10*(2), 145–152.

Smythe, H. (1972). Nonarticular rheumatism and the fibrositis syndrome. In L. Hollander (Ed.), *Arthritis and allied conditions; a textbook of rheumatology* (8th ed., pp. 874–884). Philadelphia, PA: Lea & Febiger.

Social Security Administration. (2012). Social security ruling, RSR 12–2: Title II and XVI: Evaluation of fibromyalgia. In F. Register (Ed.) (Vol. 77, pp. 43640–43644).

Sprott, H., Rzanny, R., Reichenbach, J. R., Kaiser, W. A., Hein, G., & Stein, G. (2000). 31P magnetic resonance spectroscopy in fibromyalgic muscle. *Rheumatology (Oxford), 39*(10), 1121–1125.

Staud, R. (2011). Peripheral pain mechanisms in chronic widespread pain. *Best Practice & Research. Clinical Rheumatology, 25*(2), 155–164.

Staud, R., Price, D. D., Robinson, M. E., Mauderli, A. P., & Vierck, C. J. (2004). Maintenance of windup of second pain requires less frequent stimulation in fibromyalgia patients compared to normal controls. *Pain, 110*(3), 689–696.

Stockman, R. (1904). The causes, pathology, and treatment of chronic rheumatism. *Edinburgh Medical Journal, 15*, 107–116.

Straube, S., Moore, R. A., Paine, J., Derry, S., Phillips, C. J., Hallier, E., et al. (2011). Interference with work in fibromyalgia: Effect of treatment with pregabalin and relation to pain response. *BMC Musculoskeletal Disorders, 12*, 125.

Toda, K. (2007). The prevalence of fibromyalgia in Japanese workers. *Scandinavian Journal of Rheumatology, 36*(2), 140–144.

Turk, D. C., Okifuji, A., Starz, T. W., & Sinclair, J. D. (1996). Effects of type of symptom onset on psychological distress and disability in fibromyalgia syndrome patients. *Pain, 68*(2–3), 423–430.

Turk, D. C., Robinson, J. P., & Burwinkle, T. (2004). Prevalence of fear of pain and activity in patients with fibromyalgia syndrome. *The Journal of Pain, 5*(9), 483–490.

van Denderen, J. C., Boersma, J. W., Zeinstra, P., Hollander, A. P., & van Neerbos, B. R. (1992). Physiological effects of exhaustive physical exercise in primary fibromyalgia syndrome (PFS): Is PFS a disorder of neuroendocrine reactivity? *Scandinavian Journal of Rheumatology, 21*(1), 35–37.

Vlaeyen, J. W., Kole-Snijders, A. M., Boeren, R. G., & van Eek, H. (1995). Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. *Pain, 62*(3), 363–372.

Waehrens, E. E., Amris, K., & Fisher, A. G. (2010). Performance-based assessment of activities of daily living (ADL) ability among women with chronic widespread pain. *Pain, 150*(3), 535–541.

White, L. A., Birnbaum, H. G., Kaltenboeck, A., Tang, J., Mallett, D., & Robinson, R. L. (2008). Employees with fibromyalgia: Medical comorbidity, healthcare costs, and work loss. *Journal of Occupational and Environmental Medicine, 50*(1), 13–24.

White, K. P., Nielson, W. R., Harth, M., Ostbye, T., & Speechley, M. (2002). Does the label "fibromyalgia" alter health status, function, and health service utilization? A prospective, within-group comparison in a community cohort of adults with chronic widespread pain. *Arthritis and Rheumatism, 47*(3), 260–265.

White, K. P., Speechley, M., Harth, M., & Ostbye, T. (1999). Comparing self-reported function and work disability in 100 community cases of fibromyalgia syndrome versus controls in London, Ontario: The London Fibromyalgia Epidemiology Study. *Arthritis and Rheumatism, 42*(1), 76–83.

Winkelmann, A., Perrot, S., Schaefer, C., Ryan, K., Chandran, A., Sadosky, A., et al. (2011). Impact of fibromyalgia severity on health economic costs: Results from a European cross-sectional study. *Applied Health Economics and Health Policy, 9*(2), 125–136.

Wolfe, F. (1997). The relation between tender points and fibromyalgia symptom variables: Evidence that fibromyalgia is not a discrete disorder in the clinic. *Annals of the Rheumatic Diseases, 56*(4), 268–271.

Wolfe, F., Anderson, J., Harkness, D., Bennett, R. M., Caro, X. J., Goldenberg, D. L., et al. (1997a). Health status and disease severity in fibromyalgia: Results of a six-center longitudinal study. *Arthritis and Rheumatism, 40*(9), 1571–1579.

Wolfe, F., Anderson, J., Harkness, D., Bennett, R. M., Caro, X. J., Goldenberg, D. L., et al. (1997b). Work and disability status of persons with fibromyalgia. *Journal of Rheumatology, 24*(6), 1171–1178.

Wolfe, F., Clauw, D. J., Fitzcharles, M. A., Goldenberg, D. L., Katz, R. S., Mease, P., et al. (2010). The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis Care & Research, 62*(5), 600–610.

Wolfe, F., Ross, K., Anderson, J., Russell, I. J., & Hebert, L. (1995). The prevalence and characteristics of fibromyalgia in the general population. *Arthritis and Rheumatism, 38*(1), 19–28.

Wolfe, F., Russell, I. J., Vipraio, G., Ross, K., & Anderson, J. (1997). Serotonin levels, pain threshold, and fibromyalgia symptoms in the general population. *Journal of Rheumatology, 24*(3), 555–559.

Wolfe, F., Smythe, H. A., Yunus, M. B., Bennett, R. M., Bombardier, C., Goldenberg, D. L., et al. (1990). The American College of Rheumatology 1990 Criteria for the Classification of Fibromyalgia. Report of the Multicenter Criteria Committee [see comments]. *Arthritis and Rheumatism, 33*(2), 160–172.

Wood, P. B., Patterson, J. C., II, Sunderland, J. J., Tainter, K. H., Glabus, M. F., & Lilien, D. L. (2007). Reduced presynaptic dopamine activity in fibromyalgia syndrome demonstrated with positron emission tomography: A pilot study. *The Journal of Pain, 8*(1), 51–58.

Xiao, Y., He, W., & Russell, I. J. (2011). Genetic polymorphisms of the beta2-adrenergic receptor relate to guanosine protein-coupled stimulator receptor dysfunction in fibromyalgia syndrome. *Journal of Rheumatology, 38*(6), 1095–1103.

Yunus, M. B., Arslan, S., & Aldag, J. C. (2002). Relationship between body mass index and fibromyalgia features. *Scandinavian Journal of Rheumatology, 31*(1), 27–31.

Yunus, M. B., Masi, A. T., & Aldag, J. C. (1989). Preliminary criteria for primary fibromyalgia syndrome (PFS): Multivariate analysis of a consecutive series of PFS, other pain patients, and normal subjects. *Clinical and Experimental Rheumatology, 7*(1), 63–69.

Yunus, M., Masi, A. T., Calabro, J. J., Miller, K. A., & Feigenbaum, S. L. (1981). Primary fibromyalgia (fibrositis): Clinical study of 50 patients with matched normal controls. *Seminars in Arthritis and Rheumatism, 11*(1), 151–171.

7

The Problem of Whiplash Injuries: Aetiology, Assessment and Treatment

Michele Sterling

Introduction

A large number of people are involved in a survivable road traffic crash (RTC) each year. While the health burden of major injuries, such as spinal cord and brain injuries, is clearly recognised, the physical and mental health outcomes of RTC survivors with predominantly non-hospitalised injuries are also surprisingly poor. Whiplash associated disorders (WAD) are the most common non-hospitalised RTC injury, and up to 50 % of people who experience a whiplash injury will never fully recover, and approximately 30 % will remain moderately to severely disabled by their condition (Carroll et al., 2008; Rebbeck, Sindhausen, & Cameron, 2006; Sterling, Jull, & Kenardy, 2006). Less recognised are the mental health issues that accompany this condition. The prevalence of psychiatric disorders has been shown to be 25 % for post-traumatic stress disorder (PTSD) (Kenardy, Heron-Delaney, Bellamy, Sterling, & Connelly, 2011; Mayou & Bryant, 2002; Sterling, Hendrikz, & Kenardy, 2010), 31 % for major depressive episode and 20 % for generalised anxiety disorder (Heron-Delaney, Kenardy, Bellamy, Sterling, & Connelly, 2011). Moreover, whiplash incurs enormous personal, social and economic costs. In Queensland, Australia, the economic costs related to whiplash injury are substantial, and exceeded $400 million from 2002 to 2009, with the condition accounting for the vast majority of *any* submitted claims, as well as the greatest incurred costs in the Queensland compulsory third-party insurance scheme (MAIC, 2010). Claims for personal injury after whiplash cost the United Kingdom more than £3 billion per year (Joslin, Khan, & Bannister, 2004), while data from the United States are even greater, with costs reaching $230 billion US dollars per annum (Blincoe et al., 2002).

The propensity to chronicity following whiplash injury is undoubtedly contributed to by the dearth of effective management strategies for either the early acute post-injury stage or those with an already chronic condition. Systematic reviews almost unanimously conclude that common and recommended treatment approaches, mainly comprising activity and exercise, are at best only modestly effective in reducing pain and disability (Rushton & Wright, 2011; Teasell et al., 2010a, 2010b). Despite this apparently bleak picture for health outcomes following whiplash injury, much research in recent times has focussed on understanding processes that underlie the pain, disability and psychosocial sequelae of this condition. It is envisaged that this new knowledge will lay the foundation for the

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development and testing of new interventions that may be more effective for this condition. This chapter will outline the clinical pathway following whiplash injury and the evidence supporting candidate aetiological processes involved in the initiation and maintenance of whiplash symptoms. A discussion of the implications of these findings for both the assessment and management of WAD will then be presented.

Clinical Pathway Following Whiplash Injury

While it has been generally perceived that the majority of injured people fully recover (Barnsley, Lord, & Bogduk, 1994), more recent data from various international cohorts indicate that up to 50 % of those injured will experience long-term pain and disability (Carroll et al., 2008). Most recovery, if it occurs, takes place in the first 2–3 months post-injury (Kamper, Rebbeck, Maher, McAuley, & Sterling, 2008; Sterling et al., 2010), suggesting this early time period may be crucial for appropriate intervention in order to avert the course to chronicity. Trajectory modelling techniques have identified distinct trajectory pathways for recovery of both physical and mental health issues. Physical trajectories include (Fig. 7.1) (1) initial milder pain/disability but full recovery, and 45 % participants were predicted to follow this trajectory; (2) initial moderate pain/disability with recovery to mild levels, and 39 % participants were predicted to follow this trajectory; and (3) initial severe levels of pain/disability persisting at chronic moderate/severe levels for the 12-month study period, and 16 % of participants were predicted to follow this trajectory (Sterling et al., 2010).

Mental health pathways have also been explored via measurement of post-traumatic stress symptom (PTSD) levels using the Post-traumatic Stress Diagnostic Scale (Foa, Riggs, Dancu, & Rothbaum, 1993). Trajectory modelling identified that (Fig. 7.2) 17 % of individuals will follow a trajectory of initial moderate/severe post-traumatic stress symptoms that persist for at least 12 months; 43 % will follow a trajectory of moderate initial symptoms that decrease but remain at mild to moderate (subclinical) levels for at least 12 months (the duration of the study) and 40 % will be resilient to the injury (Sterling et al., 2010). Additionally it has been shown that PTSD is present in approximately 20–30 % of individuals with chronic WAD (Dunne, Kenardy, & Sterling, 2012b; Sterling et al., 2010).

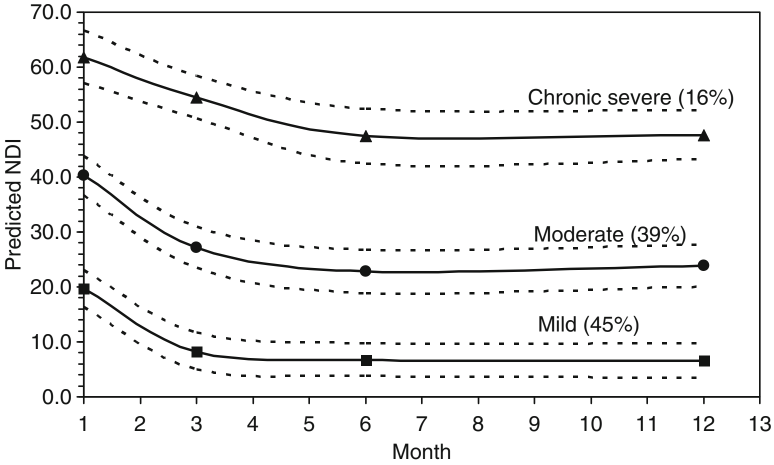

Fig. 7.1 Predicted Neck Disability Index (NDI) trajectories with 95 % confidence limits and predicted probability of membership (%). Suggested cut-offs for the NDI are 0–8 % (no pain and disability), 10–28 % (mild pain and disability), 30–48 % (moderate pain and disability), 50–68 % (severe pain and disability), and >70 % complete disability (MacDermid et al., 2009, with permission)

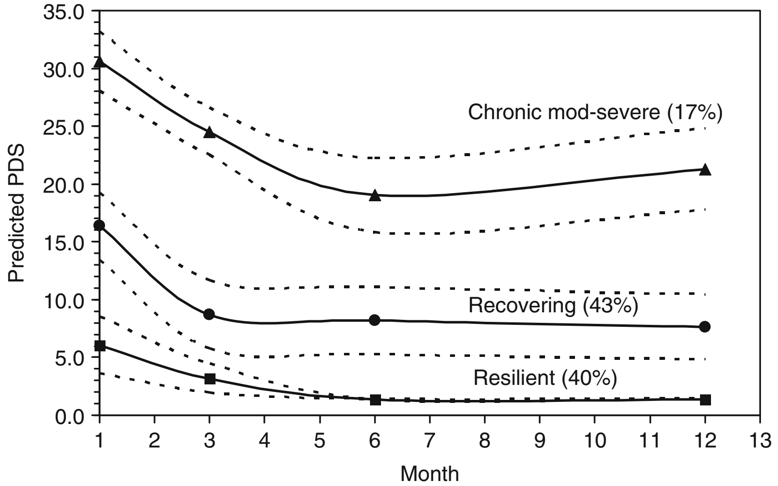

Fig. 7.2 Predicted Posttraumatic Stress Diagnostic Scale (PDS) trajectories with 95 % confidence limits and predicted probability of membership (%). Suggested cut-offs for the PDS total symptom severity score are 0 no rating, 1–10 mild, 11–20 moderate, 21–35 moderate to severe, and ≥36 severe (McCarthy, 2008, with permission)

These figures are significant as they are similar to the prevalence of PTSD in individuals admitted to hospital following 'more severe' motor vehicle injuries (O'Donnell, Creamer, Bryant, Schnyder, & Shalev, 2003). These data indicate that health outcomes following whiplash injury are poor and less favourable than originally thought, particularly as whiplash is both classified and often considered a 'minor' injury.

Prognostic Indicators for Poor Recovery

In view of the propensity to develop chronic pain and disability following a whiplash injury, it is important to be able to identify those at risk of poor recovery, as well as those with a favourable recovery pathway. This would assist in the triaging of injured people to the most appropriate interventions and optimally improve health outcomes. There are now numerous primary studies, and several systematic reviews, available that have investigated various factors for their capacity to predict those at risk. All systematic reviews conclude that initial levels of pain and/or disability soon after the MVC are consistent predictors of poor functional recovery. A recent phase 3 prognostic study also validated early higher disability levels as being predictive of later functional disability at 12 months post-injury (Sterling et al., 2012). These two factors have strong and consistent data available to support their prognostic capacity and should now be considered as requiring mandatory evaluation in the assessment of the patient with acute WAD. While most studies have evaluated these factors for prediction of physical health outcomes such as disability, several studies also show that initially higher levels of pain can predict poor psychological outcomes including later depression and PTSD symptoms (Phillips, Carroll, Cassidy, & Cote, 2010; Sterling, Hendrikz, & Kenardy, 2011).

Other factors, both physical and psychosocial, have also been studied, and several show promise as emerging prognostic factors. The physical factor with most consistent evidence is that of *cold hyperalgesia* or lowered cold pain thresholds. *Cold hyperalgesia* has been shown to predict levels of pain-related disability 12 months post-injury (Sterling et al., 2006) and psychological outcomes (Sterling, Hendrikz, et al., 2011); decreased cold pain tolerance (measured with the cold pressor test) also predicted ongoing disability (Kasch, Qerama, Bach, & Jensen, 2005). A recent systematic review concluded that there is now moderate evidence available to support cold hyperalgesia as an adverse prognostic indicator

(Goldsmith, Wright, Bell, & Rushton, 2012). Other sensory measures, such as lowered pressure pain thresholds (mechanical hyperalgesia) show inconsistent prognostic capacity. Walton et al. (2011) showed that decreased pressure pain thresholds over a distal site in the leg predicted neck pain-related disability at 3 months post-injury, but other studies have shown that this factor is not an independent predictor of later disability (Sterling et al., 2006). The exact mechanisms underlying the hyperalgesic responses are not clearly understood but are generally acknowledged to reflect augmented nociceptive processing in the central nervous system or central hyperexcitability (Curatolo, Arendt-Nielsen, & Petersen-Felix, 2004; Stone, Vicenzino, Lim, & Sterling, 2013).

To date, few movement or motor function-related factors demonstrate prognostic ability. Conflicting results have been found for the predictive capacity of neck range of movement (Walton, Pretty, MacDermid, & Teasell, 2009), while other factors, such as neck motor control, proprioceptive deficits and eye movement control, have not demonstrated predictive capacity, despite investigation in several studies (Kongsted, Leboeuf-Yde, Korsholm, & Bendix, 2008; Sterling et al., 2006). Psychosocial factors have also undergone extensive evaluation as predictors of poor recovery following whiplash injury. The more recent systematic reviews indicate that there is evidence for predictive capacity of symptoms of PTSD, lower self-efficacy, pain catastrophising and depressed mood (Walton et al., 2009; Williamson, Williams, Gates, & Lamb, 2008). Recent studies indicate that lower expectations of recovery are also predictive of poor recovery (Carroll, Holm, Ferrari, Ozegovic, & Cassidy, 2009; Holm, Carroll, Cassidy, Skillgate, & Ahlbom, 2008).

Most systematic reviews of prognosis have noted shortcomings in many of the primary cohort studies, including inconsistencies between studies in time from injury until baseline data collection, use of various and sometimes invalidated outcome measures and the lack of blinded outcome assessment among others (Carroll et al., 2008; Kamper et al., 2008; Walton et al., 2009). Additionally most have been phase 1 or exploratory studies, with few confirmatory or validation studies conducted (Sterling, Carroll, Kasch, Kamper, & Stemper, 2011). In light of this, the recent international summit meeting of researchers in this area recommended a preliminary 'core set' of predictors that may be considered as 'flags' or guides for clinicians to gauge a patient's prognosis (Sterling, Carroll, et al., 2011). The 'core set' included the following factors: self-reported pain levels, self-reported disability, neck range of movement, the presence of cold and mechanical hyperalgesia and measures of psychosocial factors (probably PTSD symptoms, but also other factors if indicated, such as depression, pain catastrophising, recovery beliefs and expectations among others) (Sterling, Carroll, et al., 2011). Since the publication of the summit outcomes and recommendations, a recent study has performed validation of a set of prognostic indicators, including initial disability, cold hyperalgesia, age and PTSD symptoms. The results indicated that while the predictive set was not precise in predicting a specific disability score at 12 months post-injury, it showed good accuracy to discriminate participants with moderate/severe disability at 12 months post-injury (Sterling et al., 2012). It was argued that this is a clinically relevant finding as practitioners aim to broadly identify patients likely to experience ongoing pain and disability. Such a validation study is rare in this area of research and goes some way towards providing greater confidence for the use of these measures in the early assessment of whiplash injury. It should also be highlighted that, while the knowledge of prognostic indicators has made great gains, it remains unclear as to whether or not the modification of the factors with targeted intervention strategies will improve outcomes for injured people. This will be the next logical progression for research of the whiplash condition.

Aetiological Processes Underlying the Whiplash Condition

One of the most controversial and unresolved issues surrounding WAD is the presence or not of a specific peripheral lesion of some kind. The current thinking is probably that there is convergent evidence available from various study types indicting that a peripheral lesion is likely to be present, at least initially, in some injured people (Curatolo et al., 2011). Data from bioengineering studies have identified the potential for lesions to occur (Yoganandan, Pintar, & Cusick, 2002): cadaveric studies where clear lesions are demonstrated in non-survivors of an MVC (Taylor & Taylor, 1996) and clinical studies identifying zygapophyseal joint involvement in a proportion of people with chronic WAD (Lord, Barnsley, Wallis, & Bogduk, 1996) support this proposal. Nevertheless, the clinical determination of specific injured-neck structures associated with a whiplash injury remains difficult, most likely due to the insensitivity of current imaging technologies (Ronnen, De Korte, & Brink, 1996; Steinberg, Ovadia, Nissan, Menahem, & Dekel, 2005). Furthermore, aside from some structures such as the zygapophyseal joint, it is also not clear how management approaches would change the target specific lesions even if they could be identified. It has also been argued that some features of WAD, such as hyperalgesia and pain, can occur in the absence of a specific peripheral lesion, but could be as consequence of factors such as those related to stress-system responses (McLean, 2011). In fact, results of animal studies have demonstrated that stress exposure by itself can induce hyperalgesia and allodynia in the absence of tissue trauma (McLean, 2011). For these reasons, much investigation focusing on the identification of potential underlying processes of the whiplash condition has been undertaken and has proven to be a fruitful area of research. Specifically, research has investigated changes in nociceptive processing, muscle and motor dysfunction, stress-related responses and psychological factors.

Changes in Nociceptive Processing

Most studies have utilised measures of quantitative sensory testing to provide an understanding of nociceptive processes. Both positive and negative sensory responses have been found to various stimuli, including hyperalgesia, allodynia as well as hypoaesthetic changes (Chien, Eliav, & Sterling, 2009; Sterling, Jull, Vicenzino, & Kenardy, 2003). Most sensory changes are widespread in nature, meaning that they are found not only over the injured area (cervical spine) but also in areas remote to the injured site, including both upper and lower limbs. These widespread sensory disturbances infer the presence of disturbed central nervous system processing which may be either facilitatory (sensitised) processes or a loss of inhibitory processes (Curatolo & Sterling, 2011). In the case of chronic WAD, two recent systematic reviews concluded that there is strong evidence of central hyperexcitability in chronic WAD (Stone et al., 2013; Van Oosterwijck, Nijs, Meeus, & Paul, 2013). These changes are not unique to WAD, but have been consistently demonstrated across many conditions including other musculoskeletal conditions such as arthritis (Bajaj, Bajaj, Graven-Nielsen, & Arendt-Nielsen, 2001), tennis elbow (Coombes, Bisset, & Vicenzino, 2012), temporomandibular joint pain (Ayesh, Jensen, & Svensson, 2007), cervical radiculopathy (Chien, Eliav, & Sterling, 2008) as well as in chronic post-surgical pain (Gottrup, Andersen, Arendt-Nielsen, & Jensen, 2000). However, there does appear to be some differences in sensory presentation among various musculoskeletal conditions. For example, cold hyperalgesia found in patients with chronic WAD, reporting moderate/severe pain and disability, seems to be greater than that observed in patients with tennis elbow and low back pain (Coombes et al., 2012; Lewis, Souvlis, & Sterling, 2010; Sterling, Jull, Vicenzino, et al., 2003), although a direct within-study comparison is yet to be undertaken. Another example is that neck pain of non-traumatic origin does not seem to display such overt sensory changes, with hyperalgesia confined to the cervical spine and little evidence of spread to distal areas (Chien, Eliav, & Sterling, 2010; Elliott et al., 2008). Taken together, these findings suggest that different nociceptive processing mechanisms likely underlie various musculoskeletal conditions, and this has implications for management where different strategies may be required depending upon the patient's presentation, as opposed to the diagnosed condition per se.

In comparison to other musculoskeletal conditions, there has been greater research of the transition from acute to chronic WAD, most probably due to the defined onset of symptoms by a specific event. In prospective cohort studies, it has emerged that sensory disturbances are also associated with the transition from acute to chronic pain after whiplash injury. The presence of generalised hyperalgesia to a variety of stimuli, including pressure, cold and heat, has been shown to occur predominantly in individuals with acute WAD, higher pain and disability (Sterling, Jull, Vicenzino, & Kenardy, 2004) and subsequent poor recovery (Sterling, Jull, Vicenzino, Kenardy, & Darnell, 2005). Importantly, some of the sensory changes demonstrate a capacity to predict individuals at risk of poor recovery. As outlined earlier, the early presence of cold hyperalgesia is emerging as a consistent prognostic factor (Goldsmith et al., 2012). Initial studies demonstrated that, in addition to initial moderate pain, decreased neck movement, older age and PTSD symptoms, cold hyperalgesia predicted higher levels of pain and disability at both 6 months and 2–3 years post-injury (Sterling et al., 2005, 2006). Decreased cold pain tolerance, measured using the cold pressor test, has also shown predictive capacity (Kasch et al., 2005).

Of course, the sensory responses measured require a cognitive response from the person being tested, either to report pain threshold or tolerance, and thus it remains a self-report measure (and, as such, may be influenced by many other factors). Nevertheless, there is evidence of spinal cord hyperexcitability in WAD via measurement of the nociceptive flexion response. This test measures reflex muscle activity in the hamstrings following electrical stimulation over the sural nerve at the ankle, and it reflects spinal cord processes (France, Rhudy, & McGlone, 2009). Lower thresholds for reflex elicitation have been demonstrated in both acute and chronic WAD (Banic et al., 2004; Sterling, 2010). As this test does not require a cognitive response from the participant, it could be deemed a more 'objective' measure of central hyperexcitability, although it should be noted that descending processes (e.g. anxiety) may influence the test outcome (Banic et al., 2004).

In summary, current evidence suggests that some central nervous system pain processes are augmented from soon after injury in those individuals who do not recover following whiplash injury. The reasons as to why this group manifests more profound changes in pain processes are not clear, but there are numerous possibilities including, but not limited to, the nature, extent and duration of the original injury providing peripheral nociceptive input to the central nervous system; stress-related responses; psychological augmentation; poorer health before the injury; or a genetic predisposition. Irrespective of the cause of the changes, the data indicate that consideration of these processes in the early management of WAD will be required.

Movement and Motor-Related Disturbances

Movement and motor-related disturbances have been well investigated in both acute and chronic WAD. Loss of neck range of movement is one of the cardinal signs of WAD, which is included in the current Quebec Task Force classification system of the injury (Spitzer et al., 1995). Numerous studies have also documented its presence (Dall'Alba, Sterling, Trealeven, Edwards, & Jull, 2001; Kasch et al., 2008; Sterling, Jull, Vizenzino, Kenardy, & Darnell, 2003). While the measurement of neck movement is a staple of the clinical examination, its capacity to predict later outcome is equivocal (Walton et al., 2009). Neuromuscular control deficits have also been found to be present in patients with WAD. Neck muscle strength is decreased around all axes of motion (Lindstrom, Schomacher, Farina, Rechter, & Falla, 2011), and these changes are also accompanied by alterations in muscle strategies. The presence of neck pain is associated with alterations in task-related modulation of neck muscle activity so that motor control of the cervical spine is achieved by alternative, presumably less efficient, combinations of muscle synergistic activities.

For example, altered performance on a task of upper-cervical flexion performed in the supine position is present in whiplash (Jull, 2000; Sterling, Jull, Vizenzino, et al., 2003), as well as in neck pain of non-traumatic origin (Falla, Jull, & Hodges, 2004) and cervicogenic headache (Jull et al., 2002). In this test, individuals with neck pain perform the movement of upper-cervical flexion with much greater activity in the superficial neck muscles than when performed by individuals without neck pain, and these changes are proposed to represent disturbed neuromuscular control (Falla et al., 2004). Altered patterns of muscle recruitment are not unique to whiplash, and similar changes have also been observed in neck pain of non-traumatic or insidious onset (idiopathic neck pain) (Jull, Kristjansson, & Dall'Alba, 2004; Nederhand, Hermens, Ijzerman, Turk, & Zilvold, 2002; Woodhouse & Vasseljen, 2008). These findings suggest that the 'driver' of such motor changes may be more due to the nociceptive input rather than the injury itself.

Structural morphological changes to muscles have also been found. Elliott et al. (2006, 2010) demonstrated the presence of fatty infiltrate in both deep and superficial cervical muscles of individuals with chronic WAD, compared to an asymptomatic control group. In contrast to neuromuscular control deficits outlined above, preliminary data indicate that similar morphological changes are not apparent in individuals with chronic idiopathic neck pain (Elliott et al., 2008). In a later cohort study, it was found that the fatty muscle infiltrate seems to develop at a time point between 1 and 3 months post-injury and that greater fatty deposits are present in those people reporting higher levels of pain and disability and who show poorer recovery at 6 months (Elliott et al., 2011). The processes that lead to the development of the muscle changes are yet to be elucidated, with possible options including muscle changes due to disuse, possible neural injury or even inflammatory processes (Elliott et al., 2011). While these scenarios require investigation, preliminary analyses indicate a relationship between stress-related symptoms and the fatty infiltrate, suggesting that stress-related responses may be at play in influencing motor and muscle function (Elliott et al., 2011). This proposal also requires further research, but data supporting a detrimental role of stress responses on tissue healing has been found elsewhere (Walburn, Vedhara, Hankins, Rixon, & Weinman, 2009).

Dysfunction of sensorimotor control is also a feature of both acute and chronic WAD. Greater joint repositioning errors have been found in patients with chronic WAD and also in those within weeks of their injury and with moderate/severe pain and disability (Sterling, Jull, Vizenzino, et al., 2003; Treleaven, Jull, & Sterling, 2003). Loss of balance and disturbed neck-influenced eye movement control are present in patients with chronic WAD (Treleaven, Jull, & Low choy, 2005; Treleaven, Jull, & LowChoy, 2005), but their presence in the acute stage of the injury are yet to be determined. It is important to note that sensorimotor disturbances seem to be greater in patients who also report dizziness in association with their neck pain (Treleaven, Jull, & LowChoy, 2005; Treleaven et al., 2003). It should also be noted that the majority of the documented movement and motor disturbances are not unique to whiplash-related neck pain, but are also found to be present in individuals with non-traumatic neck pain of insidious onset (Jull et al., 2004; Treleaven, 2008). Thus, it could be extrapolated that they are not involved in the initiation and maintenance of whiplash-related pain and disability, but rather are sequelae of as yet unexplained nociceptive processes. This is not to say that management approaches directed at improving motor dysfunction should not be provided to patients with whiplash. Rather, the identification of motor deficits alone may not equip the clinician with useful information to either gauge prognosis or potential responsiveness to physical interventions.

Stress-Related Responses

In contrast to many other musculoskeletal conditions that have a more insidious onset, whiplash is precipitated by a traumatic event, namely the motor vehicle crash. It has now been consistently shown that many whiplash-injured individuals report symptoms of PTSD (Buitenhuis, DeJong, Jaspers, & Groothoff, 2006; Sterling & Kenardy, 2006; Sullivan et al., 2009), and it is likely that physiological stress-system responses may also contribute to later poor health outcomes. In light of this, models have been proposed to theoretically link stress-system responses (e.g. sympathetic nervous system activity) to recovery outcomes, as well as to other clinical features of WAD, including hyperalgesia, muscle and motor disturbances (McLean, Clauw, Abelson, & Liberzon, 2005; Passatore & Roatta, 2006). Indeed, there is preliminary evidence available indicating that sympathetic nervous system disturbances are present in WAD. Decreased peripheral vasoconstriction in the hands, following a provocative manoeuvre of deep inspiration, has been shown in acute and chronic WAD when compared to health asymptomatic controls (Sterling, Jull, Vicenzino, et al., 2003), although the significance of these findings on recovery is not clear as this measure has not been shown to be associated with later physical or mental health outcomes (Sterling et al., 2006). In a small study ($n=20$) of chronic WAD, reduced reactivity of the hypothalamic-pituitary adrenal axis, a closely interacting system to the autonomic system, has been demonstrated (Gaab et al., 2005). Decreased heart rate variability has also been found in participants with chronic WAD and showed a moderate association with pain and disability levels (Stone & Sterling, 2009). These findings of disturbances in various aspects of autonomic system functioning suggest that further investigation is warranted in order to elucidate what roles these processes play in WAD.

Some injured people may also be more likely to have genetic variants influencing stress-system function that increase the risk of acute and chronic pain. Perhaps the most well known of such variants are those related to the *catechol-O-methyltransferase* (*COMT*) enzyme. *COMT* is the primary enzyme that degrades catecholamines, including adrenaline and noradrenaline, and increased levels of catecholamines have been shown to produce allodynia and hyperalgesia (Nackley et al., 2007). Genetic variations located in the central haploblock of the gene encoding for *COMT* have been shown to influence *COMT* activity (Chen, Lipska, & Halim, 2004; Zhu, Lipsky, & Xu, 2004). Three common variations, or haplotypes, within this haploblock have been identified (Diatchenko et al., 2005). The LPS haplotype codes for the highest enzyme activity and is associated with the highest pain tolerance and reduced risk of acute (McLean et al., 2011) and chronic (Diatchenko et al., 2005) pain. The APS haplotype codes for comparably less enzyme activity and is associated with average pain tolerance. The HPS haplotype codes for the least enzyme activity and is associated with increased risk of chronic pain (Diatchenko et al., 2005). Preliminary data indicate that, in acute WAD, a *COMT* pain vulnerable genotype is associated with more severe neck pain, headache and dizziness and more dissociative symptoms assessed very early post-injury in the emergency department (McLean et al., 2011). It is yet to be determined if this genotype will be predictive of later recovery, but such findings would have important implications for the early management of whiplash injury. For example, the early targeting of physiological stress responses via medication such as propranolol has been shown to decrease pain in individuals with temporomandibular disorder and *COMT* HPS haplotype (Tchivilera et al., 2010), and such approaches could be beneficial in the management of WAD.

Recent data also indicate that stress-related responses may influence the physical presentation of individuals with WAD. Associations between the presence of hyperalgesia (lowered pain thresholds) and PTSD symptoms have been demonstrated (Sterling, Hendrikz, et al., 2011; Sterling & Kenardy, 2006). In a preliminary within-subject study, trauma-avoidance symptoms were shown to be associated with less activity in the subsequent hours following symptom recording (Sterling & Chadwick, 2010), indicating a possible influence of stress on motor activity/function. A subsequent study demonstrated an association between early PTSD symptoms (1-month post-injury) and later morphological muscle changes (fatty infiltrate identified with MRI) at 6 months post-injury (Elliott et al., 2011). These latter findings are intriguing and consistent with evidence that stress may have a detrimental effect on tissue healing (Walburn et al., 2009). The findings may also have implications for the management of WAD. Current clinical practice guidelines recommend the maintenance and encouragement of movement and activity (MAA, 2007; TRACsa, 2008), and the results of these studies suggest that addressing early stress responses may assist in achieving these goals of treatment. In summary, investigation of physiological stress-system responses and what role they play in health outcomes following whiplash injury is at an early stage. Nevertheless, if stress-system responses contribute to poor health outcomes following whiplash injury in vulnerable individuals, then treatments that attenuate these responses might be useful.

Psychosocial Factors

As with any painful musculoskeletal condition, relationships between psychosocial factors and health outcomes have been well documented, and this is no different for whiplash. It is generally considered that psychosocial factors do not, by themselves alone, fully explain poor recovery following the injury, but they likely interact with other processes and play a role in the persistence of symptoms. In the case of whiplash injury, some factors, including PTSD symptoms (Buitenhuis et al., 2006; Sterling et al., 2012), pain catastrophising (Walton et al., 2009) and negative expectations of recovery (Holm et al., 2008), have shown prognostic capacity in some studies. Other psychological factors including depression (Carroll, Liu, Holm, Cassidy, & Cote, 2011; Walton et al., 2009) and fear of movement (Pedler & Sterling, 2011; Williamson et al., 2008) have conflicting evidence for prognosis, with some studies showing an association with poor recovery and others finding no association.

Some authors have proposed that WAD should be considered in line with neck pain as a whole and should not be viewed as a different condition (Haldeman, Carroll, Cassidy, Schubert, & Nygren, 2008). However, differences between whiplash-initiated neck pain and non-traumatic type of neck pain have been demonstrated. As discussed earlier in this chapter, the sensory presentations of traumatic versus non-traumatic neck pain are different, suggesting variations in the central processing of nociceptive processes between the two types of neck pain (Chien et al., 2010; Elliott et al., 2008). Psychosocial differences are also present. WAD is initiated by a traumatic event, usually an MVC. PTSD is a common psychosocial sequelae following MVCs (Kuch, Cox, Evans, & Shulman, 1994), yet it is only recently that there has been increasing recognition of a shared pattern of aetiology between WAD and PTSD (McFarlane, Ellis, Barton, Browne, & Van Hooff, 2008). The effect of the distress surrounding the crash itself as opposed to, or in addition to, distress about neck pain may have a significant influence on outcome. Recent data indicate that PTSD symptoms are prevalent in individuals who have sustained whiplash injuries following motor vehicle accidents (Buitenhuis et al., 2006; Sterling, Kenardy, Jull, & Vicenzino, 2003; Sullivan et al., 2009). The early presence of PTSD symptoms have been shown to be associated with poor functional recovery from the injury (Buitenhuis et al., 2006; Sterling et al., 2005, 2012). The earlier presented Fig. 7.2 illustrated distinct recovery trajectories for PTSD following whiplash injury (Sterling et al., 2010). A significant proportion (10–25 %) of whiplash-injured individuals also meet the diagnostic criteria for PTSD in addition to the cardinal signs of neck pain (Buitenhuis et al., 2006; Jaspers, 1998; Mayou & Bryant, 2002), and this comorbidity of pain and PTSD may contribute to poor recovery following the injury.

The development of pain/disability and PTSD symptoms seems to be related, and research has begun to focus on the potential shared neurobiological pathways between PTSD and pain (Asmundson, Coons, Taylor, & Katz, 2002; McLean et al., 2005). In regard to research of WAD, in addition to PTSD symptoms predicting pain-related disability following injury, the reverse relationship also exists where initially higher pain levels predict later PTSD symptoms (Sterling, Hendrikz, et al., 2011). In this study, cold hyperalgesia also predicted both pain-related

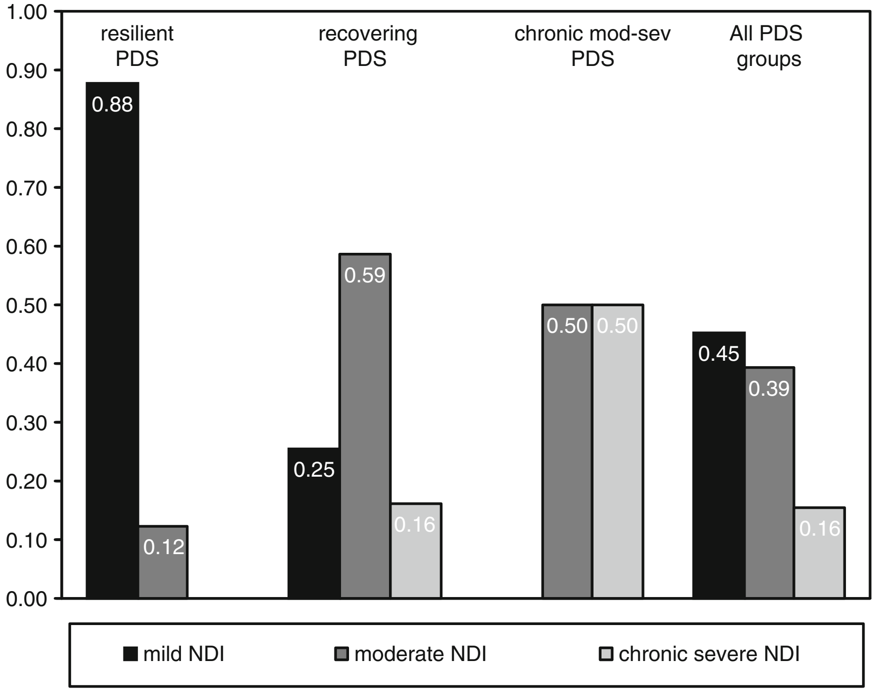

Fig. 7.3 Probability of membership in a NDI trajectory groups, given a Posttraumatic PDS trajectory group. Total probability within a PDS groups = 1.00, with permission

disability and PTSD symptoms (Sterling, Hendrikz, et al., 2011). Furthermore, it has been shown that the developmental trajectories for pain-related disability and PTSD symptoms occur mostly in synchrony (Sterling, Hendrikz, et al., 2011), as seen in Figs. 7.3 and 7.4. That is, there was a high probability (88 %) of an injured individual having a trajectory of low disability if their PTSD symptom trajectory was also at low levels. Conversely, there was a 75 % chance of having a resilient PTSD symptom trajectory if the disability trajectory was mild. Clinically, these findings suggest that, for trajectories of lower levels of disability, there is a good chance that the patient will show psychosocial resilience to the injury. The picture becomes less clear when disability trajectories are at higher levels. Nevertheless, in people with whiplash injury and initial or ongoing moderate to severe disability, clinicians should consider the possibility of PTSD symptoms being present in tandem at some level.

Further exploration of the relationship between pain-related disability and PTSD symptoms has been conducted in experimental studies. Interventions aimed at improving PTSD symptoms had been shown to also have effects on decreasing pain and disability. In a preliminary randomised controlled trial, Dunne et al. (2012b) showed that trauma-focussed cognitive-behaviour treatment, an evidence-based treatment for PTSD (NHMRC, 2007), resulted in clinically relevant changes in pain and disability, in addition to expected decreases in PTSD symptoms and PTSD diagnosis in patients with chronic WAD. In a later study, also in chronic WAD, it was shown that a trauma-cue exposure resulted in greater cold and mechanical hyperalgesia measured at sites over the cervical spine (Dunne, Kenardy, & Sterling, 2012a). Thus data are accumulating, demonstrating close relationships among the pain, disability and PTSD symptoms following whiplash injury.

Perceived injustice, defined as a cognitive appraisal characterised by a propensity to blame others for one's current suffering and a tendency to exaggerate the severity and permanence of

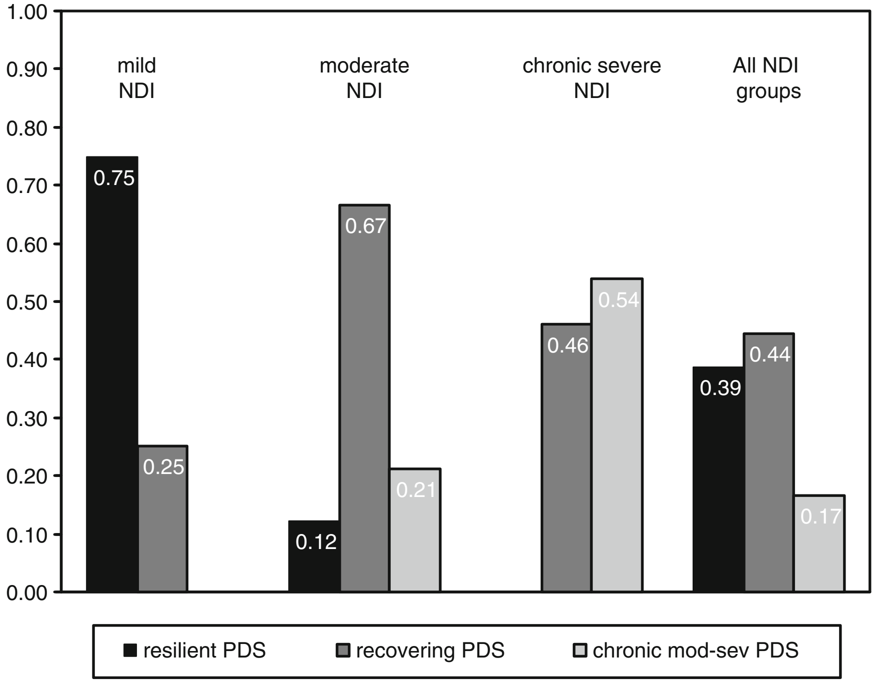

Fig. 7.4 Probability of membership in a Posttraumatic PDS trajectory groups, given a NDI trajectory group. Total probability within a NDI groups = 1.00, with permission

one's injury-related losses (Sullivan et al., 2009), is a relatively new concept that, in view of the compensable nature of whiplash injury, would appear to be relevant. Initial investigations provide support for this proposal, where perceived injustice was the best single predictor of prolonged work absence after whiplash injury, even when controlling for variables of physical function (Sullivan et al., 2008). Further studies have shown that perceived injustice predicted the persistence of PTSD symptoms during a rehabilitation programme for chronic WAD (Sullivan et al., 2009) and that it moderated the relationship between pain and depressive symptoms (again in chronic WAD) (Scott & Sullivan, 2012). These studies have been cross-sectional in design, and further evaluation of the prognostic capacity of perceived injustice in an inception-cohort study is required. In summary, many of the pain-related psychosocial features shown to be present in other musculoskeletal conditions are involved in whiplash pain and disability. Additionally, psychosocial factors related to the injury or incident (MVC), namely PTSD symptoms, also appear to play an important role in the presentation and outcomes following whiplash injury.

Environmental and Sociocultural Considerations

There is little doubt that environmental and sociocultural factors contribute to the problem of whiplash. Depending upon the jurisdiction, many injured people will be required to engage with insurance, legal and health systems during their management process. It is generally considered that when an injured person receives compensation, then long-term health outcomes are worse (Cameron & Gabbe, 2009). However, more recently, the complexity of the issue surrounding compensation-related factors and health outcomes has become more recognised. Connelly and Spearing (2011) argue that there are numerous flaws surrounding studies investigating the role of compensation-related factors on health outcomes that require consideration. These include sample-selection bias, comparisons made between different jurisdictional compensation schemes and the case of reverse causality whereby the person with worse health outcomes is more likely to pursue a claim for compensation (Connelly & Spearing, 2011). Other authors also conclude that the quality of the evidence in this area is limited and that caution is required in the interpretation of study findings (Elbers, Hulst, Cuijpers, Akkermans, & Bruinvels, 2013). In a recent systematic review of the role of compensation-related factors on whiplash outcomes, it was concluded that there is no clear evidence to support the idea that compensation and its related processes lead to worse health (Spearing, Connelly, Gargett, & Sterling, 2012). In contrast to these findings, other studies have found that filing a claim for whiplash compensation is associated with subsequent poorer health outcomes, but that this effect occurs only in those with lesser symptoms, indicating a possible differential effect on subgroups of injured people (Sterling et al., 2010).

In summary on this vexing and emotive issue, Carroll, Connelly, et al. (2011) conclude that 'Crucially, researchers and their audiences must also take care not to overgeneralize or confuse different aspects of WAD compensation. A study of one aspect of the compensation system cannot be used to draw conclusions about compensation as a whole, and because of the complexity of the compensation system and its intrinsic nature within a greater societal context, findings from one jurisdiction cannot necessarily be generalised to other jurisdictions'. Finally, as in other investigations exploring the complex question of how to prevent the transition to chronic WAD, in studying the role of compensation and compensation-related factors, it is important to retain a broad-based conceptualization of WAD and WAD recovery that includes recognition of the broad range of biological, psychological, societal, and economic factors that combine and interact to define and determine how people recover from WAD'.

Implications for the Assessment of Whiplash Associated Disorders

As has been outlined in this chapter, there is now overwhelming evidence supporting WAD to be a heterogeneous condition with varied physical and psychosocial processes at play. Adding to the complexity are the environmental constraints under which whiplash is often managed, including interactions with insurance, legal and health systems, which cannot be ignored as potential influences on the presentation and health outcomes of WAD. There is also now greater understanding of factors predictive of poor recovery following whiplash injury, and it would seem important that these are considered in the initial assessment of the patient with acute WAD. The International Summit Meeting on WAD, held in 2011, proposed a core set of prognostic factors based on available evidence to be used as 'flags' to assist in the identification of individuals at risk of non-recovery (Sterling, Carroll, et al., 2011). Based on this predictive set, the following factors should be included for assessment:

- Self-reported levels of pain. This is the most consistent predictor of poor functional recovery (Kamper et al., 2008; Walton et al., 2009).
- Self-reported levels of disability. This factor also has consistent evidence as a prognostic indicator (Kamper et al., 2008; Walton et al., 2009). It is recommended that a validated measure of neck pain-related disability be used (Scholten-Peeters et al., 2003; Sterling, Carroll, et al., 2011).
- Measurement of cold hyperalgesia. A recent systematic review concluded that there is moderate evidence supporting this factor as a prognostic indicator (Goldsmith et al., 2012). In research studies, cold hyperalgesia has been measured with sophisticated and expensive laboratory equipment not readily available in the clinical environment. Clinical alternatives have been explored to some extent, with the use of pain-intensity levels with the application of ice showing good agreement with the laboratory devices

(Maxwell & Sterling, 2013). Further testing of the validity of such measures is required.
- Range of movement of the cervical spine. There is conflicting evidence available for the prognostic capacity of this factor (Walton et al., 2009). It was included in the core measure set because it is a commonly used in the clinical environment, and it may offer some prognostic information.
- Psychosocial factors. There are numerous psychosocial factors that could be used in the early assessment of whiplash injury. The International Whiplash Summit recommended that, with the current available evidence, probably PTSD symptoms, but also other factors such as depression, pain catastrophising, recovery beliefs and expectations, should be considered for assessment of the patient with acute WAD (Sterling, Carroll, et al., 2011). This is not to say that other factors (e.g. fear avoidance, beliefs of perceived injustice) should not be included but that, at this point in time, there is less evidence indicating their prognostic capacity. It was suggested that clinicians use their clinical judgement in deciding which specific psychosocial to assess in individual patients (Sterling, Carroll, et al., 2011).

In addition to the above factors which will provide prognostic information, clinicians may decide to include assessment of other factors (e.g. more in-depth evaluation of movement and motor deficits). As outlined earlier in this chapter, there is extensive evidence of movement, motor, sensorimotor and muscle morphology changes associated with WAD. These factors are yet to demonstrate prognostic ability, but their inclusion in clinical assessment may assist in providing direction for any prescribed exercise programmes. The rationale for the early identification of clinical indicators for poor recovery would be to provide early intervention in order to avert the course to chronicity or to improve the trajectories identified as earlier presented in Figs. 7.1 and 7.2. However, it should be noted that it is not known whether treatment decisions based on the presence or not of these factors will in fact improve outcomes. It is also likely that, as further research comes to light, additional factors may be recognised for prognostic capacity.

Implications for the Management of Whiplash Associated Disorders

Clinical guidelines recommend early return to activity, exercise and education/advice for the management of acute WAD (MAA, 2007; TRACsa, 2008). However, the guidelines are based on limited available evidence, and inspection of data from clinical trials reveals that, despite active approaches showing efficacy, a significant proportion of people still develop chronic pain and disability (Provinciali, Baroni, Illuminati, & Ceravolo, 1996; Rosenfeld, Gunnarsson, & Borenstein, 2000; Rosenfeld, Seferiadis, Carllson, & Gunnarsson, 2003; Rosenfeld, Seferiadis, & Gunnarsson, 2006). This scenario is supported by systematic reviews, which conclude that there is, at best, modest evidence supporting activity/exercise for acute or chronic WAD (Rushton & Wright, 2011; Teasell et al., 2010a, 2010b). The emerging multifactorial nature of WAD suggests that while the current guidelines may benefit some whiplash patients, they are likely to be inadequate for the management of those with a more complex condition, including both marked physical impairment and psychosocial distress. There is now greater understanding of the whiplash condition, and this offers the opportunity to guide the development of improved management approaches in the acute/subacute stage of injury. Some of these options will be explored next.

The Provision of Advice and Education

A recent qualitative study in Western Australia indicated that people with whiplash injury sought reassurance and understanding of the implications of their condition from their general medical practitioner (Russell & Nicol, 2009). In contrast, many of the medical practitioners interviewed were unaware of the concerns, feelings and fears about the injury reported by the injured people (Russell & Nicol, 2009). There have been few qualitative studies of whiplash conducted, but the results of this study suggest a disconnect between patient and practitioner that could compromise quality patient-centred care and thus detrimentally influence outcomes (Russell & Nicol, 2009). A survey of staff in emergency departments in the UK also found that inconsistent advice was often provided to patients with acute WAD and that advice about return to activity and appropriate use of soft collars was rarely provided (Lamb et al., 2009). In the departments surveyed, patients were commonly encouraged to pursue a personal injury claim, even extending to the sponsorship of advice leaflets by personal injury solicitors (Lamb et al., 2009). This may potentially impede recovery in view of recent findings that poor expectations of recovery are associated with persistent pain and disability (Holm et al., 2008) and that filing a compensation claim may detrimentally influence the recovery, particularly of those with lesser symptoms (Sterling et al., 2010).

Various information and educational approaches, including information booklets, websites and videos, have been investigated for their effectiveness in improving outcomes following whiplash injury (Jull & Sterling, 2011; Kenardy & Sterling, 2008; McClune, Burton, & Waddell, 2002; Oliveira, Gevirtz, & Hubbard, 2006). However, when evaluated in clinical trials, educational approaches alone have not been shown to reduce the development of chronic pain (Ferrari et al., 2005; Kongsted, Qerama, et al., 2008). Currently, there appears to be wide variability in the nature of information and advice provided to a patient, suggesting that the best information or education approaches, as well as strategies for behaviour change and system change, are yet to be established (Jull et al., 2011). Although patients understandably want advice on the prognosis and implications of their injury (Russell & Nicol, 2009), it is not clear that advice per se will improve outcomes (Haines, Gross, Burnie, Goldsmith, & Perry, 2009) and that the most effective form and nature of the advice/education remains is yet to be established.

Early Pain Management

Following injury, the management of acute pain intensity is usually seen as a priority of treatment (Macintyre, Scott, Schug, Visser, & Walker, 2010), and it would appear that a similar approach would be worth pursuing in the management of acute WAD. This would seem to be a prudent approach because the most consistent predictor of poor functional recovery, following whiplash injury, is initial levels of pain (Carroll et al., 2008; Kamper et al., 2008; Walton et al., 2009). These do not have to be high, because moderate or greater levels of pain (pain: VAS >5.5/10) demonstrate prognostic capacity (Walton et al., 2009). It would seem logical that a primary aim of early whiplash management would be to decrease levels of pain. In addition, sensory hypersensitivity (widespread hyperalgesia) is present in some with acute whiplash injury, and these features are also predictive of poor functional recovery (Kasch et al., 2005; Sterling, Jull, Vicenzino, et al., 2003). It is now generally acknowledged that such sensory changes are indicative of augmented central nociceptive processing (central hyper excitability or disturbed endogenous pain modulation) (Curatolo, Arendt-Nielsen, & Petersen-Felix, 2006; Sterling, Jull, Vicenzino, et al., 2003). These findings have led to speculation that early medication may be able to attenuate the sensory changes and subsequently improve outcomes (Curatolo & Sterling, 2011). Yet, very few trials of pain relief via medication for early whiplash have been conducted. One early study showed that intravenous infusion of *methylprednisolone* provided in a hospital accident and emergency setting for acute whiplash resulted in fewer sick days over 6 months and less pain-related disability than those who received placebo medication (Pettersson & Toolanen, 1998). While this is an interesting finding, it would seem to be a rather unfeasible approach given many people with whiplash injury are managed in community primary care settings. In a recent randomised controlled trial, little benefit (pain relief) was found for the use of muscle relaxants either alone or combined with NSAIDs, for emergency department patients with acute neck strain (Khwaja, Minnerop, & Singer, 2010).

Some clinical guidelines recommend that analgesics for acute whiplash can be used, but not routinely and only when there is documented improvement in patient outcomes (TRACsa, 2008). Due to the lack of available evidence, these recommendations are consensus based, but would seem to be at odds with recommendations for acute pain after other injury or surgery where pain relief is seen as mandatory (Macintyre et al., 2010). There seems to be an unbalanced approach between recommendations for other painful conditions and whiplash with respect to pain management. Presumably, this discrepancy has arisen due to the lack of randomised controlled trials, specifically investigating pain control for acute WAD. Thus, it is clear that further investigations of early pain-relief strategies for acute whiplash are required. However, in the meantime, the provision of adequate pain relief in primary care would seem indicated and appropriate. The identification of strategies for effective pain management for those at risk of poor recovery following whiplash injury has been deemed a research priority (Jull et al., 2011).

In the case of chronic WAD, the situation is little better. There have been few trials of medication (Teasell et al., 2010a), despite there now being consistent evidence of central nociceptive hyperexcitability (Stone et al., 2013). This is in contrast to other conditions, with apparently similar disturbances in nociceptive processing, such as fibromyalgia (Staud, 2006). Of course, the use of medication is not the only way to achieve pain relief and improved function, and other physical and/or psychological approaches could be used.

Physical Rehabilitation

Although exercise and activity programmes for acute and chronic WAD have the strongest supporting evidence, many questions remain regarding the relative effectiveness of various protocols (Teasell et al., 2010a, 2010b). As outlined previously, the effects of such interventions are mostly modest and, in the case of acute WAD, a significant proportion of injured people still go on to develop chronic pain and disability. It may well be the case that subgroups of people respond to physical rehabilitation approaches, and others do not, but the characteristics of responders or non-responders are yet to be defined. A preliminary study of chronic WAD indicated that participants with widespread sensory hypersensitivity (cold and mechanical hyperalgesia) failed to achieve clinically relevant changes in pain-related disability following a 10-week exercise programme, compared to those without these features (Jull, Sterling, Kenardy, & Beller, 2007). In this study, post hoc subgroup analysis was performed, and the subgroups were small ($n \sim 15$), as this was primarily a hypothesis-generating analysis. Replication in studies with adequate sample size to detect possible differences between subgroups is required.

Additionally, many studies have identified motor and muscle deficits as being present in WAD (as outlined in this chapter), and the working hypothesis is that the restoration of these impairments will improve patient outcomes. However, the results of various exercise and physical rehabilitation approaches have been equivocal (Rushton & Wright, 2011; Teasell et al., 2010a, 2010b), indicating that other factors need to be considered in the management of WAD. There is some evidence available to suggest that intensive healthcare provided, within the first 3 months of the whiplash injury, may delay recovery (Cote et al., 2007; Pape, Hagen, Brox, Natvig, & Schirmer, 2009). In the study by Cote et al. (2007), early high utilisation of chiropractic intervention led to a 25 % slower rate of recovery 1 year later. Pape et al. (2009) found that early multidisciplinary evaluation increased the risk of having chronic neck pain 3 years after the injury. However, a possible confounding factor in these studies is that injured people with higher levels of initial pain and/or disability (factors prognostic of a poorer outcome) seek more healthcare as a result of this. These findings also suggest that the 'triaging' of patients based on their presenting clinical features may assist in providing more individualised treatments, rather than a 'one-size-fits-all' approach.

Psychological Interventions

The various psychosocial responses to the whiplash injury, and its associated pain and disability, have been outlined earlier in this chapter. There have been few trials of psychosocial interventions for WAD, either alone or in combination with other approaches. This is an area that is very ripe for investigation. It should also be noted that most whiplash-injured people are seen in the primary care environment, particularly in the acute stage of the injury. Primary healthcare providers, such as general medical practitioners, physiotherapists and chiropractors, may not be familiar or comfortable with managing the psychosocial sequelae of the injury. The first step in this process would be to identify the presence of psychosocial factors which may impede recovery. Then, the primary care provider must decide upon a course of action. This could involve referral to a clinical psychologist or ongoing monitoring and management by the primary care practitioner. The effective delivery of cognitive behavioural therapy interventions by those without mental health qualifications has been demonstrated reliably for individuals with chronic arthritis pain (Keefe & Somers, 2010) and for people with acute/subacute low back pain (George, Fritz, Bialosky, & Donald, 2003). There are no studies investigating this approach for acute WAD. Nevertheless, the inclusion of management directed at behavioural and psychosocial responses to pain and injury, delivered in primary care, would seem to be a reasonable approach. In the case of more serious psychopathology such as depression and PTSD, referral for more specialised psychosocial evaluation and management would be indicated.

Primary care practitioners may not be familiar with assessing patients for the presence of acute PTSD symptoms. Easily accessible questionnaires are available for this purpose, but a specific diagnosis of PTSD can only be made via a comprehensive assessment, including a clinical interview by a qualified mental health professional (Wilson & Keane, 1997). The general consensus indicates that a patient with an early PTSD reaction should be reassured and allowed some time for natural recovery to occur. Psychosocial debriefing, with a focus on recounting the traumatic event, should not be routinely offered, because this approach has the potential to detrimentally affect stress symptoms (Forbes et al., 2007). If recovery is not apparent within 3–4 weeks, guidelines suggest that referral for specialised psychosocial or psychiatric care should be instigated (MAA, 2007). For primary care providers, this may mean that symptoms indicative of PTSD should be just monitored in the early post-injury period. Additionally, sound advice and assurance in this important early post-injury phase may assist in decreasing stress symptoms (NHMRC, 2007), but this is yet to be tested in an experimental context for whiplash.

The evidence for psychosocial-based interventions for chronic WAD is sparse. Most studies have assessed the efficacy of interdisciplinary approaches (usually psychosocial approaches, combined with physical therapy), rather than a more focused psychosocial intervention, making it difficult to gauge the relative efficacy of the various components. The authors of a recent systematic review concluded that there is conflicting evidence regarding the efficacy of interdisciplinary interventions for patients with chronic WAD (Teasell et al., 2010a). Some studies have found interdisciplinary approaches to be beneficial on various outcomes, including pain, disability, psychosocial distress, as well as various physical outcomes (Sullivan, Adams, Rhodenizer, & Stanish, 2006; Vendrig, van Akkerveeken, & McWhorter, 2000), while others have found little benefit (Soderlund & Lindberg, 2001). A recent study investigated the effects of trauma-focussed cognitive behavioural therapy, compared to a wait-list control, in patients with chronic WAD and PTSD (Dunne et al., 2012b). After 6 weeks of therapy delivered by a clinical psychologist, levels of pain-related disability decreased, in addition to psychosocial measures of PTSD diagnosis and symptom severity. While the decreases in pain-related disability were significant, the majority of participants remained moderately disabled by their condition. Despite this, the results of this study suggest that trauma-focussed cognitive behavioural therapy may assist in reducing the additional disability due to neck pain reported by some individuals with comorbid PTSD. An interesting progression from this study may be that pretreatment of the PTSD may facilitate greater effectiveness of physical interventions and such an approach could be worthy of investigation. Other factors, such as recovery expectation and feeling of perceived injustice, may also need to be addressed, but there are as yet no studies investigating such approaches.

Summary and Conclusions

Whiplash is a major and costly health problem for western countries. It has a high propensity for chronicity and both poor physical and mental health outcomes for those who do not recover. Current approaches to management offer only modest effects at best. However, in recent years, much more information has been provided demonstrating complex physical and psychosocial factors that underlie this condition, no doubt influenced also by environmental and societal systems that many injured people are required to deal with. While we now have greater confidence in being able to predict injured people at risk of poor recovery, the development and testing of interventions for WAD has not kept pace with the explosion of knowledge of potential processes that contribute to the clinical presentation of injured people and of poor health outcomes in some. Of course, the conduct of clinical trials to provide information on improved management for this condition is both time consuming and expensive. Nevertheless, it appears to be now crucial that researchers move forward in this area, such that clinicians and injured people are provided with useful and beneficial approaches to management.

References

Asmundson, G., Coons, M., Taylor, S., & Katz, J. (2002). PTSD and the experience of pain: Research and clinical implications. *Canadian Journal of Psychiatry, 47*(10), 930–937.

Ayesh, E., Jensen, T., & Svensson, P. (2007). Hypersensitivity to mechanical and intra-articular electrical stimuli in persons with painful temporomandibular joints. *Journal of Dental Research, 86*(12), 1187–1192.

Bajaj, P., Bajaj, P., Graven-Nielsen, T., & Arendt-Nielsen, L. (2001). Osteoarthritis and its association with muscle hyperalgesia: An experimental controlled study. *Pain, 93*(2), 107–114.

Banic, B., Petersen-Felix, S., Andersen, O., Radanov, B., Villiger, P., Arendt-Nielsen, L., et al. (2004). Evidence for spinal cord hypersensitivity in chronic pain after whiplash injury and in fibromyalgia. *Pain, 107*(1–2), 7–15.

Barnsley, L., Lord, S., & Bogduk, N. (1994). Clinical review. Whiplash injury. *Pain, 58*, 283–307.

Blincoe, L., Seay, A., Zaloshnja, E., Miller, T., Romano, E., Luchter, S., et al. (2002). *Economic impact of motor vehicle crashes 2000* (DOT) (pp. 1–94). Washington, DC: National Highway Traffic Safety Administration.

Buitenhuis, J., DeJong, J., Jaspers, J., & Groothoff, J. (2006). Relationship between posttraumatic stress disorder symptoms and the course of whiplash complaints. *Journal of Psychosomatic Research, 61*(3), 681–689.

Cameron, P., & Gabbe, B. (2009). Editorial: The effect of compensation claims on outcomes after injury. *Injury, 40*, 905–906.

Carroll, L., Connelly, L., Spearing, N., Cote, P., Buitenhuis, J., & Kenardy, J. (2011). Complexities in understanding the role of compensation related factors on recovery from whiplash associated disorders. *Spine, 36*(25S), S316–S321.

Carroll, L., Holm, L., Ferrari, R., Ozegovic, D., & Cassidy, D. (2009). Recovery in whiplash-associated disorders: Do you get what you expect. *The Journal of Rheumatology, 36*, 1063–1070.

Carroll, L., Holm, L., Hogg-Johnson, S., Cote, P., Cassidy, D., Haldeman, S., et al. (2008). Course and prognostic factors for neck pain in whiplash-associated disorders (WAD). Results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Spine, 33*(42), 583–592.

Carroll, L., Liu, Y., Holm, L., Cassidy, D., & Cote, P. (2011). Pain-related emotions in early stages of recovery in whiplash-associated disorders: Their presence, intensity and association with pain recovery. *Psychosomatic Medicine, 73*(8), 708–715.

Chen, J., Lipska, B., & Halim, N. (2004). Functional analysis of genetic variation in catechol-O-methyltransferase (COMT): Effects on mRNA, protein, and enzyme activity in postmortem human brain. *American Journal of Human Genetics, 75*, 807–821.

Chien, A., Eliav, E., & Sterling, M. (2008). Whiplash (Grade II) and cervical radiculopathy share a similar sensory presentation: An investigation using quantitative sensory testing. *Clinical Journal of Pain, 24*(7), 595–603.

Chien, A., Eliav, E., & Sterling, M. (2009). Hypoaesthesia occurs with sensory hypersensitivity in chronic whiplash: Indication of a minor peripheral neuropathy? *Manual Therapy, 14*, 137–145.

Chien, A., Eliav, E., & Sterling, M. (2010). Sensory hypoaesthesia is a feature of chronic whiplash but not chronic idiopathic neck pain. *Manual Therapy, 15*(1), 48–53.

Connelly, L., & Spearing, N. (2011). Compensation and health outcomes. In M. Sterling & J. Kenardy (Eds.), *Whiplash: Evidence base for clinical practice*. Chatswood, NSW: Elsevier.

Coombes, B., Bisset, L., & Vicenzino, B. (2012). Thermal hyperalgesia distinguishes those with severe pain and disability in unilateral lateral epicondylalgia. *Clinical Journal of Pain, 28*(7), 595–601.

Cote, P., Hogg-Johnson, S., Cassidy, J. D., Carroll, L., Frank, J. W., & Bombardier, C. (2007). Early aggressive care and delayed recovery form whiplash: Isolated finding or reproducible result? *Arthritis and Rheumatism, 57*(5), 861–868.

Curatolo, M., Arendt-Nielsen, L., & Petersen-Felix, S. (2004). Evidence, mechanisms and clinical implications of central hypersensitivity in chronic pain after whiplash injury. *Clinical Journal of Pain, 20*(6), 469–476.

Curatolo, M., Arendt-Nielsen, L., & Petersen-Felix, S. (2006). Central hypersensitivity in chronic pain: Mechanisms and clinical implications. *Physical Medicine & Rehabilitation Clinics of North America, 17*, 287–302.

Curatolo, M., Bogduk, N., Ivancic, P., McLean, S., Siegmund, G., & Winkelstein, B. (2011). The role of tissue damage in whiplash associated disorders. *Spine, 36*(25S), S309–S315.

Curatolo, M., & Sterling, M. (2011). Pain-processing mechanisms in whiplash associated disorders. In M. Sterling & J. Kenardy (Eds.), *Whiplash: Evidence-base for clinical practice*. Australia: Elsevier.

Dall'Alba, P., Sterling, M., Trealeven, J., Edwards, S., & Jull, G. (2001). Cervical range of motion discriminates between asymptomatic and whiplash subjects. *Spine, 26*(19), 2090–2094.

Diatchenko, L., Slade, G., Nackley, A., Bhalang, K., Sigurdsson, A., Belfer, I., et al. (2005). Genetic basis for individual variations in pain perception and the development of a chronic pain condition. *Human Molecular Genetics, 14*, 135–143.

Dunne, R., Kenardy, J., & Sterling, M. (2012a). *The impact of posttraumatic stress disorder on physiological arousal, disability and sensory pain thresholds in patients with chronic whiplash*, under review.

Dunne, R., Kenardy, J., & Sterling, M. (2012b). A randomised controlled trial of cognitive behavioural therapy for the treatment of PTSD in the context of chronic whiplash. *Clinical Journal of Pain, 28*(9), 755–765.

Elbers, N., Hulst, L., Cuijpers, P., Akkermans, A., & Bruinvels, D. (2013). Do compensation processes impair mental health? A meta-analysis. *Injury, 44*(5), 674–683.

Elliott, J., Jull, G., Noteboom, T., Darnell, R., Galloway, G., & Gibbon, W. (2006). Fatty infiltration in the cervical extensor muscles in persistent whiplash associated disorders: An MRI analysis. *Spine, 31*(22), E847–E851.

Elliott, J., Jull, G., Sterling, M., Noteboom, T., Darnell, R., & Galloway, G. (2008). Fatty infiltrate in the cervical extensor muscles is not a feature of chronic insidious onset neck pain. *Clinical Radiology, 63*(6), 681–687.

Elliott, J., O'Leary, S., Sterling, M., Hendrikz, J., Pedler, A., & Jull, G. (2010). MRI findings of fatty infiltrate in the cervical flexors in chronic whiplash. *Spine, 35*(9), 948–954.

Elliott, J., Pedler, A., Kenardy, J., Galloway, G., Jull, G., & Sterling, M. (2011). The temporal development of fatty infiltrates in the neck muscles following whiplash injury: An association with pain and posttraumatic stress. *PLOS ONE, 6*(6), e21194.

Falla, D., Jull, G., & Hodges, P. (2004). Neck pain patients demonstrate reduced EMG activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. *Spine, 29*(19), 2108–2114.

Ferrari, R., Rowe, B., Majumdar, S., Cassidy, D., Blitz, S., Wright, S., et al. (2005). Simple educational intervention to improve the recovery from acute whiplash: Results of a randomized, controlled trial. *Academic Emergency Medicine, 12*(8), 699–706.

Foa, E., Riggs, D., Dancu, C., & Rothbaum, B. (1993). Reliability and validity of a brief instrument for assessing post-traumatic stress disorder. *Journal of Traumatic Stress, 6*(4), 459–473.

Forbes, D., Creamer, M., Phelps, A., Couineau, A., Cooper, J., Bryant, R., et al. (2007). Treating adults with acute stress disorder and posttraumatic stress disorder in general practice: A clinical update. *Medical Journal of Australia, 187*(2), 120–123.

France, C., Rhudy, J., & McGlone, S. (2009). Using normalized EMG to define the nociceptive flexion reflex (NFR) threshold: Further evaluation of standardized NFR scoring criteria. *Pain, 145*(1–2), 211–218.

Gaab, J., Baumann, S., Budnoik, A., Gmunder, H., Hottinger, N., & Ehlert, U. (2005). Reduced reactivity and enhanced negative feedback sensitivity of the hypothalamus-pituitary-adrenal axis in chronic whiplash associated disorders. *Pain, 119*, 219–224.

George, S., Fritz, J., Bialosky, J., & Donald, D. (2003). The effect of a fear-avoidance-based physical therapy intervention for patients with acute low back pain: Results of a randomized clinical trial. *Spine, 28*, 2551–2560.

Goldsmith, R., Wright, C., Bell, S., & Rushton, A. (2012). Cold hyperalgesia as a prognostic factor in whiplash associated disorders: A systematic review. *Manual Therapy, 17*(5), 402–410.

Gottrup, H., Andersen, J., Arendt-Nielsen, L., & Jensen, T. (2000). Psychophysical examination in patients with post-mastectomy pain. *Pain, 87*(3), 275–284.

Haines, T., Gross, A., Burnie, S., Goldsmith, C., & Perry, J. (2009). Patient education for neck pain with or without radiculopathy. *Cochrane Database of Systematic Reviews,* (4), CD005106.

Haldeman, S., Carroll, L., Cassidy, D., Schubert, J., & Nygren, A. (2008). The bone and joint decade 2000–2010 task force on neck pain and its associated disorders executive summary. *Spine, 33*(4s), S5–S7.

Heron-Delaney, M., Kenardy, J., Bellamy, N., Sterling, M., & Connelly, L. (2011). Adults' adjustment to minor and moderate injuries following road traffic crashes: Wave 2 preliminary findings. Report to MAIC.

Holm, L., Carroll, L., Cassidy, D., Skillgate, E., & Ahlbom, A. (2008). Expectations for recovery important in the prognosis of whiplash injuries. *PLOS Medicine, 5*(5), e105.

Jaspers, J. (1998). Whiplash and post-traumatic stress disorder. *Disability and Rehabilitation, 20*, 397–404.

Joslin, C., Khan, S., & Bannister, G. (2004). Long-term disability after neck injury. A comparative study. *Journal of Bone and Joint Surgery. British Volume, 86*(7), 1032–1034.

Jull, G. (2000). Deep cervical flexor muscle dysfunction in whiplash. *Journal of Musculoskeletal Pain, 8*(1/2), 143–154.

Jull, G., Kristjansson, E., & Dall'Alba, P. (2004). Impairment in the cervical flexors: A comparison of whiplash and insidious onset neck pain patients. *Manual Therapy, 9*(2), 89–94.

Jull, G., Soderlund, A., Stemper, B., Kenardy, J., Gross, A., Cote, P., et al. (2011). Towards optimal early management after whiplash injury to lessen the rate of transition to chronicity. *Spine, 36*(25S), s275–s287.

Jull, G., & Sterling, M. (2011). *Whiplash injury recovery: A self management guide*. http://www.maic.qld.gov.au/forms-publications-stats/pdfs/whiplash-injury-recovery-booklet.pdf

Jull, G., Sterling, M., Kenardy, J., & Beller, E. (2007). Does the presence of sensory hypersensitivity influence outcomes of physical rehabilitation for chronic whiplash?—A preliminary RCT. *Pain, 129*(2), 28–34.

Jull, G., Trott, P., Potter, H., Zito, G., Niere, K., Emberson, J., et al. (2002). A randomised controlled trial of physiotherapy management for cervicogenic headache. *Spine, 27*(17), 1835–1843.

Kamper, S., Rebbeck, T., Maher, C., McAuley, J., & Sterling, M. (2008). Course and prognostic factors of whiplash: A systematic review and meta-analysis. *Pain, 138*(3), 617–629.

Kasch, H., Qerama, E., Bach, F., & Jensen, T. (2005). Reduced cold pressor pain tolerance in non-recovered whiplash patients: A 1 year prospective study. *European Journal of Pain, 9*(5), 561–569.

Kasch, H., Qerama, E., Kongsted, A., Bendix, T., Jensen, T., & Bach, F. (2008). Clinical assessment of prognostic factors for long-term pain and handicap after whiplash injury: A 1-year prospective study. *European Journal of Neurology, 15*(11), 1222–1230.

Keefe, F., & Somers, T. (2010). Psychological approaches to understanding and treating arthritis pain. *Nature Reviews. Rheumatology, 6*, 210–216.

Kenardy, J., Heron-Delaney, M., Bellamy, N., Sterling, M., & Connelly, L. (2011). Adults' adjustment to minor and moderate injuries following road traffic crashes: Wave 1 fundings. In Q. Report to MAIC (Ed.).

Kenardy, J., & Sterling, M. (2008). *Whiplash evidence based treatment resource*. Accessed October 30, 2012. www.som.uq.edu.au/whiplash

Khwaja, S., Minnerop, M., & Singer, A. (2010). Comparison of ibuprofen, cyclobenzaprine or both in patients with acute cervical strain: A randomized controlled trial. *Canadian Journal of Emergency Medicine, 12*(1), 39–44.

Kongsted, A., Leboeuf-Yde, C., Korsholm, L., & Bendix, T. (2008). Are altered smooth pursuit eye movements related to chronic pain and disability following whiplash injuries? A prospective trial with one-year follow-up. *Clinical Rehabilitation, 22*, 469–479.

Kongsted, A., Qerama, E., Kasch, H., Bach, F., Korsholm, L., Jensen, T., et al. (2008). Education of patients after whiplash injury: Is oral advice any better than a pamphlet? *Spine, 33*(22), E843–E848.

Kuch, K., Cox, B. J., Evans, R., & Shulman, I. (1994). Phobias, panic, and pain in 55 survivors of road vehicle accidents. *Journal of Anxiety Disorders, 8*(2), 181–187.

Lamb, S., Williams, M., Withers, E., Perry, J., Gates, S., Williamson, E., et al. (2009). A national survey of clinical practice for the management of whiplash-associated disorders in UK emergency departments. *Emergency Medicine Journal, 26*, 644–647.

Lewis, C., Souvlis, T., & Sterling, M. (2010). Sensory characteristics of tender points in the low back. *Manual Therapy, 15*, 451–456.

Lindstrom, R., Schomacher, J., Farina, D., Rechter, L., & Falla, D. (2011). Association between neck muscle coactivation, pain, and strength in women with neck pain. *Manual Therapy, 16*(1), 80–86.

Lord, S., Barnsley, L., Wallis, B., & Bogduk, N. (1996). Chronic cervical zygapophysial joint pain after whiplash: A placebo-controlled prevalence study… including commentary by Derby R Jr. *Spine, 21*(15), 1737–1745.

MAA. (2007). *Guidelines for the management of whiplash associated disorders* (p. 16). Sydney: Motor Accident Authority (NSW). www.maa.nsw.gov.au

MacDermid, J., Walton, D., Avery, S., Blanchard, A., Etruw, E., McAlpine, C., et al. (2009). Measurement properties of the Neck Disability Index: A systematic review. *Journal of Orthopaedic & Sports Physical Therapy, 39*(5), 400–417.

Macintyre, P., Scott, D., Schug, S., Visser, E., & Walker, S. (2010). *Acute pain management: Scientific evidence*. Melbourne: ANZVA & FPM.

MAIC. (2010). *Annual report 2009–2010*. Brisbane: MAIC.

Maxwell, S., & Sterling, M. (2013). An investigation of the use of a numeric pain rating scale with ice application to the neck to determine cold hyperalgesia. *Manual Therapy, 18*(2), 172–174.

Mayou, R., & Bryant, B. (2002). Psychiatry of whiplash neck injury. *British Journal of Psychiatry, 180*, 441–448.

McCarthy, S. (2008). Posttraumatic stress diagnostic scale (PDS). *Occupational Medicine, 58*, 379.

McClune, T., Burton, A., & Waddell, G. (2002). Whiplash associated disorders: A review of the literature to guide patient information and advice. *Emergency Medicine Journal, 19*, 499–506.

McFarlane, A. C., Ellis, N., Barton, C., Browne, D., & Van Hooff, M. (2008). The conundrum of medically unexplained symptoms: Questions to consider. *Psychosomatics: Journal of Consultation Liaison Psychiatry, 48*(5), 369–377. doi:10.1176/appi.psy.49.5.369.

McLean, S. (2011). The potential contribution of stress systems to the transition to chronic whiplash associated disorders. *Spine, 36*(25S), S226–S232.

McLean, S., Clauw, D., Abelson, J., & Liberzon, I. (2005). The development of persistent pain and psychological morbidity after motor vehicle collision: Integrating the potential role of stress response systems into a biopsychosocial model. *Psychosomatic Medicine, 67*, 783–790.

McLean, S., Diatchenko, L., Lee, M., Swor, R., Domeier, R., Jones, J., et al. (2011). Catechol O-methyltransferase haplotype predicts immediate musculoskeletal neck pain and psychological symptoms after motor vehicle collision. *The Journal of Pain, 12*, 101–107.

Nackley, A., Tan, K., Fecho, K., Flood, P., Diatchenko, L., & Maixner, W. (2007). Catechol-O-methyltransferase inhibition increases pain sensitivity through activation of both beta2- and beta3-adrenergic receptors. *Pain, 128*(3), 199–208.

Nederhand, M., Hermens, H., Ijzerman, M., Turk, D., & Zilvold, G. (2002). Cervical muscle dysfunction in chronic whiplash associated disorder grade 2. The relevance of trauma. *Spine, 27*(10), 1056–1061.

NHMRC. (2007). *Australian guidelines for the treatment of adults with ASD and PTSD*. Canberra: NHMRC.

O'Donnell, M., Creamer, M., Bryant, R., Schnyder, U., & Shalev, A. (2003). Posttraumatic disorders following injury: An empirical and methodological review. *Clinical Psychology Review, 23*, 587–603.

Oliveira, A., Gevirtz, R., & Hubbard, R. (2006). A psychoeducational video used in the emergency department provides effective treatment for whiplash injuries. *Spine, 31*(15), 1652–1657.

Pape, E., Hagen, K. B., Brox, J. I., Natvig, B., & Schirmer, H. (2009). Early multidisciplinary evaluation and advice was ineffective for whiplash-associated disorders. *European Journal of Pain, 13*, 1068–1075.

Passatore, M., & Roatta, S. (2006). Influence of sympathetic nervous system on sensorimotor function: Whiplash associated disorders (WAD) as a model. *European Journal of Applied Physiology, 98*(5), 423–449.

Pedler, A., & Sterling, M. (2011). Assessing fear-avoidance beliefs in patients with whiplash associated disorders: A comparison of 2 measures. *Clinical Journal of Pain, 27*(6), 502–507.

Pettersson, K., & Toolanen, G. (1998). High-dose methylprednisolone prevents extensive sick leave after whiplash injury. *Spine, 23*(9), 984–989.

Phillips, L., Carroll, L., Cassidy, D., & Cote, P. (2010). Whiplash-associated disorders: Who gets depressed? Who stays depressed? *European Spine Journal, 19*(6), 945–956.

Provinciali, L., Baroni, M., Illuminati, L., & Ceravolo, M. (1996). Multimodal treatment to prevent the late whiplash syndrome. *Scandinavian Journal of Rehabilitation Medicine, 28*(2), 105–111.

Rebbeck, T., Sindhausen, D., & Cameron, I. (2006). A prospective cohort study of health outcomes following whiplash associated disorders in an Australian population. *Injury Prevention, 12*, 86–93.

Ronnen, J., De Korte, P., & Brink, P. (1996). Acute whiplash injury: Is there a role for MR imaging. *Radiology, 201*, 93–96.

Rosenfeld, M., Gunnarsson, R., & Borenstein, P. (2000). Early intervention in whiplash-associated disorders. A comparison of two protocols. *Spine, 25*, 1782–1787.

Rosenfeld, M., Seferiadis, A., Carllson, J., & Gunnarsson, R. (2003). Active intervention in patients with whiplash associated disorders improves long-term prognosis: A randomised controlled clinical trial. *Spine, 28*(22), 2491–2498.

Rosenfeld, M., Seferiadis, A., & Gunnarsson, R. (2006). Active involvement and intervention in patients exposed to whiplash trauma in automobile crashes reduces costs. *Spine, 31*(16), 1799–1804.

Rushton, A., & Wright, C. (2011). Physiotherapy rehabilitation for whiplash associated disorder II: A systematic review and meta-analysis of randomised controlled trials. *BMJ Open, 1*, e000265.

Russell, G., & Nicol, P. (2009). 'I've broken my neck or something!' The general practice experience of whiplash. *Family Practice, 26*, 115–120.

Scholten-Peeters, G., Verhagen, A., Bekkering, G., van der Windt, D., Barnsley, L., Oostendorp, R., et al. (2003). Prognostic factors of whiplash associated disorders: A systematic review of prospective cohort studies. *Pain, 104*(1–2), 303–322.

Scott, W., & Sullivan, M. (2012). Perceived injustice moderates the relationship between pain and depressive symptoms among individuals with persistent musculoskeletal pain. *Pain Research and Management, 17*(5), 335–340.

Soderlund, A., & Lindberg, P. (2001). Cognitive behavioural components in physiotherapy management of chronic whiplash associated disorders (WAD)—A randomised group study. *Physiotherapy Theory and Practice, 17*, 229–238.

Spearing, N., Connelly, L., Gargett, S., & Sterling, M. (2012). Systematic review: Does compensation have a negative effect on health after whiplash? *Pain, 153*, 1274–1282.

Spitzer, W., Skovron, M., Salmi, L., Cassidy, J., Duranceau, J., Suissa, S., et al. (1995). Scientific Monograph of Quebec Task Force on whiplash associated disorders: Redefining "whiplash" and its management. *Spine, 20*(8S), 1–73.

Staud, R. (2006). Biology and therapy of fibromyalgia: Pain in fibromyalgia syndrome. *Arthritis Research and Therapy, 8*, 208.

Steinberg, E., Ovadia, D., Nissan, M., Menahem, A., & Dekel, S. (2005). Whiplash injury: Is there a role for electromyographic studies. *Archives of Orthopaedic Trauma Surgery, 125*(1), 46–50.

Sterling, M. (2010). Differential development of sensory hypersensitivity and a measure of spinal cord hyperexcitability following whiplash injury. *Pain, 150*, 501–506.

Sterling, M., Carroll, L., Kasch, H., Kamper, S., & Stemper, B. (2011). Prognosis after whiplash injury: Where to from here? Discussion Paper 3. *Spine, 36*(25S), s330–s334.

Sterling, M., & Chadwick, B. (2010). Psychological processes in daily life with chronic whiplash: Relations of post-traumatic stress symptoms and fear-of-pain to hourly pain and uptime. *Clinical Journal of Pain, 26*(7), 573–582.

Sterling, M., Hendrikz, J., & Kenardy, J. (2010). Developmental trajectories of pain/disability and PTSD symptoms following whiplash injury. *Pain, 150*(1), 22–28.

Sterling, M., Hendrikz, J., & Kenardy, J. (2011). Similar factors predict disability and PTSD trajectories following whiplash injury. *Pain, 152*(6), 1272–1278.

Sterling, M., Hendrikz, J., Kenardy, J., Kristjansson, E., Dumas, J.-P., Niere, K., et al. (2012). Assessment and validation of prognostic models for poor functional recovery 12 months after whiplash injury: A multicentre inception cohort study. *Pain, 153*(8), 1727–1734.

Sterling, M., Jull, G., & Kenardy, J. (2006). Physical and psychological predictors of outcome following whiplash injury maintain predictive capacity at long term follow-up. *Pain, 122*, 102–108.

Sterling, M., Jull, G., Vicenzino, B., & Kenardy, J. (2003). Sensory hypersensitivity occurs soon after whiplash injury and is associated with poor recovery. *Pain, 104*, 509–517.

Sterling, M., Jull, G., Vicenzino, B., & Kenardy, J. (2004). Characterisation of acute whiplash associated disorders. *Spine, 29*(2), 182–188.

Sterling, M., Jull, G., Vicenzino, B., Kenardy, J., & Darnell, R. (2005). Physical and psychological factors predict outcome following whiplash injury. *Pain, 114*, 141–148.

Sterling, M., Jull, G., Vizenzino, B., Kenardy, J., & Darnell, R. (2003). Development of motor system dysfunction following whiplash injury. *Pain, 103*, 65–73.

Sterling, M., & Kenardy, J. (2006). The relationship between sensory and sympathetic nervous system changes and acute posttraumatic stress following whiplash injury—A prospective study. *Journal of Psychosomatic Research, 60*, 387–393.

Sterling, M., Kenardy, J., Jull, G., & Vicenzino, B. (2003). The development of psychological changes following whiplash injury. *Pain, 106*(3), 481–489.

Stone, A., & Sterling, M. (2009). *Decreased heart rate variability in chronic whiplash is associated with pain, disability, stress and fear of movement but not cold allodynia*. Paper presented at the Australian Physiotherapy Conference, Sydney.

Stone, A., Vicenzino, B., Lim, E., & Sterling, M. (2013). Measures of central hyperexcitability in chronic whiplash associated disorder—A systematic review and meta-analysis. *Manual Therapy, 18*(2), 111–117.

Sullivan, M., Adams, H., Horan, S., Mahar, D., Boland, D., & Gross, R. (2008). The role of perceived injustice in the experience of chronic pain and disability: Scale development and validation. *Journal of Occupational Rehabilitation, 18*, 249–261.

Sullivan, M., Adams, H., Rhodenizer, T., & Stanish, W. (2006). A psychosocial risk factor—Targeted intervention for the prevention of chronic pain and disability following whiplash injury. *Physical Therapy, 86*(1), 8–18.

Sullivan, M., Thibault, P., Simmonds, M., Milioto, M., Cantin, A.-P., & Velly, A. (2009). Pain, perceived injustice and the persistence of post-traumatic stress symptoms during the course of rehabilitation for whiplash injuries. *Pain, 145*(3), 325–331.

Taylor, J., & Taylor, M. (1996). Cervical spinal injuries: An autopsy study of 109 blunt injuries. *Journal of Musculoskeletal Pain, 4*(4), 61–79.

Tchivilera, I., Lim, P., Smith, S., Slade, G., Diatchenko, L., McLean, S., et al. (2010). Effect of COMT polymorphism on response to propranolol therapy in chronic musculoskeletal pain: A randomised, double-blind, placebo-controlled, crossover pilot. *Pharmacogenetics and Genomics, 20*(4), 239–248.

Teasell, R., McClure, J., Walton, D., Pretty, J., Salter, K., Meyer, M., et al. (2010a). A research synthesis of therapeutic interventions for WAD: Part 4—Non invasive interventions for chronic WAD. *Pain Research and Management, 15*(5), 313–322.

Teasell, R., McClure, J., Walton, D., Pretty, J., Salter, K., Meyer, M., et al. (2010b). A research synthesis of therapeutic interventions for whiplash-associated disorder (WAD): Part 2—Interventions for acute WAD. *Pain Research and Management, 15*(5), 295–304.

TRACsa. (2008). *A clinical pathway for best practice management of acute and chronic whiplash-associated disorders*. Adelaide: South Australian Centre for Trauma and Injury Recovery.

Treleaven, J. (2008). Sensorimotor disturbances in neck disorders affecting postural stability, head and eye movement control. *Manual Therapy, 13*(1), 2–11.

Treleaven, J., Jull, G., & Low choy, N. (2005). Standing balance in persistent whiplash: A comparison between subjects with and without dizziness. *Journal of Rehabilitation Medicine, 37*, 224–229.

Treleaven, J., Jull, G., & LowChoy, N. (2005). Smooth pursuit neck torsion test in whiplash associated disorders: Relationship to self-reports of neck pain and disability, dizziness and anxiety. *Journal of Rehabilitation Medicine, 37*, 219–223.

Treleaven, J., Jull, G., & Sterling, M. (2003). Dizziness and unsteadiness following whiplash injury—

Characteristic features and relationship with cervical joint position error. *Journal of Rehabilitation, 34*, 1–8.

Van Oosterwijck, J., Nijs, J., Meeus, M., & Paul, L. (2013). Evidence for central sensitization in chronic whiplash: A systematic literature review. *European Journal of Pain, 17*(3), 299–312.

Vendrig, A., van Akkerveeken, P., & McWhorter, K. (2000). Results of a multimodal treatment program for patients with chronic symptoms after a whiplash injury of the neck. *Spine, 25*, 238–244.

Walburn, J., Vedhara, K., Hankins, M., Rixon, L., & Weinman, J. (2009). Psychological stress and wound healing in humans: A systematic review and meta-analysis. *Journal of Psychosomatic Research, 67*, 253–271.

Walton, D., McDermid, J., Teasell, R., Nielson, W., Reese, H., & Levesque, L. (2011). Pressure pain threshold testing demonstrates predictive ability in people with acute whiplash. *Journal of Orthopaedic & Sports Physical Therapy, 41*(9), 658–665.

Walton, D., Pretty, J., MacDermid, J., & Teasell, R. (2009). Risk factors for persistent problems following whiplash injury: Results of a systematic review and meta-analysis. *Journal of Orthopaedic & Sports Physical Therapy, 39*(5), 334–350.

Williamson, E., Williams, M., Gates, S., & Lamb, S. (2008). A systematic review of psychological factors and the development of late whiplash syndrome. *Pain, 135*, 20–30.

Wilson, J.-P., & Keane, T. (1997). *Assessing psychological trauma and PTSD*. New York: Guilford Press.

Woodhouse, A., & Vasseljen, O. (2008). Altered motor control patterns in whiplash and chronic neck pain. *BMC Musculoskeletal Disorders, 9*, 90.

Yoganandan, N., Pintar, F., & Cusick, J. (2002). Biomechanical analyses of whiplash injuries using an experimental model. *Accident Analysis and Prevention, 34*, 663–671.

Zhu, G., Lipsky, R., & Xu, K. (2004). Differential expression of human COMT alleles in brain and lymphoblasts detected by RT-coupled 5′ nuclease assay. *Psychopharmacology, 177*, 178–184.

8

New Trends of Musculoskeletal Disorders in the Military

Cindy A. McGeary and Donald D. McGeary

Overview

Musculoskeletal pain disorders are of significant concern in the US Armed Forces. This is particularly true considering the physical requirements of many military personnel and the high-risk environments in which they work. Despite continuous advances in military medicine, the rates of disability cases within the US military have been increasing at an alarming rate and nearly doubled between 1985 and 1994 (Berkowitz, Feuerstein, Lopez, & Peck, 1999; Huang, Berkowitz, Feuerstein, & Peck, 1998; Jones, Amoroso, & Canham, 1999). Pain disorders account for the largest proportion of total disability compensation, with approximately $400 million a month (Feuerstein, Berkowitz, Pastel, & Huang, 1999). These types of disability claims are continuing to increase because of military deployments and related injuries in support of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF). Recent data on wound patterns for the US Marines and Sailors serving in Iraq indicated that upper and lower extremity musculoskeletal injuries accounted for almost 70 % of all injuries and that, therefore, orthopedic surgery was the most commonly needed medical specialty (Zouris, Walker, Dye, & Galerneau, 2006). Another study found that 53 % of patients medically evacuated from OIF and evaluated at two military pain management centers had low back pain (Cohen, Griffith, Larkin, Villena, & Larkin, 2005). It was also found that 47 % of OIF/OEF veterans reported chronic pain after deployment, with over 80 % being diagnosed with a musculoskeletal or connective tissue disorder. Without changes in the current approach to treatment, the trends of increasing disability rates and associated costs will very likely continue in the military.

The incidence of military pain sufferers will likely increase due to the unique nature of our current conflicts. Improvised explosive devices and advanced body armor have shifted wounding patterns away from mortal thoracic and head wounds toward survivable extremity and spinal trauma, leaving hundreds of thousands of soldiers alive but in pain (Belmont, Goodman, et al., 2010; Belmont, Schoenfeld, & Goodman, 2010). Additionally, the wear and tear of heavy body armor and sitting in jostled vehicles during deployment has contributed greatly to the incidence of low back pain among deployers (47 % of whom report chronic pain after returning from deployment; Belmont, Schoenfeld, et al., 2010; Champion et al., 2010; Hicks,

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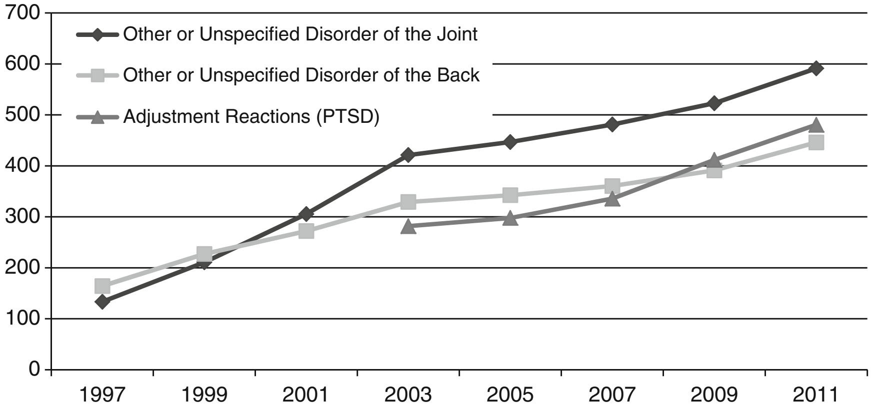

Fig. 8.1 Trends in musculoskeletal disorder ambulatory services for active-duty military service member from 1997 to 2011 (by rate per 1,000 persons per year)

Fertig, Desrocher, Koroshetz, & Pancrazio, 2010; Nevin & Means, 2009). Due to the likelihood of increased musculoskeletal disorders within the military, effective treatments are necessary to address rising concerns of military members suffering from pain and disability.

Military service is a unique occupation, due in no small part to the physical requirements of military work. Although musculoskeletal disorders have always been common among active-duty service members and veterans, recent war efforts (Operations Iraqi Freedom, Enduring Freedom, and New Dawn) have resulted in significant shifts in military injury that have drastically altered the frequency and morphology of musculoskeletal disorders. For example, improvements in body armor and critical care ambulatory transition services have resulted in increased prevalence of extremity trauma and back pain (McGeary, Moore, Vriend, Peterson, & Gatchel, 2011). Indeed, a review of ambulatory data through the Defense Medical Epidemiological Database (DMED) reveals a gradually increasing trend in the prevalence of extremity and back pain among active-duty service members. Interestingly, these musculoskeletal conditions have increased at a similar rate to PTSD (which has been widely recognized as a “signature injury” of the recent war efforts; see Fig. 8.1).

Interventions

Explanatory models for chronic pain have shifted away from simplistic biomedical models dating back to the time of Descartes toward more comprehensive biopsychosocial models stemming from the early works of George Engel (1980). As our understanding of chronic pain became increasingly complex, so too did treatment recommendations. Treatments limited to medical interventions *or* psychotherapy have now given way to integrated, interdisciplinary programs including physical interventions (pain medicine, orthopedics, physical therapy), cognitive and behavioral interventions (activity pacing, cognitive-behavioral treatment [CBT]-based psychotherapy, stress management), and social interventions (improved communication). The treatment effectiveness of interdisciplinary pain management programs has been well documented in the scientific literature (e.g., Gatchel & Okifuji, 2006) for addressing musculoskeletal disorders. Interdisciplinary care consists of coordination of services in a comprehensive program and frequent communication among healthcare professionals, all providing care “under one roof” at the same facility. All healthcare providers work together in one facility, without the need for outside consultants. The key ingredients for interdisciplinary care are the following: a common philosophy of rehabilitation, constant daily communication among on-site healthcare professionals, and active patient involvement. A truly integrated pain management program ensures the best patient care by emphasizing the regular coordination of services. Indeed, there *must* be constant communication among all treatment team members, and the team members need to ingrain the treatment philosophy in their patients to ensure effective comprehensive treatment.

Although there is no standard composition for an interdisciplinary chronic pain management team, there are solid recommendations available in the extant research literature (see Sanders, Harden, & Vicente, 2005). Most interdisciplinary pain programs are developed to directly address the complexity of pain based on the biopsychosocial model. Physical interventions are overseen by a medical director (usually a physician or nurse) who is responsible for assessing and defining the needs and limits of physical rehabilitation. Physical and Occupational Therapists then design and implement a physical rehabilitation program in coordination with the medical director and pain physicians who use medical interventions (e.g., medications and injections) to enhance participation in rehabilitation. Psychologists and Counselors typically oversee psychosocial rehabilitation designed to help the patient overcome motivational, emotional (e.g., depression and anxiety), and cognitive obstacles (e.g., fear avoidance, pain acceptance, pain catastrophization) to rehabilitation.

Cognitive and behavioral therapies are a central feature of the psychotherapeutic component of interdisciplinary treatment for chronic pain. The primary aims of CBT are to identify and replace maladaptive patient cognitions, emotions, and behaviors with more adaptive ones. By addressing both cognitive and behavioral aspects, chronic pain patients receive a more comprehensive treatment that may facilitate adjustment to issues, ranging from mood concerns to maladaptive pain behaviors. Within interdisciplinary chronic pain management programs, CBT has emerged as the psychosocial treatment of choice for chronic pain. In their meta-analysis, Morley, Eccleston, and Williams (1999) found that "CBT produced significant changes in measures of pain experience, mood/affect, cognitive coping and appraisal (reduction of negative coping and increase in positive coping, pain behavior and activity level, and social role function)" (p. 8). Specific examples of cognitive areas addressed by CBT include catastrophizing, acceptance of the pain condition, avoidance of activity due to unrealistic concerns about harm (i.e., fear avoidance, kinesiophobia), and expectations of pain treatment (Vowles, McCracken, & Eccleston, 2007). Additional CBT methods include relaxation training, attention control, motivation (i.e., motivational interviewing), and activity management training (i.e., pacing). The overarching goal for these various techniques is to help the patient identify and address maladaptive thoughts and behaviors. Pain behaviors may include fostering dependence, assuming the sick role, or missing inordinate amounts of time from work for recovery. CBT is often short term and skill oriented, two valuable aspects with regard to treatment of chronic pain patients in the context of these intensive and relatively brief programs.

McCracken and Turk (2002) reported numerous controlled clinical trials of CBT in interdisciplinary chronic pain intervention contexts and found these treatments to be successful at helping patients manage their chronic pain conditions and reduce disability. Additionally, a review by Gatchel and Rollings (2008) offers further support regarding the efficacy of CBT intervention in chronic pain. Gatchel and Robinson (2003) have also provided a comprehensive overview for CBT intervention with chronic pain populations based on the extensive support for the use of CBT found in the literature. Group CBT psychotherapy has also been widely identified and recommended as an important treatment for persistent musculoskeletal conditions (e.g., Keefe, Rumble, Scipio, Giordano, & Perri, 2004; Morley et al., 1999).

With current evidence-based clinical research overwhelmingly supportive of the use of interdisciplinary chronic pain management, clinicians should familiarize themselves with the various facets that comprise this approach. Functional restoration, individual CBT, and group CBT each offer frontline treatments within the context of interdisciplinary treatment for chronic pain. Providers must be aware that communication and collaboration among team members is a requisite element of effective interdisciplinary treatment. Essentially, the sum of the collective medical, psychological, and physical rehabilitation processes represents an improved treatment option, as compared to their worth as isolated treatments. The extensive and ever-growing literature in support of interdisciplinary treatment approaches for chronic pain reflects a collective affirmation for superior patient care.

Functional restoration, the first evidence-based form of interdisciplinary pain management for chronic musculoskeletal pain disorders, was initially developed by Mayer and Gatchel (1988). Since that time, it has been demonstrated to be an extremely effective approach in the diagnosis, intervention, and management of chronic musculoskeletal pain (Gatchel & Mayer, 2008). It requires an interdisciplinary team of clinicians to enact its goals of restoring physical functional capacity and psychosocial performance. This comprehensive approach requires excellent communication among providers in order to address physical, psychological, and vocational challenges during patient recovery. A systematic review by Guzman et al. (2001) revealed that intensive interdisciplinary rehabilitation with functional restoration achieved its goal of pain reduction and functional restoration, relative to usual care. Support for the robustness of the findings on functional restoration programs includes the fact that studies across different economic and social conditions have produced positive and comparable outcomes, not only in the United States but also in other countries such as Denmark (Bendix & Bendix, 1994; Bendix et al., 1996), Germany (Hildebrandt, Pfingsten, Saur, & Jansen, 1997), Canada (Corey, Koepfler, Etlin, & Day, 1996), France (Jousset et al., 2004), and even Japan (Shirado et al., 2005). Thus, Gatchel and Okifuji (2006) concluded "The fact that different clinical treatment teams, functioning in different states and different countries, with markedly different economic and social conditions and workers' compensation systems produced comparable positive results speaks highly for the robustness of the research findings and the utility, as well as the fidelity, of this approach to pain management…" (p. 782). Moreover, the success of the functional restoration approach has been thoroughly documented, with over 40 studies now available through MEDLINE supporting the approach, with dissemination worldwide, including into the US military.

The US House of Representatives (2008) drafted H.R. 5465, *the Military Pain Care Act*, which identified pain as a prevalent and significant problem for the US military and encouraged broad changes in how chronic pain and musculoskeletal disorders are managed within the military. Recently, both the US Army and the US Air Force have implemented functional restoration (FR) pain clinics based on a model developed through a Department of Defense-funded research initiative that began in 2003: the Functional Occupational Restoration Treatment (FORT) program. The purpose of the FORT study was to evaluate the effectiveness of an interdisciplinary FR pain program for the first time in a military population. It was designed to decrease chronic musculoskeletal pain, increase functioning, and retain military members on active duty. The major hypothesis was that the FORT intervention would significantly increase the likelihood that active-duty military personnel suffering from musculoskeletal disorders would remain on active duty and be fully qualified to perform all of their military duties, as well as positively impact other socioeconomic outcomes. All participants were active-duty military members recruited from all four branches of the military and treated at Wilford Hall Medical Center at Lackland Air Force Base, Texas. This was a pre- to posttreatment evaluation design, with evaluations conducted immediately before and after treatment, as well as at 6-, 12-, and 18-month follow-up periods, in order to determine differential outcomes on variables such as return to full duty status, work retention, and additional healthcare utilization. The specific aims of the study were to evaluate the efficacy of the FORT program in reducing patient-reported pain symptoms, unnecessary healthcare utilization, healthcare costs, and number of military members on medical profile, disability, or separated from active duty. Additional aims included improving functioning, increasing the number of military members remaining fit for duty and worldwide qualified, and increasing military members' ability to pass their physical fitness test for their respective military service. In summary, this research project addressed the clear need for clinical research to develop evidence-based assessment and treatment approaches to decrease the enormous cost associated with chronic musculoskeletal conditions within the US Armed Forces.

Data analyses to date have shown a variety of desirable outcomes associated with FORT treatment (Gatchel et al., 2009). The FORT intervention resulted in significant improvements for functional capacity, health-related quality of life, and military retention. In contrast, a treatment-as-usual group showed no significant change in physical or psychosocial outcomes over the 1-year assessment span. Furthermore, participants who completed treatment as usual were *three times* more likely to have received a medical discharge from active-duty service compared to FORT participants and were more likely to seek increased levels of pain-related healthcare and medication use. The success of this research project proved the efficacy of the interdisciplinary FR approach even when they are translated into a military medical environment. More work is needed, however, to examine the cost effectiveness of this military approach.

Medications Use in Military for Musculoskeletal Diseases

There have been significant advancements in military pain analgesia since the onset of the current war effort in 2001. In 2009, the then US Army Surgeon General, LTG Eric Schoomaker, recognized that chronic pain management was a significant problem for military medical providers without any clear guidance for providers on analgesic and opioid medication prescription (Plunkett, Turabi, & Wilkinson, 2012). LTG Schoomaker assembled the *Army Pain Management Taskforce* to address these concerns, and the taskforce published a comprehensive report in 2010 outlining the best available evidence and most notable gaps in military analgesia and pain management (Pain Management Taskforce, 2010). One of the most notable gaps identified by the *Pain Management Taskforce Final Report* was the need for increased guidance on opioid medication prescription for active-duty service members and veterans. Opioid medications are often a frontline treatment option for chronic musculoskeletal pain. Despite their benefit to the pain sufferer, these medications often come with deleterious side effects (e.g., drowsiness, difficulty concentrating) that erode an individual's ability to complete military work. Unfortunately, the increasing trend in military musculoskeletal disorders has been accompanied by a similar increase in the frequency of opioid medication prescription and use (Kent & Ong, 2011). Opioid dependence has risen among active-duty service members as opioid medications have become more prolific in treating military chronic pain. The DMED reveals a dramatic increase in the frequency of ambulatory visits for opioid dependence among active-duty service members from 2001 (when the current war effort began) to 2011 (the most recent available data). According to the DMED, there were 1,147 ambulatory visits among active-duty service members from all service branches with a primary diagnosis of opioid dependence (ICD-9 code 304.0). This number consistently increased over the next decade up to 22,211 visits in 2011 (Fig. 8.2).

The US Army *Pain Management Taskforce Final Report* (Pain Management Taskforce, 2010) stressed the addition of complementary and alternative medicine (CAM) approaches for use in military and veterans affairs (VA) treatment facilities. Top-tier CAM interventions addressed by the report include acupuncture, yoga, biofeedback, and massage. Although various other CAM modalities are recommended as second-tier treatment options, the Report does little to illuminate the data supporting (or dissuading) the use of these interventions (many of which are

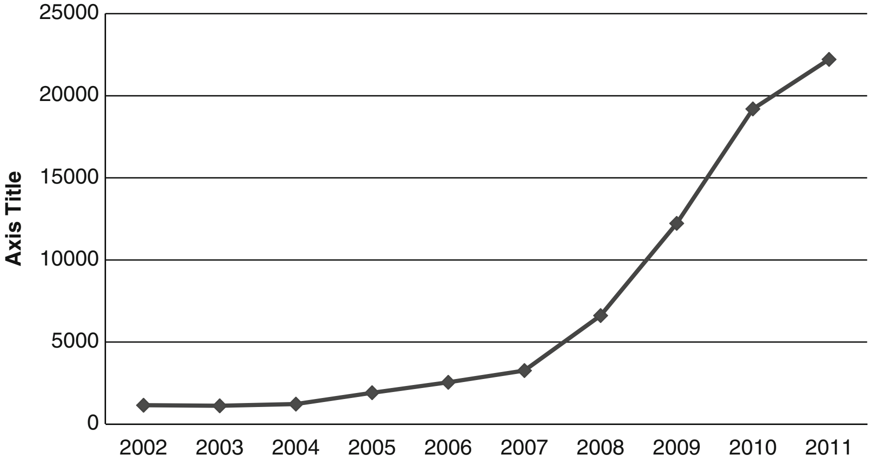

Fig. 8.2 Number of ambulatory visits for opioid type dependency (as a primary diagnosis) from 2002 to 2011 (all service branches)

already heavily utilized in DoD and VA treatment facilities). Data addressing the potential efficacy of these treatments are included below.

Noninvasive brain stimulation (*NIBS*): Noninvasive brain stimulation has become increasingly available for personal and clinic use at minimal cost. NIBS interventions include a variety of modalities including repetitive transcranial magnetic stimulation (rTMS), cranial electrotherapy stimulation (CES), and transcranial direct current stimulation (tDCS). These devices are intended to decrease pain experience through electric or magnetic stimulation of the brain resulting in altered neural activity. Some report that NIBS devices help pain patients engage in psychosocial pain management activities because they look like "real" medical devices, which erodes some of the stigma associated with psychotherapeutic pain treatment (Tan, Dao, Smith, Robinson, & Jensen, 2010). In a comprehensive 2010 meta-analysis, O'Connell, Wand, Marston, Spencer, and DeSouza (2010) found that NIBS pain management devices may offer some short-term pain relief, but the available evidence does not consistently demonstrate significant clinical benefit. Some minor, transient side effects have been noticed with NIBS therapies.

Dietary pain management: Although there are some data demonstrating effective pain relief through dietary changes and supplementation, much of the evidence is preliminary or based on weak research methodology. Lee and Raja (2011) offer an excellent overview of nutritional and dietary approaches to pain management. Side effects vary with the dietary intervention.

Magnets: Magnetics are widely advertised as an effective way to manage pain and promote health. However, studies of static magnetic fields have preliminarily demonstrated little effect on pain experience, although research is still preliminary and the evidence may change with future research. Very few to no side effects have been reported for treatment of chronic pain with magnetic fields.

Spinal traction: Noninvasive spinal traction has increased in popularity as a low-risk spinal pain management option starting in the late 1970s. Mechanical and manual traction devices are intended to decrease pressure on the spine with particular benefit for intervertebral disc herniations. However, a 2010 Cochrane summary revealed little to no evidence for single or repeated use of traction devices for spinal pain relief, with some reports of transient deleterious side effects (e.g., pain increase; Clark et al., 2007).

The Military and VA Disability Systems

The military attempts to treat disabling injuries in hopes of returning members to full capacity and enabling them to perform all duties required for continued active-duty status. Sometimes, despite best efforts, military members are no longer capable of carrying out their assigned job duties due to disability. When service members are no longer capable of performing their military duties due to physical or mental defect, they are put on a *medical profile*. This is the first step in a long process of establishing disability within the military. The military's profile system is meant to allow a service member time to recuperate and return to duty. If recuperation does not occur, the military member is referred to the Medical Evaluation Board (MEB)/Physical Evaluation Board (PEB) to determine ability to remain in the military and compensation for disability. This is a lengthy process that ends with the military member either being returned to active-duty status or being discharged/retired from the military. If the service member leaves the military, many enter the Veterans Affairs (VA) system to treat ongoing disability. The following section of this chapter will provide a discussion of the physical profile serial system, which is necessary to introduce the disability evaluation system (DES). This discussion will include the MEB/PEB and the VA disability system encompassing the four branches of the military that fall under the jurisdiction of the Department of Defense (e.g., Army, Air Force, Navy, Marines). The information in this section provides an overview of these procedures, for specifics regarding a particular service branch the reader should consult appropriate military regulations and instructions specific to that service branch.

Physical profile system: The military's physical profile serial system was established to determine whether soldiers were physically capable of performing assigned duties and to classify individuals based upon physical functional abilities. This information was then used to establish suitability for different career fields. These standards were developed to ensure readiness of military personnel while preserving health and preventing injury (United States Department of the Air Force [U.S. Dept of AF], 2010, June 25).

The physical profile system classifies military members according to physical functioning which determines the availability for worldwide duty (i.e., deployment). The military's Physical Profile Serial Chart system falls within six categories that represent different areas of physical functioning. These categories are designated "P-U-L-H-E-S" (Karpinos, 1960). Each letter signifies a different medical area:

P: The "P" relates to general physical capacity. This category encompasses organic defects or illnesses that affect overall general physical capacity which do not fall under other categories (i.e., conditions of the heart, nervous system, dental conditions, and respiratory system).

U: The "U" of the P-U-L-H-E-S system covers the upper extremities. This includes the functional use (i.e., strength, range of motion, general efficiency) of the upper extremities, including, the hands, arms, shoulders, and spine.

L: The "L" comprises the lower extremities. This includes the functional use of the lower spine and back musculature, feet, legs, and pelvis in relation to strength, range of motion, and general efficiency.

H: The "H" includes hearing and ear defects. This category represents the clarity or clearness of hearing and any diseases or defects of the ear (e.g., tinnitus, Meniere's disease).

E: The "E" represents the eyes in the physical profile system. It encompasses visual acuity or clearness of vision and any diseases or defects of the eye (e.g., corneal ulcer, night blindness).

S: The "S" in the physical profile system is not as obvious as the others. The "S" stands for psychiatric conditions. This entails personality problems, psychiatric disorders, and questions regarding emotional stability. It is often the least clear-cut category when it comes to assigning a level of functional capacity.

Numerical designations from one to four are used to reflect different levels of functional capacity within the P-U-L-H-E-S system. These numerical designations allow a physician to rate service members' functional capacity within each category and make recommendations for duty limitations based on current problems or defects. Each number corresponds to the following:

1. An individual with the designation of a "1" in all of the P-U-L-H-E-S categories is considered medically fit, with no limitations regarding duty, mobility, or deployments.
2. A military member with the designation of a "2" in any of the P-U-L-H-E-S categories indicates that the individual has a defect in that particular category that is likely to be mild but may require some activity limitations.
3. A "3" in any of the P-U-L-H-E-S categories indicates an individual who has a medical condition or defect that requires significant duty limitations. An individual may need to be retrained and enter a new career field due to the defect.
4. A military member with the designation of a "4" in the P-U-L-H-E-S system is considered non-deployable due to physical illness or defect. The service member is unable to complete most tasks related to military duty. Having a "4" in the P-U-L-H-E-S system is inconsistent with continued military service.

Physicians will put military members who are injured or suffer a medical problem on a *medical profile*. A *medical profile* is a way to communicate with command about illnesses and duty limitations suffered by service members that could affect the military mission. Whether a defect affects the military mission is often dependent upon the military members' occupational specialty. A defect that is limiting in one career field may not have mission impact in another career field. When an individual is initially put on a profile, it is generally under the assumption that the service member will recover, return to duty, and continue to meet medical retention standards developed by the military. When recuperation is expected, a service member is put on a temporary profile, which is designated with the letter "T" after the number in the P-U-L-H-E-S system (i.e., P4T). A temporary profile is only valid for 12 months from the initial profile date. After 6 months, if the service member has not recovered, a referral to a specialist will be made. The specialist will determine if recovery is likely. If it is, the temporary profile will be extended and treatment will continue until the profile is reviewed in another 6 months. If the service member is not likely to recover and does not meet medical retention standards, the service member is entered into the DES and must be referred to a MEB/PEB.

The Medical Evaluation Board/Physical Evaluation Board

Each branch of the military is responsible for assuring a fit and ready force. When a soldier is injured and unable or unlikely to recuperate, each service member must have a thorough review to determine fitness of duty, level of disability, and retirement/separation status. This is accomplished through each service's DES (United States Department of the Army [U.S. Dept of A], 2006, February 8). Two boards comprise the DES: the first is the MEB and the second is the PEB. The MEB process generally begins with a service member seeking care from a physician at a medical treatment facility (MTF). If the physician diagnoses a problem that interferes with military service that is unlikely to remit in 12 months, the service member is referred for an MEB. The MEB determines whether the service member has a medical condition that precludes further military service which includes the ability to complete fitness testing and deploy (U.S. Dept of AF, 2010, June 25). The existence of a physical or mental condition does not in and of itself necessitate an MEB. It is whether the condition inhibits the service member from effectively completing job duties.

Once an MEB has been initiated, the service member will be contacted by the Physical Evaluation Board Liaison Officer (PEBLO). It is the PEBLO's duty to help the service member through the MEB process administratively (U.S. Dept of AF, 2010, June 25). The PEBLO's duties include educating the active-duty service member on the MEB process. The service member may also be assigned a case manager to oversee the MEB process. In these cases, it is the case manager's job to help manage the service member's medical appointments and to work with the service member and his/her family in establishing realistic goals for the future and counseling on available resources. While undergoing an MEB, the service member is expected to attend medical appointments and meet with physicians to determine whether the soldier is able to meet medical retention standards. The physicians compile information from the physical exams (which can include X-rays, lab reports, etc.) into a narrative summary for the MEB. This report will include information about the service member's physical capabilities and abilities to meet job duties, based on diagnoses, symptoms, and past work performance. Most decisions regarding disability and fitness for duty ultimately arise from the MEB narrative summary.

The service member's command is also involved in the MEB process. The service member's commander is asked to write a letter to the MEB outlining the impact of disability on day-to-day military duties and the ability to deploy (U.S. Dept of AF, 2010, June 25). This step may be bypassed if it is unlikely that the service member will be retained on active duty. The MEB, which consists of physicians who are not involved in the care of the service member, will determine whether the service member meets or does not meet medical retention standards using published medical standards for continued military service. The results of the MEB are provided to the service member by the PEBLO. When the results of an MEB are returned to the service member, he/she may appeal the findings. The service member is generally given 3 days to appeal the results of an MEB. As a result, the MEB could decide either the report is accurate as it stands or the narrative summary could be returned to the examining physician for clarification.

After the MEB, if the service member is not returned to active duty, he/she is referred to the PEB, which is the next step in the DES. The PEB determines fitness for duty but will also assign the level of disability for compensation purposes and determine if the medical condition occurred during active-duty status (also known as a line-of-duty determination). The PEB is a fact-finding body that investigates the nature, origin, degree of impairment, and the probable permanence of the medical condition (U.S. Dept of AF, 2009, September 24). The PEB involves both an informal and formal PEB. Not all service members will have a formal PEB. A formal PEB is only instituted if the service member does not agree with the decision of the informal PEB. The Informal Physical Evaluation Board (IPEB) consists of voting members who review medical and personnel records to determine fitness for duty, disability compensation, and final disposition of the military member (i.e., retirement versus separation with severance pay) (U.S. Dept of A, 2006, February 8). The service member is not allowed to attend the IPEB and may not have military counsel present. Once the IPEB convenes, the PEBLO counsels the service member on the disposition of the board's findings. The service member is given 10 days to agree or disagree with the board's results. If the service member agrees with the IPEB's findings, the military will continue processing the case based upon final disposition. Service members may disagree with the IPEB's disposition or disability ratings and wish to appeal the board's findings. If the service member disagrees with the board's findings, a FPEB will convene.

The Formal Physical Evaluation Board (FPEB) meets if the service member appeals the IPEB's findings. The service member is allowed to attend and may have military counsel present and call witnesses to testify on his/her behalf (U.S. Dept of A, 2006, February 8). The PEBLO will assist the service member with transportation, orders, and reporting instructions. Once the FPEB reaches a decision, the PEBLO will report the results and counsel the service member about options. The service member has 1 day to either disagree or agree with the FPEB's findings. If the service member disagrees, one final appeal can be made disputing the results of the PEB. The service member is not allowed to participate in the final hearing and there is no military council present. As a result of the FPEB, the board may or may not overturn its initial decisions regarding duty status, disability rating, or line-of-duty determination. If a service member is found to be fit by the PEB, he/she is returned to active-duty status. This rarely occurs if the MEB has already determined that service members are unfit for continued military service, but does happen on occasion. The PEB can decide that service members are incapable of completing their current job duties, but may recommend retraining or allow them to remain on active duty if service members are qualified in a critical skill or employed in a specialty that is undermanned. The service member must be able to serve effectively with appropriate assignment and duty limitations (U.S. Dept of A, 2006, February 8). This enables a service member to remain on active duty, but with conditions, such as not being allowed to serve in areas that do not have medical facilities readily available to treat present medical conditions.

If the service member is found unfit for duty, the PEB rates the service member's disability based upon the Veterans Affairs Schedule for Rating Disabilities and Department of Defense Instruction 1332.39. The PEB will only rate medical conditions that yield the service member unfit for continued military service. The PEB then categorizes each medical condition as compensable or non-compensable. Eligibility of disability benefits is based on compensable conditions. Compensable conditions are ones the service member incurred during active-duty status and did not exist prior to joining the military. Disability ratings are made as percentages in 10 % increments, from 0 to 100 %. The higher the percentage, the more compensation is given to the service member. In addition to providing disability ratings, the PEB will decide between several courses of action, once it is determined the service member is no longer fit for active duty. The service member may be separated from the military without benefits (U.S. Dept of A, 2006, February 8). This could occur if the service member's disability existed prior to service (EPTS). This means that the medical condition under question was present prior to the service member joining the military, and it was determined the military did not aggravate the disorder while in service. An example of this would be a congenital or hereditary disease. Although, if it is determined that military service aggravated a condition that EPTS, the service member may be rated for disability for that disorder. Another reason a military member may be discharged without benefits is if the injury or disability was incurred while the service member was absent without leave (AWOL) or engaged in acts of misconduct.

A service member could also be separated with severance pay. This would occur in situations where the service member has been found unfit for continued military service, but also has fewer than 20 years in service, and the disability rating is less than 30 % (Powers, n.d.). Despite a disability rating less than 30 %, a service member who has been separated with severance pay can apply to Veterans Affairs (VA) for disability compensation if the medical condition is considered to have occurred during active-duty service. Finally, the service member may be retired from active duty. There are two types of medical retirement. The first is *Permanent Disability Retirement*. The service member can expect Permanent Disability Retirement if he/she is found unfit for continued military service and has served 20 years in the military. The disability must be considered stable and permanent and be assigned a disability rating of at least 30 % (Powers, n.d.). The member is then able to take the disability rating and apply for VA benefits. The second type of military retirement is *Temporary Disability Retirement*. A service member is placed upon a Temporary Disability Retirement List (TDRL) if he/she is found unfit for continued military service; however, the disability is not stable and may change in the future (U.S. Dept of A, 2006, February 8). Because the disability is not stable, a compensation rating is unable to be given. A service member must be reevaluated every 18 months (for up to 5 years) to assess the progress of the medical condition. If it is determined to stabilize at any time within those 5 years, a final determination in relation to disability will be made. Otherwise, the service member will be removed from TDRL status at the end of 5 years and given a final disability rating.

The Department of Defense (DoD) and the Department of Veterans Affairs (VA) both rate disabilities based upon the Department of Veterans Affairs Schedule for Rating Disabilities. However, the two entities rate disabilities differently (Powers, n.d.). The military rates conditions that are unfitting to continued military service and the military's ratings are permanent upon discharge from the military. The VA may rate any military-related or service-connected disability. This allows an individual to be compensated for being unable to obtain civilian employment due to disability. Veterans Affairs ratings may change over time based upon progression or improvement of the disability and may require periodical reexamination. The next section discusses the VA's disability system and programs.

Veterans Affairs Disability System

Entering the VA system can be a daunting process for any military member. Fortunately, information does exist to help veterans traverse this unknown and complicated terrain, and VA representatives are available to guide veterans through the process and answer questions. Also, the VA has published a handbook online for veterans that summarize benefits available (http://www.vba.va.gov/bln/vre). The VA has two main organizational branches. The first is the *Veterans Benefits Administration*, which oversees programs that focus on disability compensation, disability pension, vocational rehabilitation and educational services, life insurance, and housing grants. The other organizational branch is the *Veterans Health Administration*, which manages the healthcare system available to veterans (Miller, O'Mara, & Kregel, 2012). An overview of services provided to disabled veterans by both administrations will follow; however, benefits that fall under the Veterans Benefits Administration will be discussed first.

Disability compensation allows veterans monetary compensation due to disability. The amount is based upon the veteran's disability rating and is paid monthly. Disability compensation is not subject to Federal or State income tax. Retired veterans are able to collect both retirement pay and disability compensation. To apply for disability compensation, veterans (who did not apply for benefits prior to leaving the military) can apply by filling out a *Veterans Application for Compensation or Pension* (U.S. Dept of VA, 2011, September 29). In addition to the application form, veterans should attach military separation papers, records for any dependents (birth or marriage certificates), and medical evidence to support the disability claim. Once the application is complete, the veteran may be asked to attend medical exams (free of charge) to evaluate any conditions listed on the benefit's claim. When all examinations are complete, the findings will be used to obtain a disability rating, and the veteran will begin to receive disability compensation. Disability ratings through the VA are similar to the military disability system. Ratings range from 0 to 100 %, and increase in 10 % increments, with higher percentages reflecting more disability compensation. If the veteran does not agree with the disability rating, an appeals process exists.

The VA and DoD have a joint program to assist military members in filing for disability compensation and other VA benefits prior to discharge from the military. This program is the Predischarge Program. It allows for service members to apply for compensation and benefits up to 180 days prior to separation or retirement (U.S. Dept of VA, 2012a). This program has three components: the Benefits Delivery at Discharge (BDD), the Quick Start, and the integrated disability evaluation system (IDES).

- The BDD program allows active-duty service members to apply for VA disability benefits while still on active-duty status (U.S. Dept of VA, 2012a). To enroll in this program, the service member must have at least 60 days left on active-duty status, but no more than 180 days. The member needs to have a separation/retirement date and supply the VA with all military service medical records. The service member must also be able to attend necessary medical examinations in order to establish disability ratings prior to being discharged from the military.
- The Quick Start program is similar to BDD but is for service members who have less than

60 days left on active duty or are unable to attend all the VA medical examinations prior to leaving the military (U.S. Dept of VA, 2012a). To qualify for this program, the service member needs to have at least 1 day left on active duty. The service member also needs to have a date of separation/retirement and provide the VA with all active-duty military medical records.

- Many of today's veterans are being enrolled in the Veterans Affairs Disability System through the IDES, which is the third component of the Predischarge Program. This program is for individuals who have undergone an MEB. This is a program whose goal is to accelerate receipt of VA disability benefits for military members. The goal of the IDES is to have a single disability exam that is accepted by both the VA and the DoD and a single disability rating that is completed by the VA and accepted by both organizations (U.S. Dept of VA, 2012a). This is to ensure prompt payment of VA benefits (often within 30 days of the service member's retirement/separation from the military) to disabled veterans.

Disability pension is another monetary benefit offered to qualifying veterans. To qualify, a veteran must have a low income and be permanently and totally disabled or over the age of 65 (U.S. Dept of VA, 2012a). There are time-in-service requirements that vary depending upon when the veteran entered active-duty status. Time-in-service requirements do not apply to veterans who were discharged from the military due to a service-connected disability. The compensation received through disability pension varies. The amount received is meant to bring the veteran's total income to a national level set by the Congress (U.S. Dept of VA, 2012a). Veterans who are eligible for pensions may also qualify for Aid and Attendance or Housebound benefits. These benefits raise the maximum annual pension rate and are given to veterans who require the aid of another person to perform activities of daily living or are bedridden and unable to leave the home due to disability. Disabled veterans may also apply for vocational rehabilitation under the Veterans Benefits Administration. Vocational rehabilitation is offered through the *Vocational Rehabilitation and Employment VetSuccess Program* (U.S. Dept of VA, 2012b, July 31). The purpose of the program is to help veterans with service-connected disabilities find employment and live independently. Services can include vocational counseling, employment services (i.e., job training, resume development, and job-seeking skills), on-the-job training, apprenticeships, postsecondary education, and supportive rehabilitation services.

Veterans need to apply for Vocational Rehabilitation and Employment VetSuccess services and there are eligibility requirements. For eligibility, veterans must have received an honorable discharge and have a service-connected disability of 10 % or a memorandum rating of 20 % from the VA, which is a preliminary rating given to individuals who have not received their formal disability rating (U.S. Dept of VA, 2012b, July 31). Veterans generally need to use these services within 12 years of their date of separation or 12 years from being notified of a service-connected disability rating. Once eligibility has been determined, the veteran is scheduled to meet with a Vocational Rehabilitation Counselor (VRC) to determine if the veteran is entitled to services. Entitlement of services is based upon whether the veteran has a service-connected disability that affects employability. If such a condition exists, the veteran works closely with the VRC to develop a rehabilitation plan. This is an individualized plan that outlines the services, resources, and criteria that will be used to achieve employment (U.S. Dept of VA, 2012b, July 31). The VRC will help the veteran to meet the goals laid out in the rehabilitation plan. Services provided by the Vocational Rehabilitation and Employment VetSuccess Program fall within five tracks (U.S. Dept of VA, 2012a):

- *Reemployment with previous employer*: This track is for individuals who are separating from active duty and plan to return to work for a previous employer.
- *Rapid access to employment*: This track is for individuals who want to obtain employment soon after separation and already have competitive job market skills.

- *Self-employment*: Services provided in this track are for individuals who have limited access to traditional employment due to the need for work accommodations related to their disability or a need for a flexible work schedule.
- *Employment through long-term services*: This track is designed for individuals who do not have the specialized skills or training to obtain employment.
- *Independent living services*: This track is for veterans who are not able to work due to disability and require services to learn to live independently.

Veterans are also able to obtain life insurance through the VA. Servicemembers' Group Life Insurance (SGLI) that is provided for active-duty military members and can be converted to Veterans' Group Life Insurance (VGLI) upon separation from the military. SGLI can be converted to VGLI up to the amount of coverage the military member had prior to separation (U.S. Dept of VA, 2012a). Service members who are considered totally disabled at the time of separation are eligible for free SGLI Disability Extension for 2 years. Once the 2 years elapse, the coverage is converted to VGLI. Disabled veterans can apply for Service-Disabled Veterans' Insurance if the veteran was discharged under other than dishonorable conditions (U.S. Dept of VA, 2012a). Veterans with service-connected disabilities, but who are otherwise in good health, can apply to the VA for up to $10,000 in life insurance through the Service-Disabled Veterans' Insurance program. Veterans who are totally disabled can apply for a waiver of premiums and for supplemental coverage under this program. Housing grants are available through the VA. Service members and veterans with service-connected disabilities can apply for a specially adapted housing (SAH) grant. This funding can be used to modify or build a home to meet disability-related needs (U.S. Dept of VA, 2012a). The amount of the grant cannot exceed $63,780 or be more than 50 % of the total cost of modifications. There are eligibility requirements that include being totally and permanently disabled. An individual who qualifies for the SAH grant may also obtain a temporary residence adaption (TRA). The TRA grant is available for disabled veterans who temporarily reside in a family member's home. The TRA allows for modifications to be made to the family member's home in accordance to the special needs of the disabled veteran (U.S. Dept of VA, 2012a).

The Veterans Health Administration is the branch of the Department of Veterans Affairs that oversees the medical programs available at the VA. The Veterans Health Administration accomplishes this through the management of VA medical centers, outpatient clinics, Vet centers, and community-living centers. The VA Health Care System is the largest integrated healthcare system in the United States, with over 1,500 facilities nationwide (U.S. Dept of VA, 2012a). An integrated healthcare system allows veterans to obtain healthcare benefits from any VA healthcare facility in the nation. The VA offers healthcare benefits to individuals who served in the active-duty military and were discharged under conditions other than dishonorable. The degree of benefits available may vary from individual to individual based upon their eligibility status, which takes into account circumstances such as a veteran's wartime status, service-connected disability rating, and income. Generally, a veteran needs to apply for enrollment for healthcare benefits either online, via the telephone, or in person. After applying, veterans are assigned to one of eight priority groups. The VA assigns priority groups based on level of disability and income. Veterans in higher priority groups, like Group 1, are able to receive healthcare before veterans assigned to a lower priority group, such as Group 8 (U.S. Dept of VA, 2012c, August 8). Healthcare benefits include preventative care services, outpatient services, inpatient services (e.g., medical, surgical, mental health, residential rehab treatment programs), specialty services (e.g., dermatology, cardiology, and nephrology), ancillary services (e.g., audiology, dental, and social work), and nursing home care (Allmilitary.com, n.d.).

According to the VA, the overall veteran population has been decreasing since 1985; however, the number of disabled service-connected veterans has been on the rise, with growth concentrated among veterans receiving a 50 % or higher disability rating (National Center for Veterans Analysis and Statistics, 2012). This trend indicates the need for services dedicated to disabled veterans is at an all time high. While the VA offers many programs specifically for disabled veterans, there will likely be a need for expansion of current services to keep up with the increasing disabled veteran population.

Summary

The US Departments of Defense and Veterans Affairs serve millions of brave and selfless service members, veterans, and their families, and many of these individuals suffer from musculoskeletal disorders. In recognition of the unique problems posed to service members and veterans due to chronic pain conditions, the federal government has established some of the best systems of interdisciplinary pain care and disability management in the World. The US Army Pain Management Taskforce was established in 2009 to analyze gaps in pain care in the DoD and VA systems and to provide pain management guidelines based on the best available evidence. These treatment services are combined with a comprehensive disability board system designed to assess the long-term impacts of service-connected injury and to organize the best available benefits to help service members and veterans maximize their quality of life. This chapter was designed to provide an overview of military pain management and to briefly review the DoD and VA disability systems.

References

Allmilitary.com. (n.d.). *Veterans health programs* [online content]. Retrieved September 6, 2012, from http://www.allmilitary.com/benefits/health/med-package/eligible.html

Belmont, P. J., Goodman, G., Zacchilli, M., Posner, M., Evans, C., & Owens, B. D. (2010). Incidence and epidemiology of combat injuries sustained during "the Surge" portion of Operation Iraqi Freedom by a U.S. Army Brigade Combat Team. *Journal of Trauma Injury Infection & Critical Care, 68*, 204–210.

Belmont, P. J., Schoenfeld, A. J., & Goodman, G. (2010). Epidemiology of combat wounds in Operation Iraqi Freedom and Operation Enduring Freedom: Orthopaedic burden of disease. *Journal of Surgical Orthopaedic Advances, 19*, 2–7.

Bendix, T., & Bendix, A. (1994). *Different training programs for chronic low back pain—A randomized, blinded one-year follow-up study*. Paper presented at the International Society for the Study of the Lumbar Spine, Seattle.

Bendix, A. E., Bendix, T., Vaegter, K., Lund, C., Frolund, L., & Holm, L. (1996). Multidisciplinary intensive treatment for chronic low back pain: A randomized, prospective study. *Cleveland Clinic Journal of Medicine, 63*(1), 62–69.

Berkowitz, S. M., Feuerstein, M., Lopez, M. S., & Peck, C. A. (1999). Occupational back disability in U.S. Army personnel. *Military Medicine, 164*, 421–428.

Champion, H. R., Holcomb, J. B., Lawnick, M. M., Kelliher, T., Spott, M. A., Galarneau, M. R., et al. (2010). Improved characterization of combat injury. *Journal of Trauma Injury Infection & Critical Care, 68*(5), 1139–1150.

Clark, J., van Tulder, M., Blomberg, S. E., de Vet, H., vander Heijden, G., Bronfort, G., et al. (2007). Traction for low-back pain with or without sciatica. *Cochrane Database of Systematic Reviews*, (2), CD003010. doi: 10.1002/14651858.CD003010.pub4.

Cohen, S. P., Griffith, S., Larkin, T. M., Villena, F., & Larkin, R. (2005). Presentation, diagnoses, mechanisms of injury, and treatment of soldiers injured in Operation Iraqi Freedom: An epidemiological study conducted at two military pain management centers. *Anesthesia and Analgesia, 101*, 1098–1103.

Corey, D. T., Koepfler, L. E., Etlin, D., & Day, H. I. (1996). A limited functional restoration program for injured workers: A randomized trial. *Journal of Occupational Rehabilitation, 6*, 239–249.

Department of the Air Force. (2009, September 24). *Air Force instruction 48-123. Aerospace medicine: Medical examinations and standards*. Retrieved from http://www.e-publishing.af.mil/shared/media/epubs/AFI48-123.pdf

Department of the Air Force. (2010, June 25). *Air Force instruction 10-203, Operations: Duty limiting conditions.* Retrieved from http://www.e-publishing.af.mil/shared/media/epubs/AFI10-203.pdf

Department of the Army. (2006, February 8) *Army regulation 635-40, personal separations: Physical evaluation for retention, retirement, or separation.* Retrieved from http://armypubs.army.mil/epubs/635_Series_Collection_1.html

Engel, G. L. (1980). The clinical application of the biopsychosocial model. *American Journal of Psychiatry, 137*, 535–544.

Feuerstein, M., Berkowitz, S. M., Pastel, R., & Huang, G. D. (1999, July). *The secondary prevention program for occupational low back pain-related disability.*

Presented at the Workers' Compensation Research Group, New Brunswick, NJ.

Gatchel, R. J., & Mayer, T. G. (2008). Evidence-based review of the effectiveness of functional restoration for the management of chronic low back pain. *The Spine Journal, 8*, 65–69.

Gatchel, R. J., McGeary, D. D., Peterson, A. L., Moore, M. E., LeRoy, K., Isler, W. C., et al. (2009). Preliminary findings of a randomized controlled trial of an interdisciplinary functional restoration program. *Military Medicine, 174*, 270–277.

Gatchel, R. J., & Okifuji, A. (2006). Evidence-based scientific data documenting the treatment and cost-effectiveness of comprehensive pain programs for chronic nonmalignant pain. *The Journal of Pain, 7*(11), 779–793. doi:10.1016/j.jpain.2006.08.005.

Gatchel, R. J., & Robinson, R. C. (2003). Pain management. In W. O'Donohue, J. E. Fisher, & S. C. Hayes (Eds.), *Cognitive behavior therapy: Applying empirically supported techniques in your practice*. New York: Wiley.

Gatchel, R. J., & Rollings, K. H. (2008). Evidence-based review of the efficacy of cognitive-behavioral therapy for the treatment of chronic low back pain. *The Spine Journal, 8*, 40–44.

Guzman, J., Esmail, R., Karjalainen, K., Malmivaara, A., Irvin, E., & Bombardier, C. (2001). Multidisciplinary rehabilitation for chronic low back pain: Systematic review. *British Medical Journal, 322*, 1511–1516.

Hicks, R. R., Fertig, S. J., Desrocher, R. E., Koroshetz, W. J., & Pancrazio, J. J. (2010). Neurological effects of blast injury. *Journal of Trauma Injury Infection & Critical Care, 68*, 1257–1263.

Hildebrandt, J., Pfingsten, M., Saur, P., & Jansen, J. (1997). Prediction of success from a multidisciplinary treatment program for chronic low back pain. *Spine, 22*, 990–1001.

Huang, G. D., Berkowitz, S. M., Feuerstein, M., & Peck, C. A. (1998). Occupational upper-extremity-related disability: Demographic, physical, and psychosocial factors. *Military Medicine, 163*, 552–558.

Jones, B. H., Amoroso, P. J., & Canham, M. L. (1999). Atlas of injuries in the US Armed Forces military medicine. *Military Medicine, 164*(Suppl.), 9-1–9-26.

Jousset, N., Fanello, S., Bontoux, L., Dubus, V., Billabert, C., Vielle, B., et al. (2004). Effects of functional restoration versus 3 hours per week physical therapy: A randomized controlled study. *Spine, 29*(5), 487–493.

Karpinos, B. D. (1960). Fitness of American youth for military service. *The Milbank Memorial Fund Quarterly, 38*(3), 213–247.

Keefe, F. J., Rumble, M. E., Scipio, C. D., Giordano, L. A., & Perri, L. M. (2004). Psychological aspects of persistent pain: Current state of the science. *The Journal of Pain, 5*(4), 195–211. doi:10.1016/j.jpain.2004.02.576.

Kent, J. B., & Ong, C. N. (2011). Starting a primary care pain management clinic in a military treatment facility. *Military Medicine, 175*, 486–487.

Lee, F., & Raja, S. (2011). Complementary and alternative medicine in chronic pain. *Pain, 152*, 28–30.

Mayer, T. G., & Gatchel, R. J. (1988). *Functional restoration for spinal disorders: The sports medicine approach*. Philadelphia: Lea & Febiger.

McCracken, L. M., & Turk, D. C. (2002). Behavioral and cognitive-behavioral treatment for chronic pain: Outcome, predictors of outcome, and treatment. *Spine, 27*(22), 2564–2573.

McGeary, D., Moore, M., Vriend, C. A., Peterson, A. L., & Gatchel, R. J. (2011). The evaluation and treatment of comorbid pain and PTSD in a military setting: An overview. *The Journal of Clinical Psychology in Medical Settings, 18*, 155–163. doi:10.1007/s10880-011-9236-5.

Miller, L., O'Mara, S., & Kregel, J. (Eds.). (2012). *The WIPA: National training curriculum: Promoting employment of SSA beneficiaries with disabilities*. Richmond, VA: WIPA National Training Center at Virginia Commonwealth University. Retrieved from http://www.vcu-ntc.org/resources/cwicmanual.cfm

Morley, S., Eccleston, C., & Williams, A. (1999). Systematic review and meta-analysis of randomized controlled trials of cognitive behavior therapy and behavior therapy for chronic pain in adults, excluding headache. *Pain, 80*, 1–13.

National Center for Veterans Analysis and Statistics. (2012). *Trends in Veterans with a service-connected disability: FY1985–FY2011*. Retrieved from https://www.va.gov/vetdata/docs/QuickFacts/SCD_quickfacts_FY2011_FINAL.pdf

Nevin, R. L., & Means, G. E. (2009). Pain and discomfort in deployed helicopter aviators wearing body armor. *Aviation Space & Environmental Medicine, 80*, 807–810.

O'Connell, N., Wand, B., Marston, L., Spencer, S., & DeSouza, L. (2010). Non-invasive brain stimulation techniques for chronic pain. *Cochrane Database of Systematic Reviews,* (9), CD008208. doi:10.1002/14651858.CD008208.pub2.

Pain Management Taskforce. (2010). *Final report: Providing a standardized DoD and VHA vision and approach to pain management to optimize the care for warriors and their families*. Washington, DC: Office of the Army Surgeon General.

Plunkett, A., Turabi, A., & Wilkinson, I. (2012). Battlefield analgesia: A brief review of current trends and concepts in the treatment of pain in US military casualties from the conflicts in Iraq and Afghanistan. *Pain Management, 2*, 231–238. doi:10.2217/pmt.12.18.

Powers, R. (n.d.). *Military disability (medical) separations and retirements* [About.com guide]. Retrieved September 6, 2012, from http://usmilitary.about.com/od/theorderlyroom/a/medseparation.htm

Sanders, S. H., Harden, R. N., & Vicente, P. J. (2005). Evidence-based clinical practice guidelines for interdisciplinary rehabilitation of chronic non-malignant pain syndrome patients. *Pain Practice, 5*, 303–315. doi:10.1111/j.1533-2500.2005.00033.x.

Shirado, O., Ito, T., Kikumoto, T., Takeda, N., Minami, A., & Strax, T. E. (2005). A novel back school using a multidisciplinary team approach featuring quantitative functional evaluation and therapeutic exercises for patients with chronic low back pain. *Spine, 30*, 1219–1225.

Tan, G., Dao, T., Smith, D., Robinson, A., & Jensen, M. (2010). Incorporating complementary and alternative medicine (CAM) therapies to expand psychological services to veterans suffering from chronic pain. *Psychological Services, 7*, 148–161.

U.S. Department of Veterans Affairs. (2011, September 29). *VA disability compensation* [online content]. Retrieved from http://www.vba.va.gov/bln/21/compensation/

U.S. Department of Veterans Affairs. (2012a). *Federal benefits for veterans, dependents and survivors*. Washington, DC:Author. Retrieved from http://www.va.gov/opa/publications/benefits_book.asp

U.S. Department of Veterans Affairs. (2012b, July 31). *Vocational rehabilitation and employment service* [online content]. Retrieved from http://www.vba.va.gov/bln/vre

U.S. Department of Veterans Affairs. (2012c, August 8). *Health benefits: Medical benefits package* [online content]. Retrieved from http://www.va.gov/healthbenefits/access/medical_benefits_package.asp.

Vowles, K. E., McCracken, L. M., & Eccleston, C. (2007). Processes of change in treatment for chronic pain: The contributions of pain, acceptance, and catastrophizing. *European Journal of Pain, 11*(7), 779–787.

Zouris, J. M., Walker, G. J., Dye, J., & Galerneau, M. (2006). Wounding patterns for U.S. marines and sailors during Operation Iraqi Freedom, major combat phase. *Military Medicine, 171*, 246–252.

Part II

Conceptual and Methodological Issues

9

Search Engines and Resources Available to Obtain the Latest Incidence and Cost Data for Occupational Pain and Disability Disorders

Brian R. Theodore

Overview

Work-related injuries have a staggering impact upon the healthcare system, in addition to the pain and suffering endured by the afflicted individual. At least 31 % of the US adult population report suffering from chronic pain. In addition, the total costs incurred in terms of both healthcare and productivity losses due to chronic pain amount to approximately $635 billion annually. The present chapter serves as a guide to navigate through several online resources to contain national- and state-level data on the incidence rate of chronic pain, as well as the direct healthcare costs and indirect costs associated with occupational disability. The chapter explores in detail the US Bureau of Labor Statistics (BLS) Industry Injury and Illness reports and datasets, as well as data reports from the Agency for Healthcare Research and Quality's Medical Expenditure Panel Survey (MEPS). Finally, the chapter provides a guide for estimating and quantifying disability benefit costs accrued to injured workers from their respective Workers' Compensation jurisdiction. Upon conclusion of the chapter, readers should be familiar with at least three sources of comprehensive incidence and cost data that should be useful in conducting research studies on the economic impact of occupational pain and disability.

Introduction

The impact of chronic pain in the United States is staggering. According to a recent report by the Institute of Medicine, chronic pain impacts approximately 116 million adults in the United States, amounting to treatment costs and losses in productivity totaling $635 billion annually (Institute of Medicine, Committee on Advancing Pain Research, Care, and Education, 2011). In a recent Web-based cross-sectional survey of American adults, the results indicated a prevalence rate of 31 % for chronic pain, defined as chronic, recurrent, long-lasting pain for durations of at least 6 months (Johannes, Le, Zhou, Johnston, & Dworkin, 2010). Also noteworthy in this survey was that the top two conditions reported were low back pain and osteoarthritis pain. Both conditions also predominate within the subpopulation of patients suffering from occupational-related pain and disability due to injuries on the job (Janwantanakul, Pensri, Jiamjarasrangsri, & Sinsongsook, 2008; Yeung, Genaidy, Deddens, Alhemood, & Leung, 2002). The relationship between costs and prevalence of occupational pain and disability is also striking. It has been noted that a small minority of patients

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(approximately 7 %) account for up to 70 % of the annual costs accrued to the Workers' Compensation payor system (Hashemi, Webster, & Clancy, 1998; Hashemi, Webster, Clancy, & Courtney, 1998; Hashemi, Webster, Clancy, & Volinn, 1997). To complicate matters further, patients within occupational disability compensation systems have been noted for having persistently poor outcomes following standard treatment modalities (DeBerard, Masters, Colledge, Schleusener, & Schlegel, 2001; Franklin et al., 2005; Franklin, Haug, Heyer, McKeefrey, & Picciano, 1994; Maghout-Juratli, Franklin, Mirza, Wickizer, & Fulton-Kehoe, 2006).

Compounding the problem further is the exponential increase in the use of prescription opioids to treat chronic pain since 1990, a trend that also coincided with a spike in the rate of unintentional poisonings and overdoses due to prescription opioids since 1990 (Okie, 2010). Patients suffering from work-related injuries were also not exempt from this trend. For example, Washington State endured not only a doubling in the rate of prescribing for Schedule II opioids between 1996 and 2002 but also a 50 % increase in the morphine equivalence dose prescribed (Franklin et al., 2005). That study also reported an increase in deaths due to accidental overdose during that duration of time. The nationwide economic impact of rising rates of associated opioid abuse, dependence, and misuse has also become staggering. The total costs to society from this rising tide of prescription opioid abuse and misuse amounted to $55.7 billion in 2007, which included workplace costs due to productivity losses, healthcare costs, and costs to the criminal justice system (Birnbaum et al., 2011).

Given the magnitude of its impact on society, it is clear that the present model of care in managing chronic pain is becoming increasingly unsustainable. The culture of evidence-based guidelines and treatment approaches are now being reinforced by calls to document the cost-effectiveness of treatment modalities. Ever since the seminal publication of cost-effectiveness guidelines almost two decades ago (Gold, Siegel, Russell, & Weinstein, 1996), there have been growing calls to incorporate cost-effectiveness methodology within new clinical trials and evaluations of treatment modalities, including those programs tailored for occupational disability (Baldwin, Côté, Frank, & Johnson, 2001; Dowd et al., 2010; Kepler et al., 2012; Tompa, de Oliveira, Dolinschi, & Irvin, 2008; Turk, 2002). However, the impact of occupational pain and disability does not always fit neatly within the protocols of a defined clinical trial or research study, where as many factors as possible are controlled for, or kept equivalent, among groups being studied. The typical individual suffering from occupational pain and disability often has a history of intersecting and interacting factors that must be accounted for when trying to quantify the costs associated with their case.

Occupational injuries that result in pain and disability often result in a cascading effect beyond the injured worker. Although pain and disability impose the most immediate and primary effects upon the individual, it is important to also account for the broader societal perspective when discussing the implications of occupational pain and disability. As implied by the biopsychosocial perspective on pain, there is indeed a complex interplay among various factors such as the individual's interaction with healthcare system, medicolegal system, and the employer and interpersonal relationships that define the impact of occupational disability. The most rigorous research on occupational pain and disability should therefore carefully attempt to estimate and quantify, as best as possible, these various components. With the combination of increased transparency, as well as access to well-developed online resources (e.g., Federal and State electronic databases), the once arduous task to estimate these components is made relatively easier.

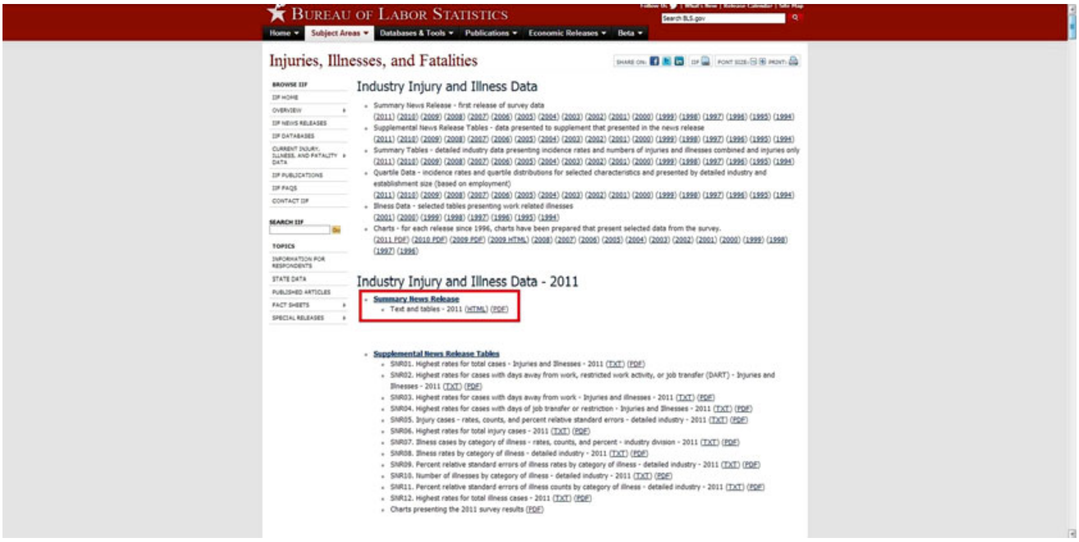
This chapter is written with the objective to familiarize readers with several sources from which to obtain data on incidence and cost associated with occupational pain and disability. Three major examples will be discussed on the topic of obtaining incidence rates of occupational disability, estimating costs of healthcare costs, and finally estimating the cost of disability benefits, such as wage-replacement schemes, and impairment benefits.

Incidence of Occupational Pain and Disability

The most reliable source for obtaining the incidence of occupational injuries, and resulting disability, is the United States Department of Labor's Bureau of Labor Statistics. This Web-based resource can be found within the section of the BLS website's section for Injuries, Illnesses, and Fatalities (http://www.bls.gov/iif/). The website provides two major categories of data for each year: (1) the incidence data for government and private sector work-related injuries and illnesses (http://www.bls.gov/iif/oshsum.htm) and (2) case and demographic characteristics of work-related injuries and illnesses involving days away from work (http://www.bls.gov/iif/oshcdnew.htm). These data are further broken down by each State.

The available data are generally dated by about a year, with data up to year 2011 available at the time of writing this chapter. For each year, there is an overall summary followed by multiple reports that include breakdowns by type of industry, category of injuries or illnesses, and the variability in the incidence of injuries and illnesses among different industries. However, the most useful report to begin with will be the summary news release and statistics for the year in question. For example, the 2011 summary news release can be accessed at http://www.bls.gov/news.release/archives/osh_10252012.pdf (also see Fig. 9.1). As reported, we see that there were a total of approximately three million cases of nonfatal work-related injuries and illnesses across the United States during year 2011, corresponding to an incidence rate of 3.5 injuries and illnesses per 100 full-time workers. Figures 9.2 and 9.3 illustrate some examples of the type of charts available in the BLS incidence reports for work-related injuries. As illustrated, the data show the breakdown of the overall incidence of injuries and illnesses to those with and without resulting days away from work.

Similarly, a rich resource of data is available for the case and demographic characteristics of work-related injuries and illnesses involving days away from work. Similar to the data on incidence rate, an ideal starting point would be the summary news release and statistics report (e.g., for year 2011, http://www.bls.gov/news.release/archives/osh2_11082012.pdf). The summary report provides detailed information on the incidence rates by gender, age group, type of occupations that have the most frequent injuries, the nature of injuries (e.g., fall, strain), the injured musculoskeletal area (e.g., back injuries account for the majority at 36 %), and the median days away from work (by occupation/industry as well as by injured musculoskeletal region). Figures 9.4 and 9.5 illustrate



Injuries, Illnesses, and Fatalities

Industry Injury and Illness Data

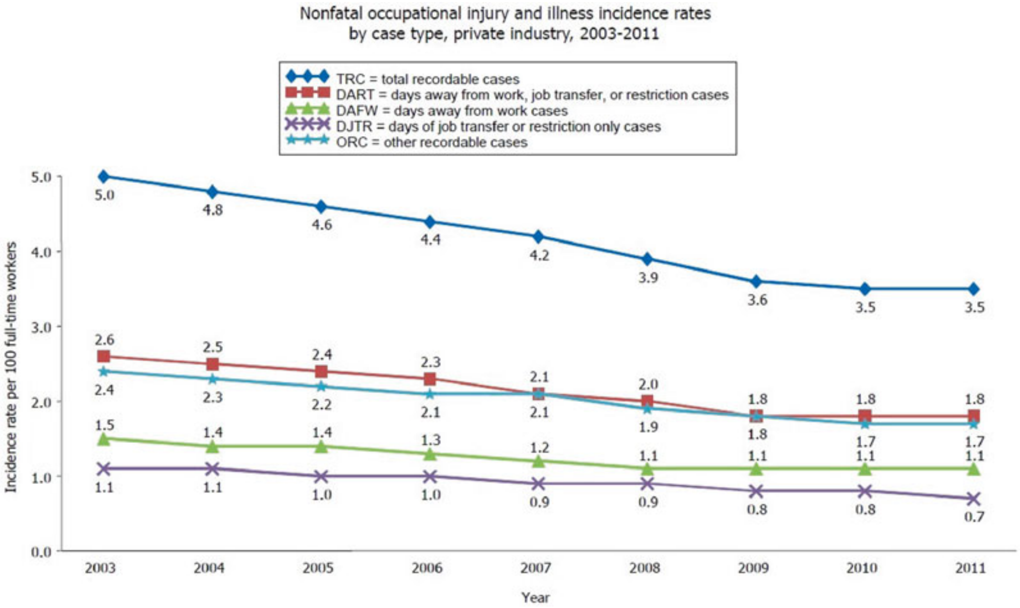
- Summary News Release - first release of survey data
  (2011) (2010) (2009) (2008) (2007) (2006) (2005) (2004) (2003) (2002) (2001) (2000) (1999) (1998) (1997) (1996) (1995) (1994)
- Supplemental News Release Tables - data presented to supplement that presented in the news release
  (2011) (2010) (2009) (2008) (2007) (2006) (2005) (2004) (2003) (2002) (2001) (2000) (1999) (1998) (1997) (1996) (1995) (1994)
- Summary Tables - detailed industry data presenting incidence rates and numbers of injuries and illnesses combined and injuries only
  (2011) (2010) (2009) (2008) (2007) (2006) (2005) (2004) (2003) (2002) (2001) (2000) (1999) (1998) (1997) (1996) (1995) (1994)
- Quartile Data - incidence rates and quartile distributions for selected characteristics and presented by detailed industry and establishment size (based on employment)
  (2011) (2010) (2009) (2008) (2007) (2006) (2005) (2004) (2003) (2002) (2001) (2000) (1999) (1998) (1997) (1996) (1995) (1994)
- Illness Data - selected tables presenting work related illnesses
  (2001) (2000) (1999) (1998) (1997) (1996) (1995) (1994)
- Charts - for each release since 1996, charts have been prepared that present selected data from the survey.
  (2011 PDF) (2010 PDF) (2009 PDF) (2009 HTML) (2008) (2007) (2006) (2005) (2004) (2003) (2002) (2001) (2000) (1999) (1998) (1997) (1996)

Industry Injury and Illness Data - 2011

- **Summary News Release**
  - Text and tables - 2011 (HTML) (PDF)

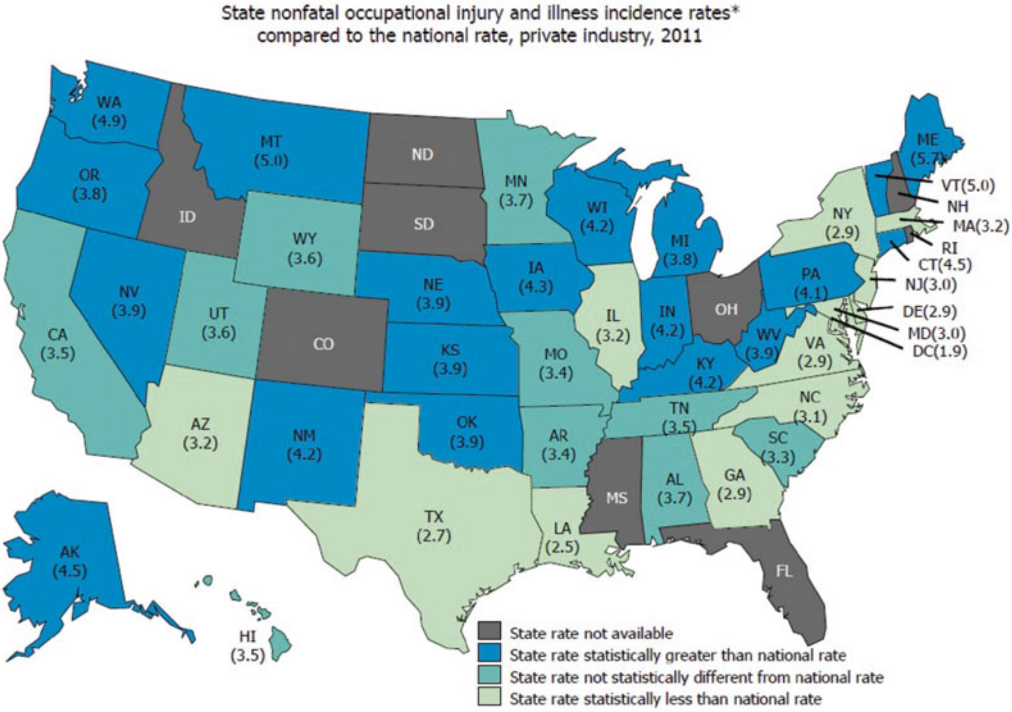
- **Supplemental News Release Tables**
  - SNR01. Highest rates for total cases - Injuries and Illnesses - 2011 (TXT) (PDF)
  - SNR02. Highest rates for cases with days away from work, restricted work activity, or job transfer (DART) - Injuries and Illnesses - 2011 (TXT) (PDF)
  - SNR03. Highest rates for cases with days away from work - Injuries and illnesses - 2011 (TXT) (PDF)
  - SNR04. Highest rates for cases with days of job transfer or restriction - Injuries and Illnesses - 2011 (TXT) (PDF)
  - SNR05. Injury cases - rates, counts, and percent relative standard errors - detailed industry - 2011 (TXT) (PDF)
  - SNR06. Highest rates for total injury cases - 2011 (TXT) (PDF)
  - SNR07. Illness cases by category of illness - rates, counts, and percent - industry division - 2011 (TXT) (PDF)
  - SNR08. Illness rates by category of illness - detailed industry - 2011 (TXT) (PDF)
  - SNR09. Percent relative standard errors of illness rates by category of illness - detailed industry - 2011 (TXT) (PDF)
  - SNR10. Number of illnesses by category of illness - detailed industry - 2011 (TXT) (PDF)
  - SNR11. Percent relative standard errors of illness counts by category of illness - detailed industry - 2011 (TXT) (PDF)
  - SNR12. Highest rates for total illness cases - 2011 (TXT) (PDF)
  - Charts presenting the 2011 survey results (PDF)

Fig. 9.1 Accessing the summary news release and statistics for the US Bureau of Labor Statistics Industry Injury and Illness Data



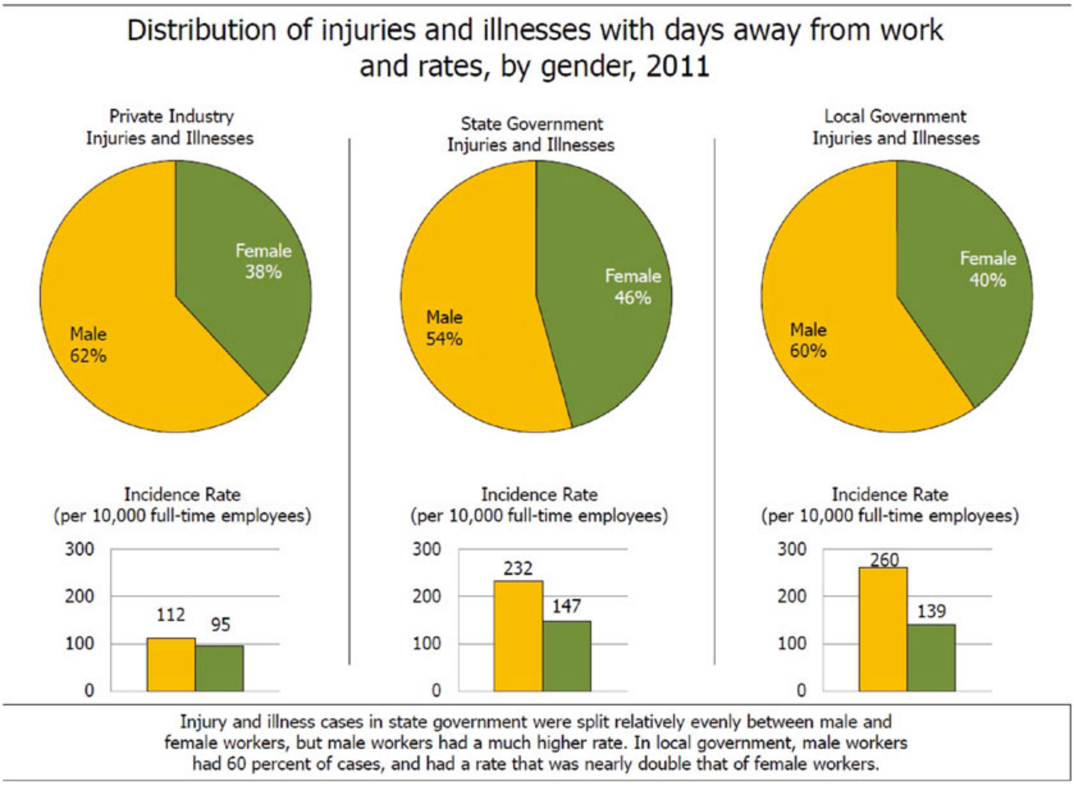
The total recordable cases (TRC) incidence rate in 2011 remained unchanged for the first time since this series was published in 2003. Incidence rates for cases with days of job transfer or restriction (DJTR) declined in 2011, while incidence rates for all other types of cases remained unchanged from 2010 at the level of detail at which estimates are presented in this chart.

Fig. 9.2 US Bureau of Labor Statistics national incidence data for workplace injuries and illnesses. *Source*: U.S. Bureau of Labor Statistics, U.S. Department of Labor, October 2012



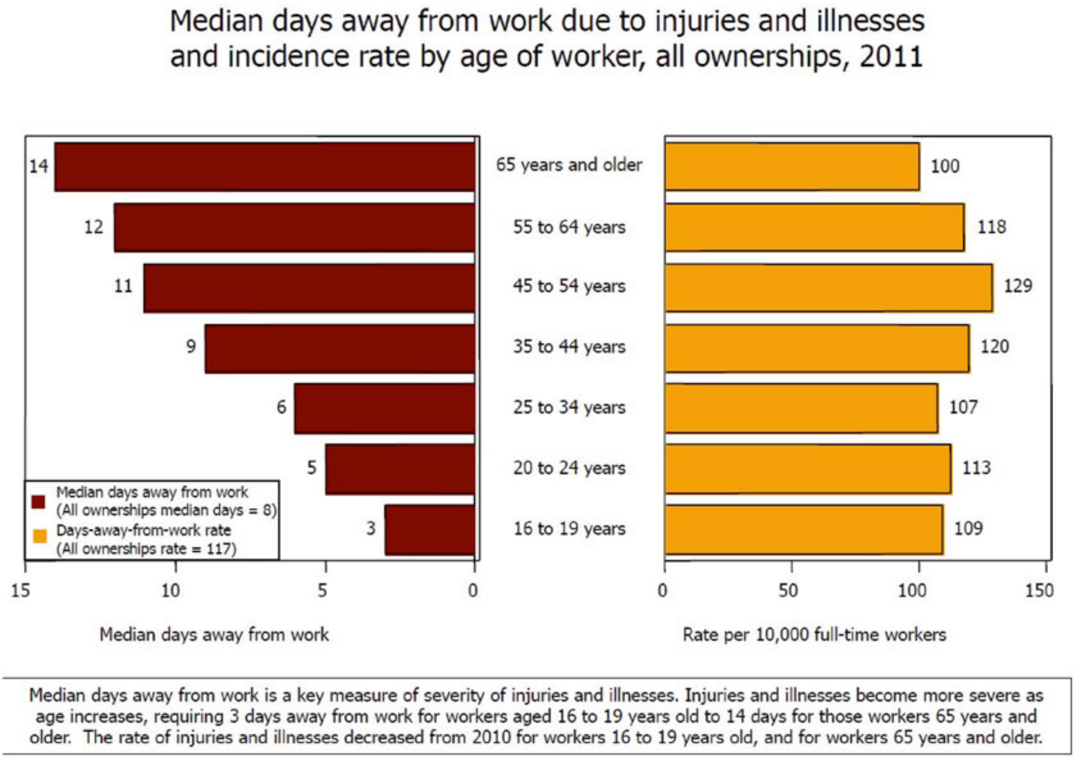
Among the 41 states and the District of Columbia for which estimates of nonfatal injuries and illnesses are available for 2011, 19 states experienced a higher incidence of injuries and illnesses than the national rate (3.5 cases per 100 full-time workers); 12 states plus the District of Columbia experienced lower rates; and 10 states had rates that were not statistically different from the national rate.

Fig. 9.3 US Bureau of Labor Statistics incidence data for workplace injuries and illnesses by US states. *Asterisk*: Total recordable case (TRC) incidence rate per 100 full-time workers. *Source*: U.S. Bureau of Labor Statistics, U.S. Department of Labor, October 2012



Injury and illness cases in state government were split relatively evenly between male and female workers, but male workers had a much higher rate. In local government, male workers had 60 percent of cases, and had a rate that was nearly double that of female workers.

Fig. 9.4 US Bureau of Labor Statistics distribution of injuries and illnesses with days away from work by sex. *Source*: Bureau of Labor Statistics, U.S. Department of Labor, November 2012



Median days away from work is a key measure of severity of injuries and illnesses. Injuries and illnesses become more severe as age increases, requiring 3 days away from work for workers aged 16 to 19 years old to 14 days for those workers 65 years and older. The rate of injuries and illnesses decreased from 2010 for workers 16 to 19 years old, and for workers 65 years and older.

Fig. 9.5 US Bureau of Labor Statistics median days away from work by age group. *Source*: Bureau of Labor Statistics, U.S. Department of Labor, November 2012 some examples of the type of charts available in the BLS case and demographic reports for work-related injuries involving days away from work.

Although for most purposes the summary reports and charts from each of the two major categories of data discussed above will be all that is required to obtain relevant statistics for research and reporting, readers can also peruse the variety of supplemental data tables available that go into very granular detail such as the type of injury for each industry sector and the related incidence rates and resulting median days away from work. Having the incidence data is the first step toward estimating the impact of chronic pain and disability due to work-related injuries. We now focus on sources for estimating the costs of work-related injuries and its resulting pain and disability.

Estimating Costs Associated with Occupational Pain and Disability

The task of accurately estimating and quantifying the costs associated with occupational pain and disability is complex and requires attention to details, such as the specific medicolegal jurisdiction under study. However, there are various sources and guidelines available to aid in undertaking this task. To begin, one must first understand the broad categories of costs usually associated with occupational pain and disability. Associated costs can be broadly categorized into *direct costs* (e.g., medical costs, indemnity/disability benefits) and *indirect costs* (e.g., productivity losses and other intangible costs). While the cost components in this chapter are emphasized due to their central importance to occupational pain and disability and availability of online resources in quantifying these costs, readers are encouraged to familiarize themselves with broader definitions of cost components as discussed in Haddix, Corso, and Gorsky (2003) and Luce, Manning, Siegel, and Lipscomb (1996).

Depending on the nature of the intervention, medical costs may include any screening and diagnostics, specific surgical or nonsurgical intervention, hospitalization costs, medication, and visits to healthcare providers (Haddix et al., 2003). Indemnity or disability compensation includes any type of compensation such as Workers' Compensation wage-replacement schemes, lump-sum payments, and Federal, State, or private short-term or long-term disability (LTD) insurance (e.g., impairment benefits, Social Security Disability Insurance (SSDI), short-term disability (STD) and LTD policies).

Productivity losses involve any costs associated with the patient's inability to engage in occupational activities, leisure activities, or activities of daily living during the period of intervention and also any period following the intervention. The most common cost associated with productivity losses is the patient's time spent receiving the intervention. For occupational disability, productivity losses mainly focus on the inability to return to work or engage in gainful employment, either through absenteeism or presenteeism (Langleya et al., 2010).

Finally, intangible costs refer to any type of costs associated with the intervention or outcomes that are often difficult to estimate or express in monetary units. Within the healthcare setting, intangible costs refer to resulting differences among the interventions being investigated on constructs such as pain, function, emotional distress, and quality of life (Haddix et al., 2003). Although these are not domains that can be expressed in monetary units, and therefore outside the scope of this chapter, it should be stressed that these are often useful outcomes to monitor (Turk & Melzack, 2011) within the context of a cost-benefit appraisal of treatment modalities or policy guidelines that impact patients suffering from occupational pain and disability.

Estimating Healthcare Costs

Estimating healthcare costs can be somewhat of a daunting challenge for several reasons. Firstly, there are a comprehensive range of medical services that must be accounted for, including inpatient services and hospitalization, outpatient services, emergency department visits, medications, ergonomic devices and supplies, and any home-based care received.

Table 9.1 Common healthcare costs to be included in cost estimation

Types of healthcare costs
1. Inpatient services and hospitalizations
2. Surgeries (a) Surgeon's fees (b) Facilities fees (c) Ancillary costs of surgery
3. Diagnostic procedures
4. Outpatient services (a) Nonsurgical interventional procedures (b) Evaluation and management (c) Counseling and behavioral services (d) Primary care provider visits (e) Physical and occupational therapy
5. Home-based care
6. Emergency department visits
7. Ergonomic devices and supplies
8. Medications

Table 9.2 Available cost data for various healthcare services in the Medical Expenditures Panel Survey (MEPS)

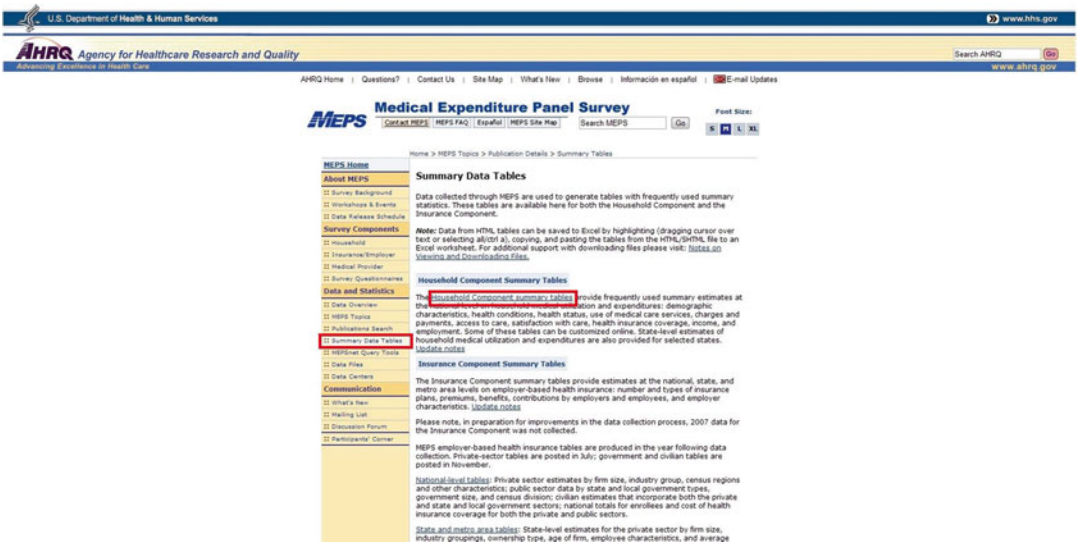
Median and mean costs per person by categories of services
1. Total health services
2. Prescription medicines
3. Dental services (further delineated by orthodontists and general dental visits)
4. Medical equipment and services (further delineated by vision aids and other supplies and equipment)
5. Hospital inpatient services (with and without overnight stays)
6. Emergency room services
7. Hospital outpatient services (further delineated by physicians and nonphysicians)
8. Office-based medical provider services (further delineated by visits to physicians, nonphysicians, chiropractors, nurse or nurse practitioners, optometrists, physicians assistants, physical or occupational therapists)
9. Home health services (further delineated by agency sponsored visits and paid independent providers)

Table 9.1 details some of the more common examples of costs that should ideally be itemized and accounted for in estimating healthcare costs. The second challenge in estimating healthcare costs is that the most detailed records of costs are often not easily available. The most accurate source for what was paid for these services is often the individual payors or the Workers' Compensation jurisdiction overseeing the reimbursement of healthcare services for the injured worker. However, these datasets may not necessarily be made available to researchers, or it may require a fee for access to these. A third challenge is due to the variability in the costs for a given service. In practice, there is often a chasm between the cost of the service and the charges incurred for the service (or price of the service). Whereas costs in theory should reflect the true resource cost of the service delivered (Finkler, 1982), charges often vary due to various reasons, such as geographic location, rural versus urban settings, the negotiated rates between the healthcare providers and the employer, insurance company, or the Workers' Compensation authority. This can often distort the true cost of the service.

However, if lacking direct access to healthcare costs data from the insurance carrier or the Workers' Compensation jurisdiction, there are several alternatives available from Federal databases. A relatively comprehensive source of data is available from the Agency for Healthcare Research and Quality (AHRQ) MEPS, at no cost and open to the public. As described in their website (http://meps.ahrq.gov/mepsweb/index.jsp), the MEPS:

> …which began in 1996, is a set of large-scale surveys of families and individuals, their medical providers (doctors, hospitals, pharmacies, etc.), and employers across the United States. MEPS collects data on the specific health services that Americans use, how frequently they use them, the cost of these services, and how they are paid for, as well as data on the cost, scope, and breadth of health insurance held by and available to U.S. workers.

Although the data are aggregate in nature, the MEPS database does provide a breakdown of median and mean costs per person, for various healthcare services as summarized in Table 9.2. To access the MEPS database for healthcare costs, access the link for the Summary Data Tables under the left-hand menu for Data and Statistics. From here, access the Household Component summary tables link (see Fig. 9.6). Then select an appropriate year and the type of summary table desired among the expenditures data (see Fig. 9.7). At the time of writing this chapter, expenditures were available through year 2010. For each of the expenditure tables presented, the total cost for all patients surveyed, as well as the



Summary Data Tables

Data collected through MEPS are used to generate tables with frequently used summary statistics. These tables are available here for both the Household Component and the Insurance Component.

Note: Data from HTML tables can be saved to Excel by highlighting (dragging cursor over text or selecting all/ctrl a), copying, and pasting the tables from the HTML/SHTML file to an Excel worksheet. For additional support with downloading files please visit: Notes on Viewing and Downloading Files.

Household Component Summary Tables

The Household Component summary tables provide frequently used summary estimates at the national level on household medical utilization and expenditures: demographic characteristics, health conditions, health status, use of medical care services, charges and payments, access to care, satisfaction with care, health insurance coverage, income, and employment. Some of these tables can be customized online. State-level estimates of household medical utilization and expenditures are also provided for selected states. Update notes

Insurance Component Summary Tables

The Insurance Component summary tables provide estimates at the national, state, and metro area levels on employer-based health insurance: number and types of insurance plans, premiums, benefits, contributions by employers and employees, and employer characteristics. Update notes

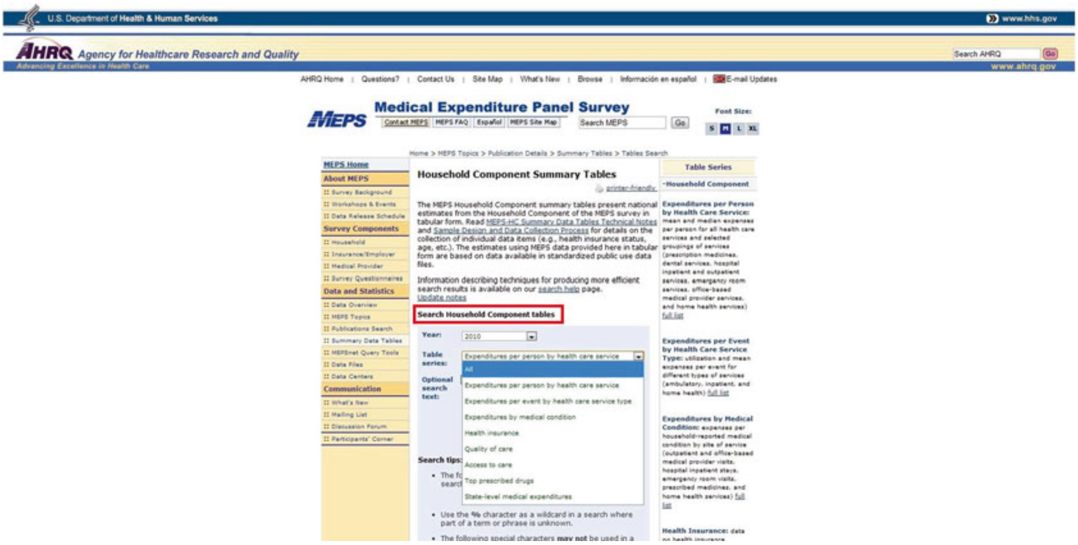
Please note, in preparation for improvements in the data collection process, 2007 data for the Insurance Component was not collected.

MEPS employer-based health insurance tables are produced in the year following data collection. Private-sector tables are posted in July; government and civilian tables are posted in November.

National-level tables: Private sector estimates by firm size, industry group, census regions and other characteristics; public sector data by state and local government types, government size, and census division; civilian estimates that incorporate both the private and state and local government sectors; national totals for enrollees and cost of health insurance coverage for both the private and public sectors.

State and metro area tables: State-level estimates for the private sector by firm size, industry groupings, ownership type, age of firm, employee characteristics, and average

Fig. 9.6 Accessing the Medical Expenditure Panel Survey summary data tables



Household Component Summary Tables

The MEPS Household Component summary tables present national estimates from the Household Component of the MEPS survey in tabular form. Read MEPS-HC Summary Data Tables Technical Notes and Sample Design and Data Collection Process for details on the collection of individual data items (e.g., health insurance status, age, etc.). The estimates using MEPS data provided here in tabular form are based on data available in standardized public use data files.

Information describing techniques for producing more efficient search results is available on our search help page.
Update notes

Search Household Component tables

Year: 2010

Table series: Expenditures per person by health care service
- All
- Expenditures per person by health care service
- Expenditures per event by health care service type
- Expenditures by medical condition
- Health insurance
- Quality of care
- Access to care
- Top prescribed drugs
- State-level medical expenditures

Optional search text:

Search tips:

- Use the % character as a wildcard in a search where part of a term or phrase is unknown.
- The following special characters **may not** be used in a

Expenditures per Person by Health Care Service: mean and median expenses per person for all health care services and selected groupings of services (prescription medicines, dental services, hospital inpatient and outpatient services, emergency room services, office-based medical provider services, and home health services) full list

Expenditures per Event by Health Care Service Type: utilization and mean expenses per event for different types of services (ambulatory, inpatient, and home health) full list

Expenditures by Medical Condition: expenses per household-reported medical condition by site of service (outpatient and office-based medical provider visits, hospital inpatient stays, emergency room visits, prescribed medicines, and home health services) full list

Health Insurance: data

Fig. 9.7 Accessing the Medical Expenditure Panel Survey cost data

median and mean costs per person, is reported and is further broken down into demographic characteristics such as by sex, age group, ethnicity, type of health insurance, socioeconomic status, region of the country, and baseline health status.

Despite the comprehensive nature of the costs available in MEPS, there are at least two notable limitations inherent in the data that readers should be aware of. Firstly, the data are aggregate in nature for each major type of medical service.

Therefore, it will not allow the quantification of costs with more granularity [e.g., to compare more expensive surgical procedures (e.g., lumbar fusion surgery) versus relatively less expensive procedures (e.g., lumbar epidural steroid injections)]. Secondly, these cost estimates are surveyed at the population level and reported nationally as well as by State. While it will be valid to use in estimating the healthcare costs related to occupational injuries in general, it will become less accurate when trying to estimate costs incurred by those injured workers who are suffering from chronic pain and disability. As mentioned in the introduction to this chapter, chronic occupational disability usually comprises a very small minority of patients who account for the vast majority of the incurred healthcare costs (Hashemi et al., 1997; Hashemi, Webster, & Clancy, 1998; Hashemi, Webster, & Clancy, et al., 1998). Therefore, use of the MEPS database will inevitably underestimate the true costs associated with chronic cases.

Despite these limitations, the MEPS datasets have been a wealth of resource for researchers investigating the cost and quality of healthcare in the United States (Jimenez, Cook, Bartels, & Alegría, 2013; Sharp & Fendrick, 2013; Shi et al., 2013; St Sauver et al., 2013). To overcome some of the limitations in granularity, there are several other Federal databases that can be accessed. Also from the AHRQ, the Healthcare Cost and Utilization Project (HCUP, http://www.hcup-us.ahrq.gov/) pools data from Federal and State governments, hospital associations, and private organizations and presents these as patient-level and encounter-level data on a broad range of healthcare variables, including cost. Similarly, the Center for Medicare and Medicaid Services also provides access to more granular, patient-level data (http://www.cms.gov/Research-Statistics-Data-and-Systems/Research-Statistics-Data-and-Systems.html). However, access to both these resources requires payment of fees and execution of data use agreements, unlike MEPS which is publicly available for free. Finally, another possibility to overcome the limitation of MEPS is to negotiate access to billing records from payors. This option would be the most desirable, especially when estimating healthcare costs of chronically disabled workers, as database queries can be limited to patients who meet certain criteria for having a certain number of days of temporary total disability (TTD) and days away from work.

Estimating Disability Benefits

As described in a previous section, disability benefits include any type of compensation such as Workers' Compensation wage-replacement schemes, lump-sum payments, and Federal, State, or private short-term or LTD insurance (e.g., impairment benefits, SSDI, STD and LTD policies). Each State has its own unique policy in terms of how disability benefits are calculated, the amount of wages replaced during periods of TTD (approximately 2/3 of pre-injury wage for most states), statutory limits on the duration that payments are effective, and deadlines to meet ratings of maximum medical improvement and subsequent payouts of impairment benefits or lifetime benefits. Similarly, Federal employees fall under unique rules related to Federal Workers' Compensation policies. Specific rules for each State, as well as Federal jurisdictions, can be obtained from their respective websites. These are conveniently compiled into a single linked resource in an online directory maintained by the School of Human Resources and Labor Relations at Michigan State University (http://hrlr.msu.edu/hr_executive_education/wcid/wc_state.php). To give an example of the methodology used in estimating the various types of disability benefits, we will focus on a single jurisdiction's rules. The Texas Workers' Compensation jurisdiction is used, as it is the most familiar to this author from previous research. All the information from the following subsections was sourced from fact sheets published online by the Texas Department of Insurance—Division of Workers' Compensation (http://www.tdi.texas.gov/wc/publications.html#factsheets).

Temporary total disability benefit. The TTD benefit is a temporary wage-loss compensation that supplements a portion of injured workers' wages that are unable to be earned due to disability.

The TTD benefit is the most common across all State and Federal jurisdictions. In the Texas Workers' Compensation (WC) system, the TTD benefit is referred to as temporary income benefits (TIBS). An injured worker becomes eligible for TIBS after missing more than 7 days from work. Benefits are not paid for the first week of lost wages unless the injured worker is unable to return to work at least 2 weeks. In general, the weekly TIBS rate is equivalent to 70 % of the average weekly wage, but not exceeding statutory ceiling limits based on the State average weekly wage for the given fiscal year that the injury occurred (i.e., a wage cap that is updated annually by the State Legislature). However, for workers earning less than $8.50 per hour, the first 26 weeks of TIBS is computed at 75 % of the average weekly wage and reverts to 70 % following this initial period, in both cases to not exceed the statutory ceiling limit for wages. The duration of TIBS is for a maximum of 104 weeks, or until the injured worker is defined to have reached maximum medical improvement (whichever comes first). In addition to the TIBS, or the TTD benefit in general, there are several other types of wage-replacement benefits that are often paid out within most State jurisdictions.

Permanent impairment benefits. This benefit amount is awarded for permanent impairment due to a work-related injury and, within the Texas Workers' Compensation jurisdiction, is known as impairment income benefits (IIBS). In general, IIBS payments begin after an injured worker receives an impairment rating, either at the time of determination for maximum medical improvement or after 104 weeks has elapsed and TIBS payments are stopped. Impairment ratings are a percentage that documents the degree of permanent damage to the body as a whole and are assigned based on guidelines published in the American Medical Association's Guides to the Evaluation of Permanent Impairment (American Medical Association, 2007). Every percentage point of impairment entitles the injured worker to 3 weeks of IIBS payments. The actual IIBS rate corresponds to 70 % of the injured worker's pre-injury weekly wage and not to exceed a statutory wage ceiling limit of 70 % of the State average weekly wage.

Supplemental income benefits (*SIBS*). In the Texas jurisdiction, SIBS payments begin after all TTD and impairment benefits have been exhausted. However, SIBS are not an automatic payment and have to be applied for quarterly, according to several criteria. Firstly, the injured worker would have to be disabled or, if having returned to work, is working less than the original capacity and consequently earning less than 80 % of his or her pre-injury weekly wage. Secondly, the impairment rating of 15 % or more must have been determined at maximum medical improvement. Thirdly, impairment benefits must have been paid out in installments and not as a one-time lump-sum. And finally, the injured worker should have demonstrated good faith in actively complying with the Texas Department of Insurance's work-search requirements to successfully return to work. Having met all these criteria, the SIBS payments are determined as a portion of the original pre-injury wage and paid out following expiration of impairment benefits and continued for up to 401 weeks (7.5 years) since the work-related injury.

Lifetime benefits. Finally, for those injured workers with serious injuries resulting in total loss (or loss of use) of limbs or sight, severe traumatic brain injury that results in mental incapacitation, spinal injuries that result in paralysis of two or more limbs, or third-degree burns in a substantial amount of the body, the Texas jurisdiction provides lifetime income benefits (LIBS). LIBS, as the name implies, are permanent wage-replacement benefits and can begin as soon as any of the conditions described has been medically determined. The amount paid out by LIBS corresponds to 70 % of the pre-injury weekly wage, subject to statutory wage caps determined by the State annually. In addition, there is a 3 % adjustment for inflation annually.

Other benefits. The benefits discussed above, although specific to the Texas Workers' Compensation jurisdiction, are similarly available in most other states and Federal jurisdictions, with some variations in the rules and eligibility criteria. In addition to the Workers'

Compensation benefits, another Federal benefit that is available to injured workers nationwide is the SSDI. SSDI eligibility, and its payout rate, is determined by such factors as the individual's age, contributions to date to Social Security, and receipt of any other TTD or disability benefits from Workers' Compensation or private disability insurance. The specific rules of the SSDI calculation are beyond the scope of this chapter, but the Social Security Administration provides online calculators that can help estimate possible SSDI benefits, given knowledge of other factors that go into its calculation. The SSDI calculator can be accessed here: http://www.ssa.gov/planners/benefitcalculators.htm. Besides the SSDI, some injured workers may also have access to private insurance benefits such as STD and LTD. These are generally specific to the individual policies purchased and the underwriting agreements determined at time of purchase. To date, no specific online resources exist to help estimate these types of benefits. However, it is important to recognize the presence of these other sources of benefits when describing the economic impact of occupational pain and disability.

Estimating Productivity Losses

Although no validated online resources or databases are available to estimate productivity losses due to occupational pain and disability, this is too important a cost component to be excluded from the discussion. However, there are several methods available to estimate these costs. In general, productivity losses can be attributed to absenteeism as well as presenteeism (Langleya et al., 2010). While absenteeism is straightforward and is defined by time away from work, presenteeism involves reduced productivity while at work due to injury or illness. In a systematic review of methods available to estimate productivity losses, Mattke and colleagues reviewed 20 self-reported assessment instruments in the published literature that aimed to measure productivity losses due to both absenteeism and presenteeism (Mattke, Balakrishnan, Bergamo, & Newberry, 2007). This review concluded that there are considerable challenges in valid documentation of presenteeism due to various factors, most notably being the nature of self-reported assessments on one's productivity, as well as lack of objective or even easily measurable criteria to define the scope of productivity decline due to presenteeism. However, recent work improving on the psychometric properties and predictive validation of self-reported presenteeism assessments are bridging the gap in not only estimating the productivity losses due to presenteeism but also monetizing those losses through statistical modeling (Mitchell & Bates, 2011).

Given the level of documentation afforded by Workers' Compensation systems in accounting for time away from work due to total or partial disability, there exist methods to more objectively quantify the costs of productivity losses among injured workers. The most direct method in accounting for productivity losses is through the Human Capital method (Rice, Hodgson, & Epstein, 1985), specifically by multiplying the pre-injury weekly wage of the injured worker by the duration of time absent from work (either total absence or modified/reduced work schedule due to disability or both). A newer approach also accounts for the intangible cost incurred by the employer when a particular worker is absent for extended durations, either through retraining of another worker, hiring of a temporary worker, or reduction in output or profits. The Lost Wages method (Berger, Murray, Xu, & Pauly, 2001; Mattke et al., 2007) is a modification of the Human Capital method in that an additional multiplier is introduced into the equation, consisting of the cost to the employer due to a worker's absence as a proportion of the worker's daily wage (Mitchell & Bates, 2011). These multipliers have been determined across various occupational types and demonstrate the economic impact to the employer that goes beyond merely the daily wage of the absent worker due to disability (Nicholson et al., 2006).

To be certain, this is not the only methodology to estimate productivity losses. In general, the Human Capital approach (and its variant described above) accounts for productivity loss mainly from the perspective of the injured worker, and it spans the entire duration of the temporary total or partial absence from work. Other methods account for the costs of productivity losses from the perspective of the employer, such that the cost terminates upon the hiring of a replacement or reorganization of the existing workforce to compensate for the loss in productivity due to the disabled worker. This method, called the Friction-Cost method, is sometimes used as an alternative estimate for the cost of productivity losses (Goeree, O'Brien, Blackhouse, Agro, & Goering, 1999). Ultimately, the choice of which method to use depends on the perspective of analysis one is undertaking (i.e., is it a patient-centered perspective or an employer-centered perspective?). To be sure, both cases apply when considering the broader societal impact of productivity losses, although health economists have argued for the superiority of the Friction-Cost method as being more accurate because it takes into account realities in the labor market (Koopmanschap, Rutten, van Ineveld, & van Roijen, 1995; van den Hout, 2010).

Conclusions

The sections above point readers toward online State and Federal resources that allow for relatively easy estimation and quantification of the impact of occupational pain and disability due to work-related injuries. Table 9.3 summarizes these resources and the Web addresses where they can be found. These resources detail the Federal datasets on the incidence and characteristics of occupational injuries and illnesses, as well as resources on how to account for the costs of disability benefits for all State and Federal Workers' Compensation jurisdictions. As with most undertakings that attempt to estimate the economic impact of a phenomenon, the reader should be aware that there are some theoretical considerations and assumptions that have to be made about these online datasets and their applicability to the population they wish to study.

Therefore, it is important to appreciate some of the limitations of these online resources, in that they may not apply to all cases of occupational disability, especially when the available data are in aggregate form and the population under study is one that has been chronically disabled. In such cases, access to patient-level, longitudinal data should be sourced from agencies such as CMS and the AHRQ HCUP databases or through access to State Workers' Compensation billing databases. In addition, to best use the State and Federal resources on Workers' Compensation jurisdictions, the reader should be aware that they will need to plan to collect key data elements that will serve as the inputs to the computation of benefits (e.g., pre-injury weekly wages, duration of disability, impairment ratings, other non-Workers' Compensation benefits received). However, with an appreciation of these inherent limitations, and appreciation of the data inputs required, it is my hope that readers will conclude this chapter with the satisfaction of having a few more tools in their toolkits to help them with some rewarding and productive research on the societal impacts of occupational pain and disability.

Table 9.3 Summary of online resources discussed for incidence and cost data relevant to occupational pain and disability

Data source	Web URL
Incidence data for occupational injuries and illnesses	http://www.bls.gov/iif/oshsum.htm
Case and demographic characteristics of occupational injuries and illnesses involving days away from work	http://www.bls.gov/iif/oshcdnew.htm
AHRQ Medical Expenditure Panel Survey (MEPS)	http://meps.ahrq.gov/mepsweb/index.jsp
AHRQ Healthcare Cost and Utilization Project (HCUP; fee-based access)	http://www.hcup-us.ahrq.gov/
Centers for Medicare and Medicaid Services (fee-based access)	http://www.cms.gov/Research-Statistics-Data-and-Systems/Research-Statistics-Data-and-Systems.html
State and Federal Workers' Compensation benefits fact sheets (courtesy of Michigan State University's School of Human Resources and Labor Relations)	http://hrlr.msu.edu/hr_executive_education/wcid/wc_state.php

References

Baldwin, M. L., Côté, P., Frank, J. W., & Johnson, W. G. (2001). Cost-effectiveness studies of medical and chiropractic care for occupational low back pain: A critical review of the literature. *The Spine Journal, 1*, 138–147.

Berger, M. L., Murray, J. F., Xu, J., & Pauly, M. (2001). Alternative valuations of work loss and productivity. *Journal of Occupational and Environmental Medicine, 43*(1), 18–24.

Birnbaum, H. G., White, A. G., Schiller, M., Waldman, T., Cleveland, J. M., & Roland, C. L. (2011). Societal costs of prescription opioid abuse, dependence, and misuse in the United States. *Pain Medicine, 12*(4), 657–667.

DeBerard, M. S., Masters, K. S., Colledge, A. L., Schleusener, R. L., & Schlegel, J. D. (2001). Outcomes of posterolateral lumbar fusion in Utah patients receiving workers' compensation: A retrospective cohort study. *Spine, 26*(7), 738–746; discussion 747.

Dowd, B., McGrail, M., Lohman, W. H., Sheasby, B., O'Connor, H., Calasanz, M., et al. (2010). The economic impact of a disability prevention program. *Journal of Occupational and Environmental Medicine, 52*(1), 15–21.

Finkler, S. A. (1982). The distinction between cost and charges. *Annals of Internal Medicine, 96*(1), 102–109.

Franklin, G., Haug, J., Heyer, N., McKeefrey, S., & Picciano, J. (1994). Outcome of lumbar fusion in Washington state worker's compensation. *Spine, 17*, 1897–1904.

Franklin, G. M., Mai, J., Wickizer, T., Turner, J. A., Fulton-Kehoe, D., & Grant, L. (2005). Opioid dosing trends and mortality in Washington State workers' compensation, 1996–2002. *American Journal of Industrial Medicine, 48*(2), 91–99.

Goeree, R., O'Brien, B. J., Blackhouse, G., Agro, K., & Goering, P. (1999). The valuation of productivity costs due to premature mortality: A comparison of the human-capital and friction-cost methods for schizophrenia. *Canadian Journal of Psychiatry, 44*, 455–463.

Gold, M. R., Siegel, J. E., Russell, L. B., & Weinstein, M. C. (Eds.). (1996). *Cost-effectiveness in health and medicine*. New York: Oxford University Press.

Haddix, A. C., Corso, P. S., & Gorsky, R. D. (2003). Costs. In A. C. Haddix, S. M. Teutsch, & P. S. Corso (Eds.), *Prevention effectiveness: A guide to decision analysis and economic evaluation* (2nd ed., pp. 53–76). New York: Oxford University Press.

Hashemi, L., Webster, B., & Clancy, E. (1998). Trends in disability duration and cost of workers' compensation low back pain claims (1988–1996). *Journal of Occupational and Environmental Medicine, 40*(12), 1110–1119.

Hashemi, L., Webster, B. S., Clancy, E. A., & Courtney, T. K. (1998). Length of disability and cost of work-related musculoskeletal disorders of the upper extremity. *Journal of Occupational and Environmental Medicine, 40*(3), 261–269.

Hashemi, L., Webster, B., Clancy, E., & Volinn, E. (1997). Length of disability and cost of workers' compensation low back pain claims. *Journal of Occupational Rehabilitation, 39*(10), 937–945.

Institute of Medicine, Committee on Advancing Pain Research, Care, and Education. (2011). *Relieving pain in America: A blueprint for transforming prevention, care, education, and research*. Washington, DC, National Academies Press.

Janwantanakul, P., Pensri, P., Jiamjarasrangsri, V., & Sinsongsook, T. (2008). Prevalence of self-reported musculoskeletal symptoms among office workers. *Occupational Medicine, 58*(6), 436–438.

Jimenez, D. E., Cook, B., Bartels, S. J., & Alegría, M. (2013). Disparities in mental health service use of racial and ethnic minority elderly adults. *Journal of American Geriatrics Society, 61*(1), 18–25.

Johannes, C. B., Le, T. K., Zhou, X., Johnston, J. A., & Dworkin, R. H. (2010). The prevalence of chronic pain in United States adults: Results of an Internet-based survey. *The Journal of Pain, 11*(11), 1230–1239.

Kepler, C. K., Wilkinson, S. M., Radcliff, K. E., Vaccaro, A. R., Anderson, D. G., Hilibrand, A. S., et al. (2012). Cost-utility analysis in spine care: A systematic review. *The Spine Journal, 12*(8), 676–690.

Koopmanschap, M. A., Rutten, F. F. H., van Ineveld, B. M., & van Roijen, L. (1995). The friction cost method for measuring indirect costs of disease. *Journal of Health Economics, 14*, 171–189.

Langleya, P., Müller-Schwefeb, G., Nicolaouc, A., Liedgensd, H., Pergolizzie, J., & Varrassif, G. (2010). The impact of pain on labor force participation, absenteeism and presenteeism in the European Union. *Journal of Medical Economics, 13*(4), 662–672.

Luce, B. R., Manning, W. G., Siegel, J. E., & Lipscomb, J. (1996). Estimating costs in cost-effectiveness analysis. In M. R. Gold, J. E. Siegel, L. B. Russell, & M. C. Weinstein (Eds.), *Cost-effectiveness in health and medicine* (pp. 176–213). New York: Oxford University Press.

Maghout-Juratli, S., Franklin, G. M., Mirza, S. K., Wickizer, T. M., & Fulton-Kehoe, D. (2006). Lumbar fusion outcomes in Washington State workers' compensation. *Spine, 31*(23), 2715–2723.

Mattke, S., Balakrishnan, A., Bergamo, G., & Newberry, S. (2007). A review of methods to measure health-related productivity loss. *The American Journal of Managed Care, 13*(4), 211–217.

Mitchell, R. J., & Bates, P. (2011). Measuring health-related productivity loss. *Population Health Management, 14*(2), 93–98.

Nicholson, S., Pauly, M. V., Polsky, D., Sharda, C., Szrek, H., & Berger, M. L. (2006). Measuring the effects of work loss on productivity with team production. *Health Economics, 15*, 111–123.

Okie, S. (2010). A flood of opioids, a rising tide of deaths. *New England Journal of Medicine, 363*, 1981–1985.

Rice, D., Hodgson, T., & Epstein, A. (1985). The economic costs of illness: A replication and update. *Health Care Financing Review, 7*, 61–80.

Sharp, A., & Fendrick, A. M. (2013). Inside out: Reversing the focus on emergency departments to enhance efficiency. *The American Journal of Managed Care, 19*(1), 33–35.

Shi, L., Lebrun-Harris, L. A., Daly, C. A., Sharma, R., Sripipatana, A., Hayashi, A. S., et al. (2013). Reducing disparities in access to primary care and patient satisfaction with care: The role of health centers. *Journal of Health Care for the Poor and Underserved, 24*(1), 56–66.

St Sauver, J. L., Warner, D. O., Yawn, B. P., Jacobson, D. J., McGree, M. E., Pankratz, J. J., et al. (2013). Why patients visit their doctors: Assessing the most prevalent conditions in a defined American population. *Mayo Clinic Proceedings, 88*(1), 56–67.

Tompa, E., de Oliveira, C., Dolinschi, R., & Irvin, E. (2008). A systematic review of disability management interventions with economic evaluations. *Journal of Occupational Rehabilitation, 18*(1), 16–26.

Turk, D. C. (2002). Clinical effectiveness and cost-effectiveness of treatments for patients with chronic pain. *The Clinical Journal of Pain, 18*(6), 355–365.

Turk, D. C., & Melzack, R. (2011). *The handbook of pain assessment* (3rd ed.). New York: Guilford.

van den Hout, W. B. (2010). The value of productivity: Human-capital versus friction-cost method. *Annals of the Rheumatic Diseases, 69*(S1), i89–i91.

Yeung, S. S., Genaidy, A., Deddens, J., Alhemood, A., & Leung, P. C. (2002). Prevalence of musculoskeletal symptoms in single and multiple body regions and effects of perceived risk of injury among manual handling workers. *Spine, 27*(19), 2166–2172.

Epidemiology of Musculoskeletal Disorders and Workplace Factors

10

J. Mark Melhorn

Overview

The title of this chapter contains three key elements: (1) epidemiology, (2) musculoskeletal disorders (MSDs), and (3) workplace factors. In order to understand how these three elements are linked, it is necessary to separately define each element.

Epidemiology

Epidemiology is the study of the distribution and determinants of diseases and injuries in human populations (American Heritage Dictionary Editors, 2011). Disease does not develop randomly, and all individuals are not equally likely to develop a specific disease at a given time. Therefore, the risk of developing a disease is different for each individual, and it is a function of his or her personal characteristics (inheritance) and his/her surroundings (environment). In the occupational setting, epidemiology is often used to determine association or causation (and, hence, financial responsibility). Epidemiology can also help direct prevention programs by reduction of risk (Melhorn, 1996, 1999a; Melhorn, Wilkinson, Gardner, Horst, & Silkey, 1999; Melhorn, Wilkinson, & O'Malley, 2001; Melhorn, Wilkinson, & Riggs, 2001). The epidemiological literature on occupational disorders is often confusing because of conflicting evidence on the importance of various potential risk factors. This chapter describes basic epidemiologic methods so the reader can learn to evaluate and critically analyze the published literature on occupational disorders. Epidemiology requires a methodology for testing scientific hypotheses in groups of individuals (Melhorn & Hegmann, 2011). By understanding the fundamental strengths and limitations of the study design, combined with the implementation of published studies, it is possible to evaluate the strength of the evidence derived from these studies and even to make sense of conflicting results from different studies on the same issue. In this chapter, we will present an overview of the basic terminology used in epidemiology and their characteristics. Additional information regarding strengths and limitations of analytic (hypothesis testing) study designs, with an emphasis on observational study designs, can be found in this chapter(Melhorn, 2012a; Melhorn, Brooks, & Seaman, 2013).

Musculoskeletal Disorders

MSDs are not a specific medical diagnoses but are labels or descriptive terms for aches and

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pains that can affect the body's muscles, joints, tendons, ligaments, and nerves. Unlike a specific medical diagnosis that requires precise criteria for a diagnosis (such as an appropriate subjective history, unique physical examination findings, and exact supporting studies), MSDs are basically "I hurt and I hurt at work or with physical activities" (Melhorn, 1994, 2012b). Musculoskeletal pain with physical activity is a normal physiological process. Energy is required to perform work. Work requires muscles to move. By-products, such as lactic acid, are created as potential energy and are turned into kinetic energy to move the muscle and complete the physical activity. Increasing functional capacity (the ability to do more work) is the key to physical conditioning that all athletes understand. This understanding gives rise to the common adage of coaches' "no pain, no gain." However, there are occasions when the work activities can contribute to the MSD or pain, and therefore, the musculoskeletal pain or disorder is considered juristically as work-compensable (Melhorn, 1997). This does not mean that the job caused the MSD, but it implies that the job activities may have contributed to the disorder. This determination requires an understanding of the legal threshold that is established by each jurisdiction as to what is considered work-compensable (Hegmann, Thiese, Oostema, & Melhorn, 2011; Melhorn, Ackerman, Talmage, & Hyman, 2011).

Workplace Factors

The World Health Organization (WHO) has characterized "work-related" diseases as multifactorial and considers the following list to illustrate a number of risk factors (e.g., physical, work organizational, psychosocial, individual, and sociocultural) that can contribute to causing these diseases. WHO also acknowledges that much of the controversy surrounding work-related MSDs is a result of their multifactorial nature. Commonly described workplace factors are included in Table 10.1 and commonly described individual risk factors are included in Table 10.2 (Melhorn, 1999b, 2000a; Melhorn, Wilkinson, & O'Malley, 2001; Melhorn, Wilkinson, & Riggs, 2001).

Table 10.1 Common list of possible workplace risk factors

Repetition
Force
Awkward posture
Vibration
Temperature
Contact stress
Unaccustomed activities
Lifting/forceful movement
Heavy physical work
Whole body vibration
Static work posture
Handling heavy loads over long periods
Frequently repeated manipulation of objects
Static muscular load
Muscular inactivity
Monotonous repetitive manipulations
Physical environment
Psychosocial
Combined or combinations of above

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Table 10.2 Common list of possible individual risk factors

Individual
Gender
Genetics
Biopsychosocial
Nonwork activities

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Although there have been concerns expressed regarding the inclusion criteria and methodology, an additional reference source is *Musculoskeletal Disorders and Workplace Factors—A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back* by the US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, and National Institute for Occupational Safety and Health (NIOSH), July 1997 (public domain) at www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf.

Linking the Key Elements

Why is this explanation important? The answer is that because most of the "science" we have regarding MSDs comes from epidemiological studies which often use the inclusion criteria of a "survey" to establish a "diagnosis" of MSD, which is then used in determining an association (risk) between a specific activity and the onset of the MSD in question. Therefore, occupational exposures and their association with, or causation of, injuries and illnesses are often debated. Because a determination for association or causation is required to determine eligibility for compensation and, therefore, financial responsibility for workers' compensation or tort cases, debates and disputed legal cases often ensue (Melhorn & Ackerman, 2008). The significance of such disputes is underscored by the reported 1997 data listing direct health-care costs for the nation's work forces of more than $418 billion and indirect costs of more than $837 billion (Brady et al., 1997).

An example of how the science may differ from public opinion would be helpful. Carpal tunnel syndrome was linked to keyboard activities. Because this proposed linkage is appealing and pervasive and seems to make sense, the lay press has advanced this association despite quality scientific investigations that found little or no relationship between carpal tunnel syndrome and occupation or hand use (Andersen et al., 2003; Brenner, Bal, & Brenner, 2007; Clarke Stevens, Witt, Smith, & Weaver, 2001; Egilman, Punnett, Hjelm, & Welch, 1996; Fisher & Gorsche, 2004; Garland et al., 1996; Hadler, 1999; Lo, Raskin, Lester, & Lester, 2002; Lozano Calderon, Anthony, & Ring, 2008; Melhorn, Martin, Brooks, & Seaman, 2008, 2011, Nathan, Keinston, & Meadows, 1993, Nathan & Keniston, 1993; Nathan, Keniston, Myers, & Meadows, 1992; Nathan, Meadows, & Istvan, 2002; Nordstrom, Vierkant, DeStefano, & Layde, 1997; Ring, 2007). Using Bradford Hill causation criteria, if an activity is the cause, removal or modification of the activity (the keyboard) should result in a reduction of the incidence. Two studies found that keyboard modification did not change the incidence of carpal tunnel syndrome (Lincoln et al., 2000; Rempel, Tittiranonda, Burastero, Hudes, & So, 1999). So how do we know what we know? This chapter will discuss what we know and how we know the *Epidemiology of Musculoskeletal Disorders and Workplace Factors*. The terms musculoskeletal disorders (MSDs), musculoskeletal condition, and musculoskeletal pain will be used interchangeably.

Introduction

The huge costs of work-related musculoskeletal pain and its associated disability are not new or unique to the population of the United States, but are a worldwide problem. Many historical manifestations of workplace pain have been related to innovation and changing technology. Some examples include miners' nystagmus (change from candle to battery-powered head lamps), train dispatchers' nystagmus (due to watching fast moving trains pass by the station), telegraphists' cramp (1900s due to tapping on key), and watchmakers' cramp (spasm of the finger) (Culpin, 1933). A list of other historical conditions is provided in Table 10.3 (Zeppieri & Melhorn, 2000).

Musculoskeletal pain is often separated into two categories: occupational and nonoccupational. This distinction is often considered when reviewing the outcome of treatment but is commonly overlooked during treatment. This legal

Table 10.3 History of workplace diseases

BC	Greece	Pain in workplace
1473	Ellenbon	Pain with work of goldsmith
1567	Paracelsus	Pain with work of miners
1700	Ramazzini	Pain with work of potters
1830	UK	Writer's cramp (50 % bilateral)
1880	UK	Occupational neurosis—steel nib
1882	UK	Telegraphists' cramp
1960	Japan	Cervicobrachial disease
1960	Sweden	Tension headache
1960	Finland	Occupational headache
1962	Switzerland	Tension headache
1979	Scandinavia	Occupational cervicobrachial
1980	Australia	RSI (repetitive strain injury)

distinction is not required by the physician for treatment of the condition, but it has great importance for the patient. Injuries or illnesses can cause musculoskeletal pain in the workplace. An occupational injury by definition is one that results from a work-related event or from a single instantaneous exposure in the work environment. Injuries are reportable by the employer on the Occupational Safety and Health Administration (OSHA) 300 log if they result in lost work time, require medical treatment (other than first aid), or the worker experiences loss of consciousness, restriction of work activities or motion, or is transferred to another job (United States Bureau of Labor Statistics, 1997). An occupational illness is any abnormal condition or disorder (other than one resulting from an occupational injury) caused by exposure to a factor(s) associated with employment. Included in this category are acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact (United States Bureau of Labor Statistics, 1997). Musculoskeletal injuries are often defined as traditional traumatic injuries such as fractures, sprains, strains, dislocations, or lacerations, while musculoskeletal illnesses are commonly called cumulative trauma disorders (CTD), repetitive motion injuries (RMI), or musculoskeletal disorder (MSD).

Occupational medicine presents a number of challenges to the physician. Management of work-related musculoskeletal pain is often frustrating. Patients may have more complaints and longer recovery times, require longer and more frequent office visits, and may be accompanied by the employer or nurse case manager during the office visit (Black & Frost, 2011; Daniell, Fulton-Kehoe, Chiou, & Franklin, 2005). They frequently have more questions about work status, require more phone calls, and have more paper work requirements. Many have attorneys, and they commonly require a permanent physical impairment rating with subsequent depositions or mandatory court appearances. NCCI (National Council on Compensation Insurance, Inc.) data suggest that the average treatment duration is four times greater in workers' compensation (WC) cases than in non-WC cases—206.6 versus 51.9 days, respectively (https://www.ncci.com/NCCIMain/Pages/Default.aspx). Treatment outcomes often shift from good to poor (Kasdan, Vender, Lewis, Stallings, & Melhorn, 1996). The negative shift in outcome indicates that WC involvement introduces additional factors that influence patients and complicate treatment efforts (Berecki-Gisolf, Clay, Collie, & McClure, 2012). Traditional Western medical education is heavily weighted in the scientific study of the biologic systems of health and disease, often to the exclusion of biopsychosocial factors (Zeppieri, 1999). Physicians who provide care to those with work-related injuries are often inadequately prepared to deal with the biosocial (also labeled as psychosocial or biopsychosocial) issues—including motivation, social factors, psychological overlays, economic incentives, and legal complications—that influence the outcomes of treatment (Marchand & Durand, 2011; Melhorn, 1998a). Those physicians who are adequately prepared are often faced with the difficult task of separating fact from fiction. Occasionally, the patient's symptoms can be disproportional to the clinic examination. Because an occupationally related OSHA event requires only a complaint of pain, multiple subjective issues must be reviewed. This can make the clinical picture confusing and require more tests and studies to be used to arrive at the appropriate medical diagnosis, relative to a similar nonoccupational patient. Other factors impacting treatment costs might include somatization behavior among patients and medicalization among physicians (Barsky & Borus, 1995; Gross & Battie, 2005), cost shifting from commercial insurance to WC insurance (Butler, 1996), and removing disincentives for early return to work (National Practitioner Data Bank, 1994).

According to a 2011 survey conducted for the Center for Disease Control (http://www.cdc.gov/Workplace/), 51.5 % of adults reported a chronic musculoskeletal condition in 2009, twice the rate of chronic heart or respiratory conditions. Musculoskeletal conditions are so ubiquitous that they have become the third most common reason that Americans seek medical attention. A US Department of Health study showed that, from 1996 to 2004, managing musculoskeletal conditions, including lost wages, costs an average $850 billion annually (compared to the 1997 data above), making it the largest WC expense (http://www.hhs.gov/news/). For employers paying WC claims, the economic strain has reached a breaking point. How significant is the category of musculoskeletal conditions? Consider the following data:

- 80 % of all claims under WC are musculoskeletal sprain/strain injuries, with lower back injury consuming more than 33 % of every WC dollar.
- Back pain causes more than 314 million bed days and 187 million lost work days yearly (data from the US Department of Labor, 1998–2005).
- Employers lose 5.9 h of productivity per week from those suffering from musculoskeletal pain who continue to be on the job (referred to as “presenteeism”).

It should be noted that the exact prevalence rates/figures for occupational injuries and illnesses are not available. The best data for the United States are provided by the *Annual Survey of Occupational Injuries and Illnesses* by the Bureau of Labor Statistics (BLS), US Department of Labor. The annual BLS data are obtained by having employers complete their data entry at http://www.bls.gov/respondents/iif/. The website states “Welcome to the Survey of Occupational Injuries and Illnesses respondent’s website. This website is your source for information that will help you to complete and submit your response to the Survey of Occupational Injuries and Illnesses. You have been selected to participate in this survey to help us to obtain a complete and accurate representation of work-related injuries and illnesses in America’s work places.”

In order to understand the data, it is important to know the definitions for injuries and illnesses. According to OSHA, an occupational *injury* is any injury such as a cut, fracture, sprain, or amputation that results from a work accident or from a single instantaneous exposure in the work environment. *Minor injuries* are defined as injuries requiring only first aid treatment (e.g., not involving medical treatment, loss of consciousness, restricted work, or transfer to another job) and are not recorded in the logs. An occupational *illness* is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. Occupational illnesses include acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact. All occupational illnesses are recordable. However, there are known limitations of the BLS data (Melhorn & Ackerman, 2008). The survey estimates of occupational injuries and illnesses are based on a selected probability sample, rather than a census of the entire population. Because the data are based on a sample survey, the injury and illness counts are helpful estimates but are not accrued values. Underreporting, along with selection bias, can occur. Additionally, the survey measures only the number of *new* work-related injury and illness cases that are recognized, diagnosed, and reported during the year.

In September 2010, the BLS completed a major revision to the *Occupational Injury and Illness Classification System* (OIICS). The OIICS is used in the *Census of Fatal Occupational Injuries* (CFOI) and the *Survey of Occupational Injuries and Illnesses* (SOII) to code various circumstances of the individual injury or illness reported. OIICS provides a structure to classify the *nature* of the injury and *part of the body affected*, *source* and *secondary source* of the injury, and *event or exposure* that precipitated the injury. Data for 2010 reported 3,063,400 cases involving days away from work. Sprains, strains, and tears were 370,130, back injuries were 185,270, and falls were 208,470. The total recordable cases of nonfatal occupational injury and illness incidence rates among private industry employers declined in 2010 to 3.5 cases per 100 workers, from 3.6 in 2009 (http://www.bls.gov/news.release/osh.toc.htm).

Interesting facts include:

- Manufacturing was the sole private industry sector to experience an increase in the incidence rate of injuries and illnesses in 2010—rising to 4.4 cases per 100 full-time workers, from 4.3 cases the year earlier. The increased

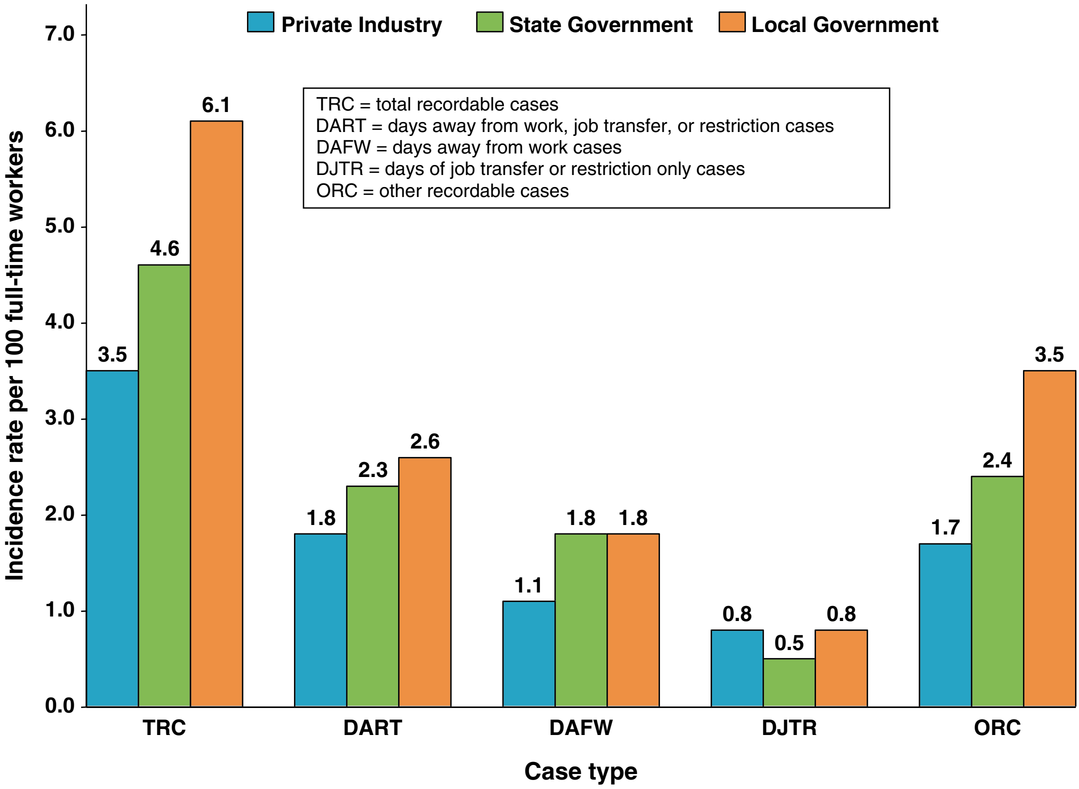


Fig. 10.1 Nonfatal occupational injury and illness incidence rates by case type and ownership, 2010

rate resulted from a larger decline in hours worked than the decline in the number of reported cases in the industry sector.

- Health care and social assistance experienced an incidence rate of injuries and illnesses of 5.2 cases per 100 full-time workers—down from 5.4 cases in 2009—and was the lone industry sector in which both reported employment and hours worked increased in 2010.
- National public sector estimates, covering more than 18.4 million state and local government workers, are available for the third consecutive year, with an incidence rate of 5.7 cases per 100 full-time workers in 2010; this was relatively unchanged from 2009 (Fig. 10.1).
- Approximately 2.9 million (94.9 %) of the 3.1 million nonfatal occupational injuries and illnesses in 2010 were injuries. Of these, 2.2 million (75.8 %) occurred in service-providing industries, which employed 82.4 % of the private industry workforce covered by this survey. The remaining 0.7 million injuries (24.2 %) occurred in goods-producing industries, which accounted for 17.6 % of private industry employment in 2010, while workplace illnesses accounted for 5.1 % of the 3.1 million injury and illness cases in 2010. The rate of workplace illnesses in 2010 (18.1 per 10,000 full-time workers) was not statistically different from the 2009 incidence rate (18.3 cases).
- Goods-producing industries, as a whole, accounted for 36.3 % of all occupational illness cases in 2010, resulting in an incident rate of 31.8 per 10,000 full-time workers—up from 29.1 cases in 2009. The manufacturing industry sector accounted for over 30 % of all

private industry occupational illness cases, resulting in the highest illness incidence rate among all industry sectors of 41.9 cases per 10,000 full-time workers in 2010—an increase from 39.0 cases in 2009. Service-providing industries accounted for the remaining 63.7 % of private industry illness cases and experienced a rate of 14.6 cases per 10,000 full-time workers in 2010—statistically unchanged from the prior year. Among service-providing industry sectors, health care and social assistance contributed 24.2 % of all private industry illness cases and experienced an incidence rate of 30.2 cases per 10,000 full-time workers in 2010—down from 34.8 cases in 2009.

- Review of injury case type and the employer type is suggesting and interesting pattern to nonfatal injury and illness. Efforts by private industry to reduce "risk factors" in the workplace appears to be having some impact, while state and local government efforts have been less successful.
- Another source for data is the NCCI at www.ncci.com/. Their Workers Compensation Temporary Total Disability Indemnity Benefit Duration 2012 Update (https://www.ncci.com/nccimain/IndustryInformation/ResearchOutlook/Pages/WC-Temp-Benefit-2012-Upate.aspx) found that the average duration of temporary total disability (TTD) indemnity benefits began to increase at the onset of the recent recession and that the rate of increase had moderated for injuries occurring during the first 6 months of 2010. Using an additional 12 months of reported data, they find that this more moderate rate of increase continues for injuries occurring through the first 6 months of 2011.
- NCCI estimated that the ultimate mean duration of TTD indemnity benefits rose from 130 days for Accident Year 2005 to 147 days for Accident Year 2009 and rose again to 149 days for claims in the first half of Accident Year 2011. The national unemployment rate deteriorated from 4.6 % in December 2007 to 8.9 % in December 2011.

Therefore, the statistics surrounding musculoskeletal conditions clearly define them as the primary threat to employers' WC programs. The magnitude of this problem is related to the three principle issues related to the delivery of efficient and effective care: (1) The condition often lacks a reliable or precise diagnosis. (2) This can lead to the use of ineffective treatment methods. (3) And there has been limited application or emphasis on self-care and preventive strategies (http://www.ctdmap.com/downloadsinfo/1887.aspx). Thus, the occupational physician must recognize, understand, and address these multiple factors to achieve the more favorable outcomes to treatment that are seen in non-WC injuries and illnesses (Melhorn & Talmage, 2011).

Definitions

In order to provide a consistent approach to definitions and terms, this section has been provided with permission from the American Medical Association's Press *Guides to the Evaluation of Disease and Injury Causation* (editors J. Mark Melhorn and William E. Ackerman, Chapter 1 Introduction) (Melhorn & Ackerman, 2008).

Evidence-Based Literature

Evidence-based medicine has become the standard for determining appropriate medical care. The most common definition was provided by Dr. David Sackett: "Evidence-based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients … [which] means integrating individual clinical expertise with the best available external clinical evidence from systematic research" (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). Unfortunately, randomized controlled clinical studies are difficult to perform in the workplace and, hence, are uncommon. Therefore, most of the information available is from epidemiologic studies that can disprove, but not prove, an association (Hadler, 1999).

Epidemiology

As noted earlier, epidemiology focuses on the distribution and determinants of disease in groups of individuals who happen to have some characteristics, exposures, or diseases in common. Viewed as the study of the distribution and societal determinants of the health status of populations, epidemiology is the basic science foundation of public health (Melhorn, 1999c). The goal of epidemiologic studies is to identify factors associated (positively or negatively) with the development or recurrence of adverse medical conditions. A search strategy of bibliographic databases was used to identify epidemiologic literature that addresses causation of specific medical conditions, as outlined in *Guides to the Evaluation of Disease and Injury Causation* (editors Melhorn and Ackerman, Chapter 4 Methodology) (Melhorn & Hegmann, 2008). Although the referenced Chapter 4 is copyrighted, Drs. Melhorn and Hegmann have decided to offer the materials therein as "in the public domain and may be freely copied or reprinted" if appropriate acknowledgment of the reference source is used.

Specific Definitions

- Medical conditions are defined as an injury or illness that meets the standard criteria for an ICD-10 diagnosis (Melhorn & Ackerman, 2008).
- Disability refers to an alteration of an individual's capacity to meet personal, social, or occupational demands or statutory or regulatory requirements because of impairment. Disability is a relational outcome, contingent on the environmental conditions in which activities are performed (AMA, 2001).
- Impairment refers to a loss, loss of use, or derangement of any body part, organ system, or organ function (AMA, 2001).
- Occupational exposures and physical factors at work are defined as identifiable occupational exposures to possible exacerbating or aggravating agents. For the musculoskeletal system, physical factors are often described in terms of repetition, force, posture, vibration, temperature, contact stress, and unaccustomed activities (CtdMAP, 2006; Melhorn, 1998b). For hearing, sound levels are measured in decibels. Radiation exposure is measured in millirads, and chemical exposure in milligram per cubic meter or parts per million.
- Nonoccupational exposures are defined as individual risk characteristics such as age, gender, hand preference, comorbid medical conditions such as diabetes, body mass index (BMI), depression, and hobbies.
- Under paragraph 1904.5(b)(1), the Occupational Safety and Health Act (OSHA) defines the work environment as the establishment and other locations where one or more employees are working or are present as a condition of their employment. The work environment includes not only physical locations but also the equipment or materials used by the employee during the course of his or her work (U.S. Department of Labor, 2006a).
- Aggravation refers to a preexisting injury or illness that has been significantly aggravated, for purposes of OSHA injury and illness record keeping, when an event or exposure in the work environment results in any of the following:
  - Death, provided that the preexisting injury or illness would likely not have resulted in death but for the occupational event or exposure
  - Loss of consciousness, provided that the preexisting injury or illness would likely not have resulted in loss of consciousness but for the occupational event or exposure
  - One or more days away from work or days of restricted work or days of job transfer that otherwise would not have occurred but for the occupational event or exposure
  - Medical treatment in a case where no medical treatment was needed for the injury or illness before the workplace event or exposure or a change in medical treatment was necessitated by the workplace event or exposure (U.S. Department of Labor, 2006a)

The above are similar to aggravation as defined by the AMA *Guides to the Evaluation of Permanent Impairment*, fifth Edition: a factor(s) (e.g., physical, chemical, biological, or medical condition) that adversely alters the course or progression of the medical impairment or worsening of a preexisting medical condition or impairment (AMA, 2001).

- Exacerbation is defined as a transient worsening of a prior condition by an injury or illness, with the expectation that the situation will eventually return to baseline or pre-worsening level (Talmage & Melhorn, 2005). Some take issue with this definition because the signs or symptoms of a preexisting injury or illness may be temporarily worsened by something (i.e., activity, exposure, weather, reinjury), but the "something" is not an injury or illness. For example, a set of tennis will temporarily worsen the symptoms of degenerative arthritis in the serving shoulder, but tennis is neither an injury nor illness. This concept is clarified by the following.

Exacerbation is defined in the AMA *Guides to the Evaluation of Permanent Impairment*, sixth Edition, as *temporary* worsening of a preexisting condition. Following a transient increase in symptoms, signs, disability, and/or impairment, the person recovers to his or her baseline status or what it would have been had the exacerbation never occurred. Given a condition whose natural history is one of progressive worsening, following a prolonged but still temporary worsening, return to pre-exacerbation status would not be expected, despite the absence of permanent residuals from the new cause (Oakley, 2011, p. 611).

- Recurrence is defined as the reappearance of signs or symptoms of a prior injury or illness with minimal or no provocation and not necessarily related to work activities (Talmage & Melhorn, 2005).
- Apportionment is defined as a distribution or allocation of causation among multiple factors that caused or significantly contributed to the injury or disease and resulting impairment. The factor could be a preexisting injury, illness, or impairment (AMA, 2001).

For purposes of this present chapter, the words diagnosis, disorder, condition, injury, or illness are essentially considered the same.

Why Epidemiology?

Epidemiology, the science, is used to determine association or causation between MSDs and risk factors (individual and workplace). Understanding association or causation allows for intervention and treatment (medical) and the determination of compensability (legal and financial responsibility). Medical and legal "causation" are not the same. This concept of medical and legal causation has been discussed in detail in the following publications: Chapter 1 Introduction, Chapter 2 Understanding Work-Relatedness, and Chapter 3 Causal Associations and Determination of Work-Relatedness in *Guides to the Evaluation of Disease and Injury Causation, Second Edition*, editors Melhorn, Ackerman, Talmage, and Hyman, AMA Press (2011) granted. Medical intervention and treatment can include prevention. Prevention comes in three forms (jmm, 1999). *Primary prevention* keeps disorders from occurring. It is focused on the universal application of safety and health and, when successful, reduces the risk and obviates the need for secondary or tertiary prevention. Once a disorder has emerged (become detectable), primary prevention is not possible; *secondary prevention* must be designed to keep the disorder from increasing in severity. The goal of secondary prevention is to arrest the growth of the disorder and, if possible, reverse or correct it. This process is the traditional health-care model. *Tertiary prevention* is designed for disorders that have reached advanced stages of development and threaten to produce significant side effects or complications. The goal of tertiary prevention is to keep the disorder from overwhelming the individual, leading to long-term disability. Unfortunately, prevention of musculoskeletal conditions has also been limited by legislated mandates such as ADA and Equal Employment Opportunity Commission (EEOC). ADA is the Americans with Disabilities Act of 1990, including changes made by the ADA Amendments Act of 2008 (Pub L 110-325), which became effective on January 1, 2009. The ADA was originally enacted in public law format and later rearranged and published in the US Code. The EEOC is the agency that watches for discriminatory practices that are prohibited under Title VII, the ADA, GINA, and the ADEA, for any aspect of employment, including testing, training and apprenticeship programs, and other terms and conditions of employment. GINA is the *Genetic Information Nondiscrimination Act* of 2008 (Pub L 110-233, 122 Stat. 881, enacted May 21, 2008). ADEA is the Age Discrimination in Employment Act of 1967. Although the goals of such legislation are socially appropriate, the application of the law has been detrimental to the prevention of musculoskeletal workplace injuries and illnesses. Additionally, the above legislation can be in conflict with the Occupational Safety and Health Act of 1970 (OSH Act) which requires the employer to provide a safe workplace. OSH Act is Pub L 91-596, 84 STAT. 1590, 91st Congress, S.2193, December 29, 1970, as amended through January 1, 2004, "To assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the Act; by assisting and encouraging the States in their efforts to assure safe and healthful working conditions; by providing for research, information, education, and training in the field of occupational safety and health; and for other purposes." For example, if medical screening or testing has determined an increased risk for a musculoskeletal condition in an individual, an attempt by the employer to reduce the workplace risk could be interpreted as "a discriminatory action and therefore punishable" even though the effort on the employer's part is to reduce risk of the musculoskeletal condition for the individual in compliance with the OSH Act. This obvious confusion has led many employers to elect not to precede with appropriate prevention programs to the detriment of the worker (Melhorn et al., 1999, Melhorn, Kennedy, & Wilkinson, 2002; Melhorn, Wilkinson, & Riggs, 2001; Melhorn, Wilkinson, & O'Malley, 2001; jmm, 1999).

What We Know and How We Know It

Epistemology (E·pis·te·mol·o·gy) [ih-pis-tuh-mol-uh-jee] is a branch of philosophy that investigates the origin, nature, methods, and limits of human knowledge. In other words "What We Know and How We Know It" or "What There Is to Know About Knowing" (Melhorn, 2008). Therefore, as is often the case, a decision on association or causation may be difficult because the determination is based on imperfect or inadequate information (the science). To understand epidemiology it is important to acknowledge these intrinsic limitations. Limiting causal conclusions to proven and established facts does not guarantee that future studies will not prove the current data wrong. Conversely, shunning everything unproven will result in rejection of many statements that are true but just not proven. The best illustration of this concept is in Table 10.4.

The Science

Health-care providers are often asked whether a condition is work-related or not (i.e., if it is causally related to a specific occupational injury or exposure). It is incumbent upon the clinician to give an opinion based on a careful review and analysis of the individual's clinical findings and his or her workplace exposures and the literature linking (or not) the injury or exposure of concern and the condition in question (Melhorn & Ackerman, 2008). In contrast to a witnessed occupational injury causing immediate symptoms and corroborated by objective physical and diagnostic test findings, a cause-and-effect relationship between a disease (nontraumatic injuries are classified by OSHA as illnesses) and an agent or condition in the workplace may be unclear. Occupational diseases may develop slowly, with months or years between exposure and onset of symptoms and/or signs. Disease manifestations may be confused with changes due to normal aging. Information on past work exposure is often unavailable, inadequate, or incomplete. In addition, not all individuals react or respond in the same way to similar exposures to disease-producing agents. In some cases, there is a clearly identifiable single cause for the condition, whether work-related or nonoccupational. More often, causation is multifactorial, with one or more nonoccupational causes (e.g., age-related

Table 10.4 Medical knowledge

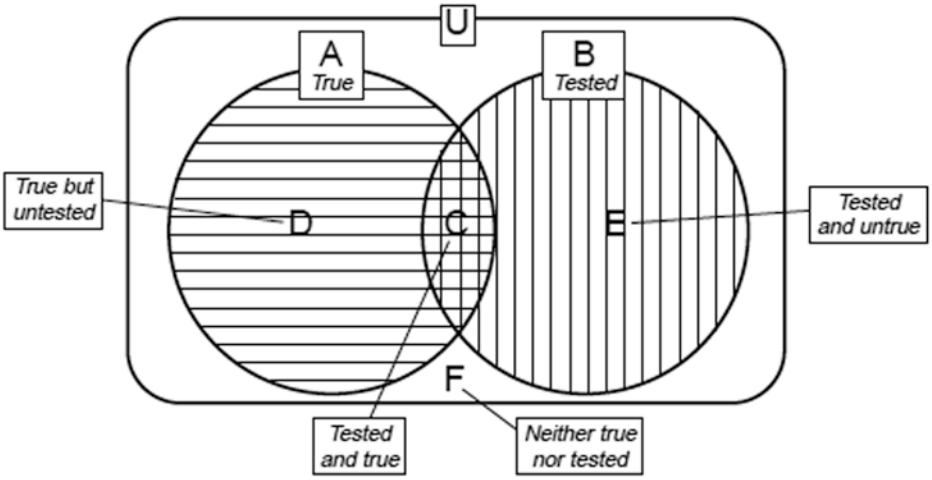


Figure 2 A Venn diagram representing the universe (U) of medical knowledge. Area A represents all true statements and area B, all tested statements. Area C represents all validated (tested and true) statements, but it does not contain all truths: it is missing Area D, which represents truths that have not been proved (true but untested). Area E represents invalidated knowledge, that is, all tested and untrue statements. Area F is those statements that are neither true nor tested. A clinician using untested knowledge hopes to use statements that fall within area D but may in fact sample from Area F.

J. Bernstein. Evidence-based medicine. J Am Acad Orthop Surg 12 (2):80–88, 2004. or 6319 (permission granted)

degeneration, smoking, or obesity), in addition to varying contribution from the workplace.

Causality determination may be difficult and result in contested claims. Honest differences of opinion are common when the facts are subject to different interpretations. Therefore, considerable judgment is necessary when data are lacking or incomplete. With occupational diseases, what appears obvious to some may nevertheless still be controversial, and it is important to assemble a complete database (history including occupational and nonoccupational exposures, physical and test findings, health-care records, etc.), be familiar with the relevant medical literature, and then review and analyze the data in a logical and unbiased manner to ensure a correct and equitable decision on causation. In 1976, the NIOSH created *A Guide to the Work-Relatedness of Disease* (Publication No. 79-116) to assist clinicians and, therein, provided a six-step method to assist in this decision-making process (Hegmann & Oostema, 2008; NIOSH, 1979). These six steps are listed in Table 10.5.

Table 10.5 NIOSH causation decision-making process

1.	Consideration of evidence
2.	Consideration of epidemiologic data
3.	Consideration of evidence of exposure
4.	Consideration of validity of testimony
5.	Consideration of other relevant factors
6.	Evaluation and conclusion

J. M. Melhorn. Epidemiological Methods for Determining Potential Occupational Health and Illness Issues. In: *Handbook of Occupational Health and Wellness*, edited by R. J. Gatchel and I. Z. Schultz, New York, NY:Springer, 2011—used with permission)

Consideration of Evidence

The first step in determining the probability of a cause-and-effect relationship, between an exposure in the workplace and the subject illness, is to establish that a disease does in fact exist and the disease and its manifestations appear to be the result of exposure to a specific harmful agent. Evidence elicited in the course of a medical evaluation should address these questions and specifically include the following:

- Complete medical, personal, family, military, and occupational histories from the employee
- A thorough physical examination and acquisition or review of appropriate radiographic, laboratory, or other diagnostic tests
- Analysis and reporting of these clinical data

The occupational history should include, but is not limited to:

- – Job titles
- – Type of work performed (complete listing of actual duties)
- – Duration of each type of activity
- – Dates of employment and worker's age for each job activity
- – Geographical and physical location of employment
- – Product or service produced
- – Condition of personal protective equipment used (if any) and frequency and duration of periods of use
- – Nature of agents or substances to which worker is, or has been, exposed, if known (including frequency and average duration of each exposure situation)

The resultant report should include a complete list of all diagnoses, with an opinion, whenever possible, as to which diagnoses are occupationally related and which are not.

Consideration of Epidemiological Data

The essential approach of epidemiology is the investigation of relative and absolute measures of frequency while comparing the characteristics of individuals with and without the condition. The most obvious measures of frequency are case counts and their variations, which are often referred to as *numerator data*. This number (the numerator) describes the frequency of the disorder, without reference to the underlying population at risk (the *dominator* data). The US Congress recognized that statistics on workplace injuries and diseases were essential to an effective national program of occupational disease prevention (Melhorn & Ackerman, 2008). Therefore, when the OSHA was passed in 1970, employers were required to maintain records on workplace injuries and illnesses (commonly labeled as OSHA 300 logs). The act delegated the responsibility for collecting statistics on these occupational injuries and illnesses to the BLS. To comply with the OSHA, the BLS conducts an annual survey of the occupational injuries and illnesses in the United States (U.S. Department of Labor, 2006b). The survey compiles the OSHA 300 logs from over 200,000 establishments, grouped together by industry codes established by BLS as the North American Industry Classification System (NAICS) (http://www.bls.gov/bls/naics.htm). The frequency of the particular disorder can also be expressed as a proportionate ratio (the number of cases of the particular disorder, compared to cases of all disorders, in the study population). By itself, *numerator data* cannot provide useful information regarding the risk or probability of acquiring the disorder. The case frequency has to be related to the underlying population that could have potentially developed the disorder (the *denominator*). Without the denominator (the number of people at risk), it is not possible to estimate the risk of a specific condition in the population or to test hypotheses regarding risk factors for a specific condition.

There are, though, known limitations of the BLS data. The survey estimates of occupational injuries and illnesses are based on a scientifically selected probability sample rather than a census of the entire population. Because the data are based on a sample survey, the injury and illness estimates probably differ from the figures that would be obtained from all units covered by the survey. Also, the survey measures the number of new work-related illness cases that are recognized, diagnosed, and reported during the year. Some conditions (e.g., long-term latent illnesses caused by exposure to carcinogens) often are difficult to relate to the workplace and are not adequately recognized and reported. These long-term latent illnesses are believed to be understated in the survey's illness measures. In contrast, the overwhelming majority of the reported new illnesses are those that are easier to track (e.g., contact dermatitis) (Melhorn & Ackerman, 2008). Furthermore, employer bias in selecting which conditions to report may result in underreporting. Additionally, the OSHA definition for work-relatedness is more inclusive than most. Injuries and illnesses that occur at work may not have a clear connection to an occupational activity or substance peculiar to the work environment. For example, an employee may trip for no apparent reason while walking across a level factory floor, be sexually assaulted by a co-worker, or be injured accidentally as a result of an act of violence perpetrated by one co-worker against a third party. For this reason, rates are often used when the objective is to assess the risk of the disorder or determinants of disorders or their outcomes.

Rates

Rates describe the frequency of a disorder (or disorder per unit size of the population per unit time of observation). The most common rates are *incidence* and *prevalence*. The incidence rate is based on new cases of a disorder, whereas the prevalence rate reflects existing cases. Because they are based on new versus existing cases, incidence and prevalence rates have different uses and limitations. Therefore, the incidence rate is a rate of change, often described as the frequency with which people change from healthy to injured, sick, or disabled. Thus, the appropriate denominator is the population at risk of acquiring the disorder (i.e., those who are free of the disorder at the start of the time interval). The incidence rate may be quantified in a number of ways when the population is stable and the number of new events is counted each year. This is often expressed as the number of new events per 1,000 persons per year. Alternatively, incidence rate may be quantified as the number of new events per 1,000 person-years, as is done in prospective studies where a fixed population is followed until the end of the study. In practice, although the best denominator for incidence rates is the number of people free of the disorder at the start of the time interval, surveillance incidence rates (and prevalence rates) that are based on case reports often use the total population derived from estimates or census data.

The prevalence rate is the number of existing cases of a disorder in a given population in a given time period, while *point prevalence* is the number of cases per unit population at one moment. For example, point prevalence would be the number of railroad employees receiving disability because of a medical condition on a specific day such as January 1, 2010. Therefore, the unit of time is not expressed. A *period prevalence* would be the number of cases existing at one time during a definable time interval such as 1 year. Lifetime prevalence (which is a form of period prevalence) is defined as the number of individuals in a population that, at some point in their lives (which could be several to more than 100 years), have the condition in question, compared to the total number of persons. Prevalence is sometimes not defined as a rate because, in practice, data are often derived from surveys that are difficult to assign to a specific time interval. A number of variables, other than the risk factor under study, may affect the incidence and prevalence rates. Examples include demographic characteristics of the underlying population. The most common variable is age distribution because aging is associated with the onset of most disorders. Gender and ethnicity distributions must also be taken into account. Other confounders that can distort the incidence rate include company policies, WC claims, and health-care system influences that affect the likelihood of seeking medical attention, of being diagnosed with a given disorder, or of having the disorder reported. These variables must be considered when measures of disorder frequency are evaluated, particularly when changes are assessed over time or when different populations are compared. In order to eliminate the effects of differences in these variables, the rates may be adjusted or standardized algebraically. The adjusted rates express the risk of acquiring the disorder in the populations being compared as if they had the same age, sex, and ethnicity distributions. In other words, the "variables" have been accounted for. Sometimes, it is appropriate to not account for these variables (e.g., the morbidity rates within population strata defined by age, sex, and ethnicity). Remember, the number of existing cases of a disorder at any time is a function of both the rate of new cases (incidence) and the duration of that disorder. Accordingly, a change in prevalence may reflect changes in the incidence rate, duration, or both. Consequently, when a population is stable and the duration of a disorder is also stable, it is possible to estimate prevalence from incidence and vice versa, according to the following approximation:

$$\text{Prevalence} \approx \text{incidence} \times \text{duration}$$

Therefore, rates become the first step in considering causality and lead to further epidemiological studies.

Epidemiological Study Design

Epidemiological studies are of two major types which can be subdivided. The first is the *descriptive epidemiology* study, which drives the need to explain variation and formulate causal hypotheses that draw on current available information. However, while it supports the development of causal hypotheses, descriptive epidemiology does not itself support conclusions about disorder causality or any hypotheses. In descriptive epidemiology, the frequency of a disorder in the population is characterized in terms of person (e.g., individual risk factors—age, gender, ethnicity-specific incidence rates, economic, behavioral, occupational, and other factors), place (country, rural, urban, type of industry, job requirements), and time (day, week, month, year, lifetime), as seen in Table 10.5. Each epidemiologic study also has certain basic elements: occurrence relation, outcome, determinant(s), study population, and domain. Determinants are defined as the risk factors related to the diagnosis. The study population must be well defined in order to allow the data obtained to be applied, or theoretically generalized, to a larger population called the domain. This requirement is often described as *external validity* (Table 10.6).

Table 10.6 Descriptive epidemiology study design

Person
Place
Time
Condition or disorder

J. M. Melhorn. Epidemiological Methods for Determining Potential Occupational Health and Illness Issues. In: *Handbook of Occupational Health and Wellness*, edited by R. J. Gatchel and I. Z. Schultz, New York, NY:Springer, 2011—used with permission)

Specific hypotheses are developed by inductive reasoning to explain observed patterns of variation and then evaluated using a study designed to test them. Studies that test specific hypotheses are *analytic epidemiologic* studies (the second major type of epidemiologic study). As the results of hypothesis testing (analytic), studies are accrued, and their data added to the basis for causal inference, depending on their strengths and generalizability. Hypotheses can then be supported, modified, or negated. Analytic (hypothesis testing) epidemiology relies on two types of study designs: observational and experimental. In observational studies, exposure to the hypothesized causal factor and the subsequent development of the selected disorder in the population under study occur in the natural course of events; in other words, the investigator does not cause the exposure to the causal factor. The study is designed and implemented to maximize the extent to which it is a natural experiment. Extraneous sources of variation are eliminated, and only exposure to the alleged cause and the frequency of the selected disorder vary between populations being compared. Once substantial observational evidence has accrued, causality is often widely accepted. However, only prospective randomized interventional or experimental studies can prove causation; and these are unlikely to be performed in the workplace as it would require exposing individuals to known or suspected risk factors and, thereby, potential harm.

Table 10.7 Literature review

1. Collect all epidemiologic literature on the disorder
2. Identify the design of each study
3. Assess the methods of each study
    - (a) Exposure assessment methods and potential biases
    - (b) Disease ascertainment methods and potential biases
    - (c) Absence of significant uncontrolled confounders; consideration of residual confounding
    - (d) Addressing of other potential biases
    - (e) Adequacy of biostatistical methods and analytic techniques
4. Ascertain statistical significance and the degree to which chance may have produced the results
5. Assess the studies using the Updated Hill Criteria; apply the criteria to individual studies (especially 5a–c) and to the studies as a whole (5a–l)
    - (a) Temporality
    - (b) Strength of association
    - (c) Dose-response relationship
    - (d) Consistency
    - (e) Coherence
    - (f) Specificity
    - (g) Plausibility
    - (h) Reversibility
    - (i) Prevention/elimination
    - (j) Experiment
    - (k) Analogy
    - (l) Predictive performance
6. Conclusion about the degree to which a causal association is or is not present

AMA Press Guides to the Evaluation of Disease and Injury Causation, editors J. Mark Melhorn and William E. Ackerman, Chapter 3 Causal Associations and Determination of Work-Relatedness (granted)

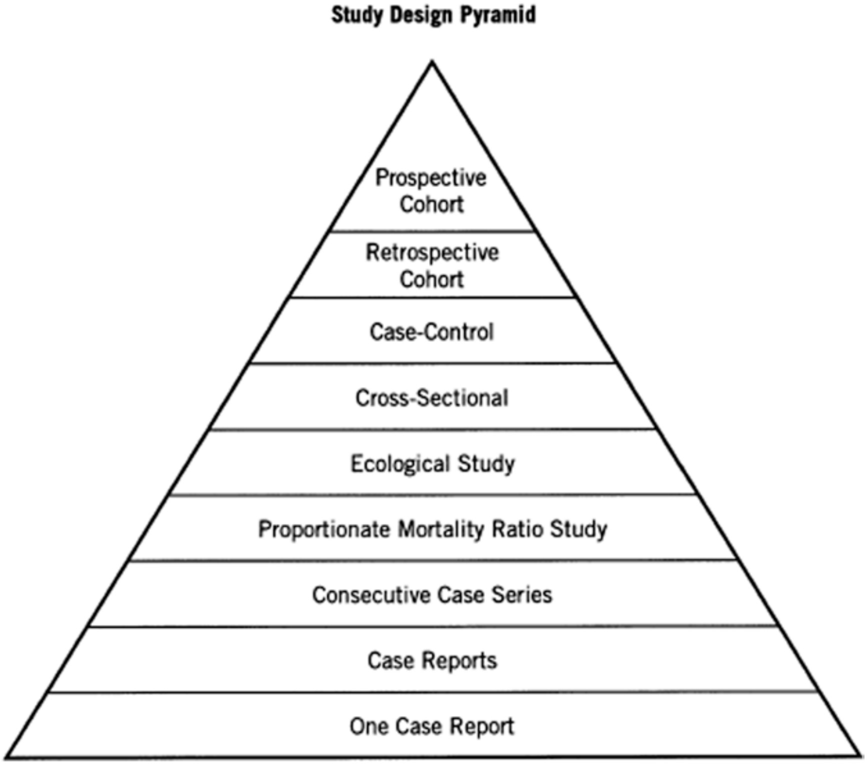
Literature Review Summaries

Epidemiological versus individual causal assessment requires determination that a "risk factor" is truly a disease determinant, rather than merely an associated factor (Hegmann & Oostema, 2008). If the risk factor is causal, then elimination of the risk factor must result in fewer cases of the particular disease. Literature review summaries require five steps, as listed in Table 10.7. To summarize, one must try to avoid omitting articles in the review of the literature. Of course, the purpose of a well-designed study is to provide insight into the "truth" regarding causation. The ability to determine the truth, or to infer from a limited sample to the whole, is compromised by a systematic or study design flaw in the form of bias and/or confounding. Alternatively, chance or random occurrence may influence whether the results of a study accurately reflect the truth. Etiologic epidemiology tests whether a hypothesized factor is a determinant or cause of a disorder in previously healthy population, whereas, in clinical epidemiology, one tests whether risk factors are determinants of the specific disease. The classic observational analytic study designs are the cohort study, the case–control study, and the cross-sectional study.

Table 10.8 summarizes the various types of study designs, based on their strength.

Because it is not possible to study the entire universe of potentially eligible subjects (workers), epidemiologic studies are conducted on samples of the population of interest. Even a study of an entire city's work force constitutes a sample. The method of sampling should not introduce selection biases, but epidemiological studies are commonly affected by them. For example, no characteristics of the individuals should affect the likelihood of selection for the study.

Table 10.8 Study design pyramid



AMA Press Guides to the Evaluation of Disease and Injury Causation, editors J. Mark Melhorn and William E. Ackerman, Chapter 3 Causal Associations and Determination of Work-Relatedness—permission granted

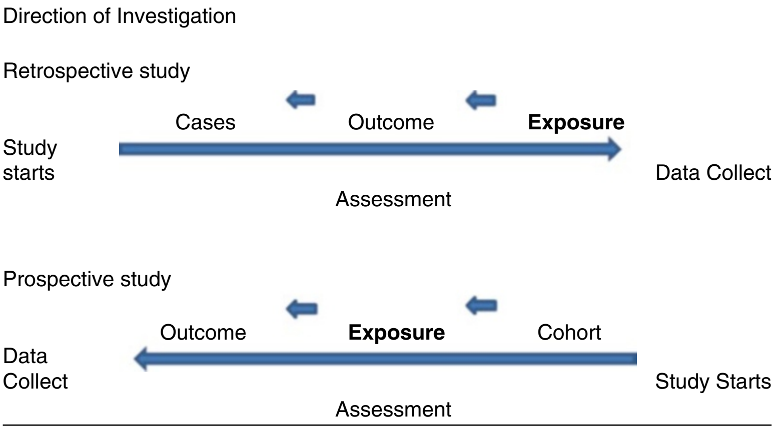
However, a volunteer study is potentially susceptible to selection bias because the health behavior and health status of people who volunteer for research are known to be better than those who refuse. Relatedly, *internal validity* refers to both how well a scientific study was conducted and how confidently one can conclude there is a cause-and-effect relationship. Research design, definitions used, what variables were and were not measured, how accurately they were measured, completeness of data collection, and other factors all influence validity. This applies to both descriptive and experimental studies. However, in experimental studies, one also wants to know how certain it is that the effect was caused by the independent variable rather than extraneous ones. For example, did the treatment really cause or contribute to the difference observed between subjects in the control and experimental groups? If there is inaccuracy (measurement error) in the information collected, the ability to detect the association of interest is reduced. If the accuracy of information is worse for one exposure group than another, the effect on the study results may not be predictable. Hence, evaluation of the accuracy (or validity) of measurements is necessary for any study. Research reports should describe the validity of the sources of information. For example, questionnaires or reporting methods that have been validated in the study population, or in similar populations or circumstances, should be used. Finally, the strength of evidence regarding etiology varies depending on the type of study. Prospective cohort studies are best, while retrospective cohort studies are of low to medium strength, and case–control and cross-sectional are of low strength. Frequently used analysis tools are listed in Table 10.9.

Table 10.9 Common statistical tests

Type of data	No. of groups	Independent	Paired
Continuous			
Normal	2	Student's test	Paired test
Non-normal	2	Mann-Whitney U test	Wilcoxon's signed rank test
Normal	>2	ANOVA test	Repeated measures ANOVA test
Non-normal	>2	Kruskal-Wallis test	Friedman's test
Proportions	2 (large number of observations)	Chi square test	
	2 (small number of observations)	Fisher's exact test	
Ordinal	2	Mann-Whitney U test	Wilcoxon's signed rank test
	>2	Kruskal-Wallis test	Friedman's test
Nominal	2	Fisher's exact test	McNemar's test
	>2	Pearson chi square test	Cochran's Q test
Survival	2/>2	Log-rank test	Conditional logistic regression

R. J. O'Keefe, G. R. Huffman, and S. V. Bukata. Orthopaedic Research: Clinical Epidemiology and Biostatistics. In: Orthopaedic Knowledge Update, edited by J. S. Fischgrund, Chicago, IL: American Academy of Orthopaedic Surgeons, 2008—permission granted

Table 10.10 Direction of investigation



Cohort Study

Cohort studies can be *prospective* or *retrospective*. The direction of data collection or investigation can be seen in Table 10.10. When well designed and executed, a cohort study produces the soundest results for incidence rates, disorder etiology, and/or prognostic determinants of all the observational study designs. The hallmark of a cohort study is that a population is initially free of the disease of interest. Potential confounders and important covariates are identified and characterized with respect to the hypothesized risk factor. The population (cohort) is observed for a period of time adequate for development of the disorder (exposure), and the new (incident) cases are recorded (outcomes). Rates of disorder development are compared between those who are and are not exposed to the hypothesized risk factor. Loss to follow-up, though, is a potential problem. If a number of individuals are lost to follow-up, the observed relative risk underestimates the true relative risk. Selective survival or selective attrition bias can occur. Long latency periods increase the cost to continue these studies. In retrospective studies, the exposure occurs first and then the outcome is observed, which allows for the individual to be included in the "cases."

Case–Control Study

The essential feature of the case–control study that differentiates it from other observational study types is that individuals are selected for the study based on the presence of the disorder in question (cases) and then compared with others who do not have the disorder (control subjects). The presence or absence of the hypothesized cause is then ascertained in both case and control subjects. Although this appears to be a simple undertaking, case–control studies present a number of methodological challenges that must be solved for the study results to be valid. Case–control studies frequently suffer from information biases and unbiased recall failure.

Cross-Sectional Study

Cross-sectional studies simultaneously ascertain exposure to risk factors and the presence of the disorder in question in a population sampled, without regard to the presence of either. This type of sampling is sometimes called *naturalistic sampling*. In contrast to a cohort study, which follows subjects over time and ascertains incidence, a cross-sectional study ascertains conditions present at the moment of study, that is, prevalence of the disorder. The estimates of relative risk derived from cross-sectional studies are therefore estimates of prevalence relative risk. Cross-sectional or survey studies are often undertaken because, unlike case–control studies, they require few a priori decisions regarding subject selection and, unlike cohort studies, it is not necessary to wait for the study outcome. These advantages are offset by their susceptibility to some of the problems of both cohort and case–control studies listed above and resultant decreased strength of evidence.

Assess the Methods of Each Study

Strength and weakness of the data should be assessed. Another way of looking at this is to consider “threats to validity.” There are three general reasons why the results of a study may not be valid: chance, bias, and confounding.

- Chance

  Chance is defined as the absence of any cause of events that can be predicted, understood, or controlled (American Heritage Dictionary Editors, 2011). Measurements made during research are nearly always subject to random variation. Determining whether findings are due to chance is a key feature of statistical analysis. The best way to avoid error due to random variation is to ensure that the sample size is adequate (O’Keefe, Huffman, & Bukata, 2008). The *confidence interval* is a plus-or-minus figure and is often reported as the margin of error. For example, with a confidence interval of 5, if 40 % percent of a sample picks an answer, one can be reasonably certain that between 35 and 45 % (40 ± 5) of the entire study population would have selected the same answer if asked that question. The *confidence level* is the statistical likelihood that a variable lies within the confidence interval, expressed as a percentage, such as, 50, 95, or 99 %. It measures the reliability of a statistical result and indicates the probability of the result is correct. The 95 % confidence level is most commonly used. The sample size required depends on the confidence and confidence level (Creative Research Systems, 2011). For a given confidence level, the larger the sample size, the smaller your confidence interval and the more certain one can be that the results truly reflect the entire population.

- Bias

  While chance is due to random variation, bias is caused by systematic variation. A systematic error in the selection of study subjects, disease or condition, outcome measures, or data analysis will lead to inaccurate results. The numerous types of bias can be broadly divided into three categories delineated below:

  - Selection bias: The selection of individuals for a sample or their allocation to groups may produce a sample not representative of the entire population. Random selection and allocation prevent this type of bias.
  - Measurement bias: Measurement of a condition or outcomes may be inaccurate due to

inaccuracy in criteria for diagnosis of the disease or a measurement instrument or bias in the expectations of study participants or researchers. The latter may be addressed by blinding both the subjects and investigators to the real purpose of the study.

- Analysis bias: The protection against bias afforded by randomization will be maintained only if subjects remain in the study group to which they were allocated and then complete follow-up. Participants who change groups, withdraw from the study, or are lost to follow-up may be systematically different from those who complete the study. Analysis bias can be reduced by maximizing follow-up.

There are also other factors to be considered in determining the strength studies, as delineated below.

- Accuracy and precision

Random variation (chance) leads to imprecise results, while systematic variation (bias) leads to inaccurate results. For example, a large observational study involving thousands of individuals may produce results that are precise (specific), but not accurate. A small, high-quality randomized controlled trial may produce results that are accurate but not precise.

- Confounding

This is similar to bias and is often confused. Whereas bias involves error in the measurement of a variable, confounding involves error in the interpretation of what may be an accurate measurement. A classic example of confounding is to interpret the finding that people who carry matches are more likely to develop lung cancer as a cause-and-effect relationship. Smoking is the confounder. Smokers are more likely to carry matches and also more likely to develop lung cancer. Confounding occurs when the study results can be explained by a factor unnecessary to the hypothesis being tested. A potential confounding factor must be associated with both the disorder in question and the hypothesized cause. That is to say, the study group with the disorder having the confounding exposure must be different from the study group without the disorder who also have the confounding exposure. Additionally, it is necessary that the study group of those with the hypothesized cause and confounding exposure are different from the group not exposed to the hypothesized cause who have the confounding factor. For example, a study finding an association between low job satisfaction and occupational carpal tunnel syndrome could be confounded by the physical requirements of work. Specifically, those individuals whose work involves repetitive high force activities in a cold environment are at greater risk of developing carpal tunnel syndrome, but this group also has a lower job satisfaction than individuals employed in less physically demanding occupations. So, which factor is actually responsible for the risk of occupational carpal tunnel syndrome? Potential confounding factors can be eliminated in the design of the study by restricted or matched sampling or, in the data analysis phase, by stratified or multivariate analysis, for example. In the study just described, if statistical analyses controlled for the physical requirements of work, or if the researchers conducted an exploratory analysis and found no association between job satisfaction and the physical requirements of work, the confounding could be reduced or eliminated. In experimental studies, potential confounding should be eliminated by truly random assignment of individuals to the treatment and control groups. Comparability of the groups should be confirmed by presentation of the baseline characteristics of each group upon entry to the study. Thus, confounding invalidates a study as a test of the null hypothesis, and its results cannot be taken as evidence of causality. Lack of generalizability, unlike confounding, does not invalidate a study's results, but merely restricts inference to populations similar to those under study.

Because of its importance, we will summarize the concept of confounders.

- What is a confounder?

A confounder is any factor that is prognostically linked to the disease of interest and unevenly distributed between the study groups. A factor is *NOT* a confounder if it lies on the causal pathway between the elements of interest. For example, the relationship between diet and coronary heart disease may be explained by serum cholesterol level. Elevated cholesterol is not a confounder because it may be the causal link between diet and coronary heart disease.

- Known confounders

Dealing with confounding is relatively easy if the likely confounders are known. The data could be stratified. For example, in the study on diet and coronary heart disease, smokers and nonsmokers could be analyzed separately, or one could use statistical techniques to adjust for confounding.

- Unknown confounders

Allocating for unknown confounders is much more difficult. There is always a risk that an apparent association between a risk factor and the disease is being mediated by an unknown confounder. This is particularly true of observational studies where selection is not randomized. Again, randomization suggests that both known and unknown confounders will be approximately evenly distributed between two study groups.

Ascertain Statistical Significance

Research is typically conducted on a sample of individuals (the study group) from a target population. Therefore, the results of such studies are estimates of the true means, proportions, relative risks, etc. of the populations from which the sample groups were selected. The precision of a study estimate of the population value is described by the *standard error of estimate*. The standard error (SE) is the square root of the ratio of the variance (s^2), or variability of the measurement in the sample, to the number of subjects (N) in the study, as expressed by the formula

$$\mathrm{SE}_{\mathrm{mean}} = \sqrt{\frac{\boldsymbol{s}^2}{\mathbf{N}}}.$$

The statistical hypothesis test evaluates the null hypothesis that the study results observed occurred because of sampling error when there was no true association in the population from which the sample of study subjects was derived. If the observed association is large enough that this kind of error is improbable, the null hypothesis is rejected. The investigators then accept the alternative hypothesis that the observed estimates of relative risk or association reflect the true situation in the sampled population. By convention, the cutoff for rejecting the null hypothesis is usually set at 0.05. Thus, if the probability (p value) that the observed results are due to sampling error is less than 0.05, the null hypothesis is rejected. The results are declared statistically significant because, within an acceptable margin of error, they probably did not occur by chance. The larger the observed association, relative to the underlying variability of the outcome being measured, the more likely it will be statistically significant.

A *Type I error*, also known as a false positive, occurs when a statistical hypothesis test rejects the null hypothesis, even though it is true. For example, the null hypothesis states a new treatment is no better than an older, less expensive one. A Type I error would occur if researchers concluded the new treatment produced outcomes when in reality there was no difference. The rate of Type I errors is represented by the Greek letter alpha (α) and usually equals the significance level of a test. Relatedly, a Type II error, also known as a false negative, occurs when a statistical hypothesis test fails to reject a false null hypothesis. Continuing the prior example, a Type II error would occur if researchers concluded there was no difference in outcomes between the new and old treatments when, in fact, the new treatment was more effective. False-negative results are often due to too small sample sizes. The rate of Type II error is represented by the Greek letter beta (β). Finally, the probability that a study will be able to correctly reject the null hypothesis when it is false, that is, correctly detect an association when there is one in the population, is called *statistical power* ($1-\beta$). Table 10.11 illustrates the different conditions and possible results of a statistical hypothesis test.

In the planning phase of research, investigators should determine how strong an association (how large an estimated relative risk or how big a difference between treatments) would be statistically significant. Because a valid study requires that it be a true test of the research hypothesis, it is important to design it so the study has sufficient

Table 10.11 Testing hypothesis

Study conclusions	Risk not different	Risk are different	Leads to PPV
Risk not different	Correction conclusion	Type II error (probability = beta)	Leads to NPV
Risk are different	Type I error(probability = alpha)	Correction conclusion	

J. M. Melhorn. Epidemiological Methods for Determining Potential Occupational Health and Illness Issues. In: *Handbook of Occupational Health and Wellness*, edited by R. J. Gatchel and I. Z. Schultz, New York, NY: Springer, 2011—used with permission)

statistical power to detect a statistically significant association. The larger the sample size, the more power the statistical test has to detect associations. In other words, as expected differences or relative risks get smaller, the number of subjects studied must increase to have adequate statistical power to test the hypothesis. With very large sample sizes, it is possible to declare trivial associations statistically significant. When studies with small sample sizes report results that are not statistically significant, they should also report how large an association would have been required to detect it. One should also evaluate whether the observed difference and its upper confidence limit, although not statistically significant, are clinically significant. Conversely, when studies with large numbers of subjects report statistically significant results, one needs to determine if the differences are significant clinically or not.

Other Important Terms

An *independent variable* is one whose value determines that of other variables. A *dependent variable* is that which is observed in a study and whose changes are determined by the presence and extent of one or more independent variables. A *continuous variable* describes numerical information that can be any value within a range. Continuous data may be *parametric* or *nonparametric*. Parametric data may be represented in a distribution explained by a single mathematical equation. Nonparametric data are not represented by a single mathematical equation and do not belong to any particular distribution. *Relative risk* (RR) estimates the magnitude of the association between the exposure and disease of interest. RR equals the incidence of disease in exposed subjects divided by that in unexposed individuals. A RR of 1.0 means the disease incidence rates are identical in the exposed and unexposed study groups. A RR greater than 1.0 suggests a positive association (increased incidence in exposed group), while a RR of less than 1.0 suggests a negative or inverse association (decreased incidence in the exposed study group). Finally an *odds ratio* (OR) is used in retrospective case–control studies where incidence cannot be determined. OR equals the probability (odds) of being exposed in the group with the disease divided by the probability of exposure those without the disease. Statistical tests of inference require assumptions about the data type and distribution. Examples of statistical tests were previously listed in Table 10.9.

It should also be noted that disease detection and correct diagnosis depend on the sensitivity and specificity of tests. A test that yields a positive result when the disease is present is called a *true positive*. A positive test result when the disease is not present is a *false positive*. A negative result when the disease is not present is a *true negative*, whereas a negative result when the disease is present is a *false negative. The positive predictive value* (PPV) of a test is the probability that the patient has the disease when the test result is positive, specifically the number of true positives (TP) divided by the sum of true positives and false positives (FP). So, PPV = TP/(TP + FP). It can also be described as PPV = [(prevalence)(sensitivity)]/[(prevalence)(sensitivity) + (1-prevalence)(1-specificity)]. *Negative predictive value* (NPV) of a test is the probability that the patient does not have the disease when the test result is negative, specifically the number of true negatives (TN) divided by the sum of true negatives and false negatives (FN). NPV = TN/(TN + FN). It can also be calculated as NPV = [(specificity)(1 − prevalence)]/[(specificity)

Table 10.12 Sensitivity and specificity

A		Disease +	Disease –
	Test +	A (true +)	B (false +)
	Test –	C (false –)	D (true –)
		Sensitivity = a/(a + c)	
		False negative rate = (1 – sensitivity)	
B		Disease +	Disease –
	Test +	A (true +)	B (false +)
	Test –	C (false –)	D (true –)
		Sensitivity = d/(b + d)	
		False positive rate = (1 – sensitivity)	

A, Sensitivity; B, Specificity
R. J. O'Keefe, G. R. Huffman, and S. V. Bukata. Orthopaedic Research: Clinical Epidemiology and Biostatistics. In: Orthopaedic Knowledge Update, edited by J. S. Fischgrund, Chicago, IL: American Academy of Orthopaedic Surgeons, 2008, p. 173–185. or 10262 (permission granted)

(1 – prevalence) + (1 – sensitivity)(prevalence)]. Disease prevalence affects the PPV. Also note that PPV is not intrinsic to the test. Table 10.12 summarizes some of the above review.

Conclusions About the Degree of Causal Association

Strength of evidence of causation in epidemiological studies can be combined using a point value to suggest an association between a risk factor and a disease or condition as very strong evidence, strong evidence, some evidence, or insufficient evidence (Melhorn & Hegmann, 2008). Additional details on this methodology are available in *Guides to the Evaluation of Disease and Injury Causation* (editors Melhorn and Ackerman), Chapter 4 Methodology, or can be downloaded from www.ctdmap.com/downloadsinfo/29101.aspx. This method is in the public domain and may be copied and used if appropriate acknowledgment is used. For additional information, the reader is referred to Users' Guide to Medical Literature by Gordon Guyatt and Drummond Rennie (editors), AMA Publication ISBN 1-57947-191-9, and Guides to the Evaluation of Disease and Injury Causation by J. Mark Melhorn and William E. Ackerman (editors), AMA Press ISBN 978-1-57947-945-9.

Consideration of Evidence of Exposure

How does the evaluator take the general epidemiological data and apply this information to the specifics of the individual in question regarding causation? Occasionally, occupational data will be presented for each relevant job or duty. The following information would be helpful: the identification of risk factor(s) and data from industrial hygiene studies, especially any that indicates the magnitude of worker exposure. With regard to occupational disease, there is no generally accepted medical definition of *aggravation*. However, for WC, aggravation of a disease or impairment may be defined as any occupational occurrence, act, or exposure that permanently worsens, intensifies, or increases the severity of any preexisting physical or mental problem. The existence of a condition before exposure does not necessarily mean before employment. Furthermore, an individual may experience multiple exposures while working for different employers having different WC insurance carriers. An example may be helpful.

A 35-year-old man has worked as a chain saw logger for the past 15 years and complains of a 10-year history of numbness in both hands and digits. History, physical examination, and nerve conduction study by a physician reveal bilateral carpal tunnel syndrome. A judge decided his condition was compensable under the current state's workers' compensation system and asked for an apportionment of the medical condition. During his 15 years of employment, he has worked for three different companies. The last employer changed insurance carriers 1 month before he filed the workers' compensation claim.

Appointment

WC boards in all jurisdictions are faced with an expanding challenge in the management of occupational disease claims. In some cases, there are multiple risk factors, with multifactorial causation, and the resultant needs to clarify the contribution of each risk factor to the condition in question in order to apportion liability and financial costs. The process of adjudicating WC claims depends on the applicable statute but may involve differentiation between occupational and nonoccupational causes of disease and injury. Although, in practice, this can be exceedingly difficult and, in some cases, impossible, establishing causation and *apportionment* are integral parts of the philosophy of workers' compensation. Apportionment by cause is the estimation in an individual case of the relative contribution of several risk factors or potential causal exposures to the disease. In the tort system, the equivalent concept is apportionment of harm (meaning responsibility for causing harm). However, because WC is a no-fault insurance system, assignment of blame or responsibility is generally irrelevant.

Apportionment by cause must be performed on the individual case, which may vary from the population as a whole. However, often apportionment cannot be determined with certainty, and epidemiologic data may then be used to derive an estimate of the relative contribution of risk factors in an individual claim. The estimate for apportionment of causation derived should not to be confused with the apportionment of its social derivative, disability. The benefits of fair and accurate apportionment, when it can be done, are obvious. Adjudication may be simpler, quicker, cheaper, and fairer to injured workers, employers, and insurers. Workers might be encouraged to take responsibility for their own health. The financial resources conserved could be used to increase benefits and/or decrease premium costs. Fiscal exposure for health care, disability, and impairment would be more fairly divided among payers, such as provincial or private health-care plans, Social Security, or WC.

Although apportionment is an attractive option for adjudication in workers' compensation, it has many drawbacks and uncertainties (Melhorn, Andersson, & Mandell, 2001). The single greatest obstacle to apportionment is the availability of data and limitations on the methodology of assessment of relative contribution to the disease. Therefore, apportionment is often consensus- or expert-derived. WC carriers are generally required to accept medical claims in their totality if a component of the disease is work-related. However, there is wide variation between jurisdictions regarding how big the occupational component must be before the condition is accepted as work-related. A minimal contribution from work, even one iota, is sufficient to render a disease compensable in some states, whereas others require that work have been the substantial factor, the major contributing cause, or a significant contributor. Furthermore, defining what constitutes a substantial, significant, or even minimal component is often difficult. Apportionment is more often applied to the permanent impairment rating, which is often used to determine a financial settlement in workers' compensation claims.

A special case of apportionment is *presumption*, of which there are two types: A *rebuttable presumption* shifts the burden of proof to the part against which the presumption applies (Melhorn, Ackerman, Glass, & Deitz, 2008). In law, it is an assumption by a court that is considered true until a preponderance of evidence disproves (rebuts) the presumption. For example, in criminal law, a defendant is presumed innocent until proven guilty. On the other hand, an *irrebuttable presumption* establishes a legal conclusion which may be based not on scientific or other evidence but the desire for social justice and fair play (Melhorn, Ackerman, et al., 2008). Judges and legislatures have the power to substitute convenience for science. For example, an irrebuttable presumption may be made based on information (not necessarily facts) that because most cases of a disease in persons with a given job can be attributed to an occupational risk factor, any such case for which a claim is filed will be accepted as work-related. Many presumptions are written into law, often without good evidence, such as the presumption in California that heart disease among firefighters and police officers is work-related (Brooks & Melhorn, 2008). Others are "scheduled" or designated on lists. Presumption logically requires both strong evidence of an association and a risk that is at least doubled.

A simple association can be accepted at a greater than 50 % level of certainty for the occupational group overall at whatever degree of association, but a simple association is not the same as presumption. A presumption involves the same degree of certainty but an actual proportion of the disease (attributable fraction) compatible with at least 50 % in the occupation or population overall. At such a high frequency, it is statistically likely that for any one individual drawn from that population (and submitting a claim) who presents with the disease or outcome in question, the occupational cause would be the risk factor. For example, firefighters have a much higher risk of kidney cancer than the general population, but their risk of lung cancer is only elevated by about 50 % (Guidotti, 2006). One can justify a presumption for kidney cancer, but not for lung cancer. Any firefighter with kidney cancer probably would not have been at risk if he or she were not in that occupation. Presumptions can also be legislated in the opposite fashion. For example, in 1996, the Virginia Supreme Court said that carpal tunnel syndrome does not make a person eligible for WC benefits even if a doctor insists the problem is work-related (Carrico, 1996).

The effects of increasing requests for apportionment are reflected in the definition used in the AMA *Guides to the Evaluation of Permanent Impairment*. The fourth edition, published in 1995, states apportionment is an estimate of the degree to which each of the various occupational or nonoccupational factors may have caused or contributed to a particular impairment. For each alleged factor, two criteria must be met: The alleged factor could have caused or contributed to the impairment, which is a medical determination, and in the case in question, the factor did cause or contribute to the impairment, which usually is a nonmedical determination. The physician's analysis and explanation of causation is significant. The fifth edition, published in 2001, defines apportionment as the distribution or allocation of causation among multiple factors that caused or significantly contributed to the injury or disease and existing impairment. The sixth edition, published in 2008, states apportionment is the extent to which each of two or more probable causes are found responsible for an effect (injury, disease, impairment, etc.). Only probable causes (at least more probable than not) are included. Hence, the first step in apportionment is scientifically based causation analysis. Second, one must allocate responsibility among the probable causes and select apportionment percentages consistent with the medical literature and facts of the case in question. Arbitrary, merely opinion-based unscientific apportionment estimates which are nothing more than speculations must be avoided. When appropriate, the current impairment can also be apportioned to more than one cause.

The Changing Threshold for WC Compensability

Kansas House Bill No. 2134, An Act Concerning Workers' Compensation, passed May 15, 2011, as Law 04-18-2011 (Kansas House, 2011) defines "Prevailing Factor Test" in which, under this test, the employee's work must be the "prevailing factor" for the injury to be considered work-compensable. If it is not the "prevailing factor," the injury is not compensable. It is believed that, under this standard, employers will have a defense against preexisting degenerative conditions not "caused" by work. In other words, employees will no longer have a compensable claim for an aggravation, acceleration, or intensification of a preexisting condition. Unfortunately, the legislature did not define "prevailing factor" and did not reference the Missouri law which could then have been used as "case law" to assist in the definition. Consensus opinion is that the need to define "prevailing factor" will increase ligation and the associated costs. The Missouri Workers' Compensation Law was passed and is in Chapter 287 of the Revised Statutes of Missouri (www.moga.mo.gov/statutes/statutes.htm). The WC statute is the law that controls the rights and obligations of employees and employers when employees are injured at work. It outlines that the work injury must be the "prevailing factor" in causing the level of disability and medical condition for it to be compensable. Medical causation is needed in cases where a traumatic incident occurred or where an employee is injured by an occupational exposure or repetitive motion that is part of their employment. The prevailing factor is the primary factor in comparison to any other possible factor resulting in the employee's injury. It should also be pointed out that Oklahoma SB878 (Oklahoma, 2011) passed May 2011 now requires "major cause provision" (which has yet to be defined by case law but will probably "contribute more than half") and the requirement that objective medical evidence be determined by the Daubert criteria (Fed Rule of Evidence 702) for the opinion of "major cause."

Consideration of Validity of Testimony

Nonprofessional persons cannot be expected to collect and evaluate all the information needed in causation analysis. In most cases, physicians will provide testimony on test results, medical conditions, and causation, using information from industrial hygienists regarding exposure and epidemiologists regarding epidemiologic data. These professionals must consider all pertinent facts and literature in their area of expertise to present an accurate and meaningful evaluation of the available data. The judicial entity requesting the information or determination may have additional expert witness criteria, such as the *Daubert Standard*, to be discussed next. The law of evidence governs whether testimony (e.g., oral or written statements, such as an affidavit), exhibits (e.g., physical objects), and other documentary material are admissible (i.e., allowed to be considered by the trier of fact, whether a judge or jury) in a judicial or administrative proceeding (e.g., a court of law) and how they are used (Wikipedia, 2011). In 1993, the US Supreme Court established the current standards for the admissibility of scientific evidence in Daubert v. Merrell Dow Pharmaceuticals, Inc. This decision abolished the old "general acceptance" test and set forth a new standard which focuses on the reliability and relevance of scientific testimony. In evaluating scientific testimony, trial courts will consider the following factors: whether the research was conducted prior to the litigation, whether it has been tested, whether it had been subjected to peer review and publication, whether there is a known or potential rate of error, whether the research was conducted according to fixed standards, and whether the technique is generally accepted in the scientific community (Klimek, 2001).

The Daubert Standard is a rule of evidence regarding the admissibility of expert witness testimony during US federal legal proceedings (Wikipedia, 2011). Pursuant to this standard, a party may raise a Daubert motion, which is a special case of motion in limine raised before or during trial to exclude the presentation of unqualified evidence to the jury. A motion in limine (Latin, "at the threshold") is one made before the start of a trial requesting that the judge rule that certain evidence may, or may not, be introduced at trial. This is done in judge's chambers or in open court with the jury absent. Usually, it is used to shield the jury from evidence that may be inadmissible and/or unfairly prejudicial. Nonexpert witnesses are permitted to testify only about facts they observed and not their opinions about these facts. An expert (professional) witness is one who, by virtue of education, training, skill, or experience, has knowledge and expertise in a scientific, technical, or other subject beyond that of a layperson, sufficient that others may rely upon his or her opinion on evidence and facts within the expert's area of expertise, even though he or she was not present at the time of the injury, exposure, or other event. In law and religion, testimony is a solemn attestation as to the truth of a matter, and the expert opinion is intended to educate the judge and/or jury on a specialized subject matter, thereby assisting the trier of fact.

Consideration of Other Relevant Factors

Medical causation is drawn from science while, in law, causation is the connection between a wrongful act and harm (Melhorn, Ackerman, et al., 2008). Work-relatedness, in the context of occupational injury or illness, involves concepts of both medical and legal causation. The two may be mutually exclusive. Definitions of medical causation and legal causation arise from different sources—one from science and the other from desire for social justice (with origins in religion). This has been described by Melhorn as "the difference between why things are as they are, and how things ought to be" (Melhorn, 2008). For physicians treating injured or ill workers, understanding the differences between the two concepts is essential. Legal causation requires two components: cause in fact and proximate (or "legal") cause (Melhorn, Ackerman, et al., 2008). Both must be present. If the occurrence of one event brings about another, the former can be considered the cause in fact of the latter. This is true regardless of the number of events involved. Causal fallacies exist, and at least one of them requires attention here. The *post hoc ergo propter hoc* fallacy occurs when "after this, therefore because of this" reasoning leads to the assertion of a causal relationship. It is a fallacy to conclude that the occurrence of one event followed by a second necessarily demonstrates a causal relationship between the two. The second part of the legal analysis of causation seeks to determine whether two events that are linked in fact should also be linked in law. This second test, proximate or legal cause, is whether the two events are so closely linked that liability should be attached or assigned to the first event that produced the harm, the second event. The most common legal threshold is "that the injury arises, in whole or in significant part, out of or in the course and scope of employment" (Melhorn, 2000b). The most common level of legal certainty needed to establish medical causation in the legal system is "more likely than not" or "more probable than not" (Melhorn, 2007).

Evaluation and Conclusions

Seven questions that can be used to address the question of causation based on the best available science are as follows:

1. Has a disease condition been clearly established?
2. Has it been shown that the disease can result from the suspected agent(s)?
3. Has exposure to the agent been demonstrated (by work history, sampling data, expert opinion)?
4. Has exposure to the agent been shown to be of sufficient degree and/or duration to result in the disease condition (by scientific literature, epidemiologic studies, special sampling, and replication of work conditions)?
5. Has nonoccupational exposure to the agent been ruled out as a causative factor (or a contributory factor—suggesting apportionment)?
6. Have all special circumstances been considered?
7. Has the burden of proof been met—did the evidence prove that the disease resulted from, or was aggravated by, conditions at work?

Summary and Conclusions

What is cause? An event, condition or characteristic that plays an essential role in producing an occurrence of a disease.

What is causation? The act of causing.

What is causality? The relationship of cause to effect.

What is risk? Risk is the probability that an event will occur if exposed to the risk factor.

What is a causal relationship? Inferring a causal relationship requires an understanding of epidemiology.

Epidemiology is a science and, as such, adopts the scientific standard of proof, generally greater than or equal to 95 % probability. However, civil litigation and adjudication hold to a different standard. How does one apply epidemiology when the standard is "more likely than not?" In general, this requires a relative risk odds ratio of greater than 2.0. Unfortunately, there is often insufficient data to establish a relative risk. Furthermore, conventional statistics for risk derived from epidemiologic research are generalized and may be difficult to apply to an individual case because the individual's experience in the future may not be similar to the group studied. Health and medical knowledge are essential to the resolution of disputes in legal and administrative applications (such as WC), and it provides essential input into public policy decisions. There are no socially agreed-upon rules for the application of this knowledge except in the law. On a practical level, the legal system lacks the capacity to evaluate the validity of knowledge as evidence and therefore relies heavily on expert opinion.

The determination of causation may be extremely difficult in contested claims. Honest differences of opinion are common when the "facts" may be subject to different interpretations. The practitioner faced with the above questions should know the legal definitions that determine whether the condition is considered work-related. Although the condition may not meet the medical criteria of causation, the condition may meet the legal threshold and therefore be considered work-compensable. Considerable judgment is necessary when data are lacking or incomplete. It is important to assemble complete information in a logical and orderly sequence wherever possible to ensure a correct and an equitable decision regarding causation.

Future Directions

Epidemiology will play a major role in future research into the ever broadening field of healthcare and public health concerns. This is evidenced by the exponential growth of research studies claiming to be "evidence-based." This growth will not occur without challenges and opportunities, examples listed below.

The challenges include:

1. The growing threats to data access. Unfortunately, many recent attempts to place limits on the collection and storage of personal health data have completely ignored the potential impact of the proposed legislation on epidemiological medical research. This has been less of a problem for Europe which has "universal health care" and government data available for research. For perspective, remember, this limitation of health-care data access is occurring at a time when "social data" is commonly shared by individuals on the internet on multiple websites.
2. The challenge of communicating epidemiologic data to the public. Often, the science is not intuitive and therefore can be difficult to accept.
3. The intensifying interface between epidemiologic data and the legal and legislative system.

The opportunities include:

1. Scientific answers or insight to specific questions
2. The ability to convert global data to the individual and thereby reduce individual risk factors
3. The potential to maintain and improve the public and thereby reduce impairment and disability while improving the quality of life for the individual

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References

AMA. (2001). *Guides to the evaluation of permanent impairment* (5th ed.). Chicago, IL: American Medical Association Press.

American Heritage Dictionary Editors. (2011). *The American Heritage dictionary of the English language*. Boston, MA: Houghton Mifflin.

Andersen, J. H., Thomsen, J. F., Overgaard, E., Lassen, C. F., Brandt, L. P., Vilstrup, I., et al. (2003). Computer use and carpal tunnel syndrome: A 1-year follow-up study. *JAMA, 289*, 2963–2969.

Barsky, A. J., & Borus, J. F. (1995). Somatization and medicalization in the era of managed care [see comments]. *JAMA, 274*, 1931–1934.

Berecki-Gisolf, J., Clay, F. J., Collie, A., & McClure, R. J. (2012). Predictors of sustained return to work after work-related injury or disease: Insights from workers' compensation claims records. *Journal of Occupational Rehabilitation, 22*, 286–291.

Black, D. C., & Frost, D. (2011). *Health at work—An independent review of sickness absence*. London, England: Crown Copyright.

Brady, W., Bass, J., Royce, M., Anstadt, G., Loeppke, R., & Leopold, R. (1997). Defining total corporate health and safety costs: Significance and impact. *Journal of*

Occupational and Environmental Medicine, 39, 224–231.

Brenner, L. H., Bal, B. S., & Brenner, J. A. (2007). Beyond medical negligence—Judgement immunity. *Orthopaedic Medical Legal Advisor, 1*, 1–4.

Brooks, C. N., & Melhorn, J. M. (2008). Apportionment. In J. M. Melhorn & W. E. Ackerman (Eds.), *Guides to the evaluation of disease and injury causation* (pp. 61–72). Chicago, IL: AMA Press.

Butler, R. J. (1996). Increasing claims for soft tissue injuries in workers' compensation, cost shifting and moral hazard. *Journal of Risk and Uncertainty, 12*, 379–393.

Carrico, H. L. (1996). Virginia declares carpal tunnel not a job injury. *Occupational Health Management, 60*, 79–80.

Clarke Stevens, J., Witt, J. C., Smith, B. E., & Weaver, A. L. (2001). The frequency of carpal tunnel syndrome in computer users at a medical facility. *Neurology, 56*, 1568–1570.

Creative Research Systems. (2011). *Sample size calculator*. http://www.surveysystem.com/sscalc.htm.

CtdMAP. (2006). *Workplace activity risk factors. CtdMAP occupational health intervention technologies*. Wichita, KS: MAP Managers.

Culpin, M. (1933). The occupational neuroses (including Miners' Nystagmus). *Proceedings of the Royal Society of Medicine, 26*, 655–666.

Daniell, W. E., Fulton-Kehoe, D., Chiou, L. A., & Franklin, G. M. (2005). Work-related carpal tunnel syndrome in Washington State workers' compensation: Temporal trends, clinical practices, and disability. *American Journal of Industrial Medicine, 48*, 259–269.

Egilman, D., Punnett, L., Hjelm, E. W., & Welch, L. (1996). Evidence for work-related musculoskeletal disorders. *Journal of Occupational and Environmental Medicine, 38*, 1079–1080.

Fisher, B., & Gorsche, R. (2004). *Diagnosis, causation and treatment of carpal tunnel syndrome: An evidence-based assessment*. Edmonton, AB: Workers' Compensation Board.

Garland, F. C., Garland, C. F., Doyle, E. J., Balazs, L. L., Levine, R., Pugh, W. M., et al. (1996). Carpal tunnel syndrome and occupation in U.S. Navy enlisted personnel. *Archives of Environmental Health, 51*, 395–407.

Gross, D. P., & Battie, M. C. (2005). Work-related recovery expectations and the prognosis of chronic low back pain within a workers' compensation setting. *Journal of Occupational and Environmental Medicine, 47*, 428–433.

Guidotti, T. L. (2006). Evidence-based medical dispute resolution. In S. L. Demeter & G. B. J. Andersson (Eds.), *Disability evaluation* (2nd ed., pp. 86–94). St. Louis, MO: Mosby.

Hadler, N. M. (1999). *Occupational musculoskeletal disorders* (2nd ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Hegmann, K. T., & Oostema, S. J. (2008). Causal associations and determination of work-relatedness. In J. M. Melhorn & W. E. Ackerman (Eds.), *Guides to the evaluation of disease and injury causation* (pp. 33–46). Chicago, IL: AMA Press.

Hegmann, K. T., Thiese, M. S., Oostema, S. J., & Melhorn, J. M. (2011). Causal associations and determination of work-relatedness. In J. M. Melhorn, W. E. Ackerman, J. B. Talmage, & M. H. Hyman (Eds.), *Guides to the evaluation of disease and injury causation* (2nd ed.). Chicago, IL: American Medical Association.

Melhorn, J. M. & Gardner, P. (2014). How we prevent prevention of musculoskeletal disorders in the workplace. *Clinical Orthopaedic 419* (2):285–296.

Kansas House. (2011). *Kansas House Bill No. 2134. An act concerning workers compensation*. Topeka, KS: Kansas State Legislature.

Kasdan, M. L., Vender, M. I., Lewis, K., Stallings, S. P., & Melhorn, J. M. (1996). Carpal tunnel syndrome. Effects of litigation on utilization of health care and physician workload. *Journal of the Kentucky Medical Association, 94*, 287–290.

Klimek, E. H. (2001). *or4936 Klimek References*.

Lincoln, A. E., Vernick, J. S., Ogaitis, S., Smith, G. S., Mitchell, C. S., & Agnew, J. (2000). Interventions for the primary prevention of work-related carpal tunnel syndrome. *American Journal of Preventive Medicine, 18*, 37–50.

Lo, S. L., Raskin, K., Lester, H., & Lester, B. (2002). Carpal tunnel syndrome: A historical perspective. *Hand Clinics, 18*, 211–217, v.

Lozano Calderon, S. A., Anthony, S., & Ring, D. (2008). The quality and strength of evidence for etiology: Example of carpal tunnel syndrome. *Journal of Hand Surgery. American Volume, 33*, 525–538.

Marchand, A., & Durand, P. (2011). Psychological distress, depression, and burnout: similar contribution of the job demand-control and job demand-control-support models? *Journal of Occupational and Environmental Medicine, 53*, 185–189.

Melhorn, J. M. (1994). Occupational injuries: The need for preventive strategies. *Kansas Medicine, 95*, 248–251.

Melhorn, J. M. (1996). A prospective study for upper-extremity cumulative trauma disorders of workers in aircraft manufacturing. *Journal of Occupational and Environmental Medicine, 38*, 1264–1271.

Melhorn, J. M. (1997). CTD RSI, and their relationship to work injury. In D. M. Spengler & J. P. Zeppieri (Eds.), *Workers' compensation case management: A multidisciplinary perspective* (pp. 1–25). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Melhorn, J. M. (1998a). The future of musculoskeletal disorders (cumulative trauma disorders and repetitive strain injuries) in the workplace—Application of an intervention model. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders function, outcomes, and evidence* (pp. 353–367). Philadelphia, PA: Lippincott, Williams & Wilkins.

Melhorn, J. M. (1998b). Upper-extremity cumulative trauma disorders on workers in aircraft manufacturing [letter, response] upper extremities cumulative trauma disorders. *Journal of Occupational and Environmental Medicine, 40*, 12–15.

Melhorn, J. M. (1999a). The impact of workplace screening on the occurrence of cumulative trauma disorders and workers' compensation claims. *Journal of Occupational and Environmental Medicine, 41*, 84–92.

Melhorn, J. M. (1999b). Risk factors for workplace pain: Individual and employer. In J. M. Melhorn & J. P. Zeppieri (Eds.), *Workers' compensation case management: A multidisciplinary perspective* (pp. 371–402). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Melhorn, J. M. (1999c). Epidemiology of musculoskeletal disorders and workplace factors. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders function, outcomes, and evidence* (pp. 225–266). Philadelphia, PA: Lippincott, Williams & Wilkins.

Melhorn, J. M. (2000a). Workplace pain: Risk factors for the individual and employer. In J. M. Melhorn (Ed.), *Occupational orthopaedics and workers' compensation: A multidisciplinary perspective* (pp. 80–97). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Melhorn, J. M. (2000b). Identifying risk in the workplace and management of musculoskeletal disorders. In *Tenth annual national workers' compensation and occupational medicine seminar* (pp. 11–30). Falmouth, MA: SEAK, Inc.

Melhorn, J. M. (2007). Understanding causation: An example using carpal tunnel syndrome. *AMA Guides Newsletter,* pp. 5–9.

Melhorn, J. M. (2008). *Causation of occupational injuries: Fact & fiction*. Fairmount, MA: SEAK, Inc.

Melhorn, J. M. (2012a). Epidemiology of musculoskeletal disorders and workplace factors. In R. J. Gatchel & I. Z. Schultz (Eds.), *Handbook of musculoskeletal pain and disability disorders in the workplace*. New York: Springer.

Melhorn, J. M. (2012b). Stay at work or return to work—Upper limb conditions. In J. M. Melhorn & E. J. Carragee (Eds.), *14th Annual occupational orthopaedics and workers' compensation: A multidisciplinary perspective*. Rosemont, IL: American Academy of Orthopaedic Surgeons.

Melhorn, J. M., & Ackerman, W. E. (2008). Introduction. In J. M. Melhorn & W. E. Ackerman (Eds.), *Guides to the evaluation of disease and injury causation* (pp. 1–12). Chicago, IL: AMA Press.

Melhorn, J. M., Ackerman, W. E., Glass, L. S., & Deitz, D. C. (2008). Understanding work-relatedness. In J. M. Melhorn & W. E. Ackerman (Eds.), *Guides to the evaluation of disease and injury causation* (pp. 13–32). Chicago, IL: AMA Press.

Melhorn, J. M., Ackerman, W. E., Talmage, J. B., & Hyman, M. H. (2011). Understanding work-relatedness. In J. M. Melhorn, W. E. Ackerman, J. B. Talmage, & M. H. Hyman (Eds.), *Guides to the evaluation of disease and injury causation* (2nd ed.). Chicago, IL: American Medical Association.

Melhorn, J. M., Andersson, G. B. J., & Mandell, P. J. (2001). Determining impairment and disability. In J. M. Melhorn (Ed.), *The fundamentals of workers' compensation* (pp. 13–21). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Melhorn, J. M., Brooks, C. N., & Seaman, S. (2013). Epidemiological methods for determining potential occupational health and illness issues. In R. J. Gatchel & I. Z. Schultz (Eds.), *Handbook of occupational health and wellness*. New York, NY: Springer.

Melhorn, J. M., & Hegmann, K. T. (2008). Methodology. In J. M. Melhorn & W. E. Ackerman (Eds.), *Guides to the evaluation of disease and injury causation* (pp. 47–60). Chicago, IL: AMA Press.

Melhorn, J. M., & Hegmann, K. T. (2011). Methodology. In J. M. Melhorn, W. E. Ackerman, J. B. Talmage, & M. H. Hyman (Eds.), *Guides to the evaluation of disease and injury causation* (2nd ed.). Chicago, IL: American Medical Association.

Melhorn, J. M., Kennedy, E. M., & Wilkinson, L. K. (2002). Solving the "ergonomics injury" enigma: A reasonable approach for employers. *Workers' Compensation Policy Review, 2*, 11–25.

Melhorn, J. M., Martin, D., Brooks, C. N., & Seaman, S. (2008). Upper limb. In J. M. Melhorn & W. E. Ackerman (Eds.), *Guides to the evaluation of disease and injury causation* (pp. 141–202). Chicago, IL: AMA Press.

Melhorn, J. M., Martin, D. P., Brooks, C. N., & Seaman, S. M. (2011). Upper limb. In J. M. Melhorn, W. E. Ackerman, J. B. Talmage, & M. H. Hyman (Eds.), *Guides to the evaluation of disease and injury causation* (2nd ed.). Chicago, IL: American Medical Association.

Melhorn, J. M., & Talmage, J. B. (2011). Work-related illnesses, cumulative trauma, and compensation. In J. M. Flynn (Ed.), *Orthopaedic knowledge update 10* (10th ed., pp. 147–156). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Melhorn, J. M., Wilkinson, L. K., Gardner, P., Horst, W. D., & Silkey, B. (1999). An outcomes study of an occupational medicine intervention program for the reduction of musculoskeletal disorders and cumulative trauma disorders in the workplace. *Journal of Occupational and Environmental Medicine, 41*, 833–846.

Melhorn, J. M., Wilkinson, L. K., & O'Malley, M. D. (2001). Successful management of musculoskeletal disorders. *Journal of Human Ecological Risk Assessment, 7*, 1801–1810.

Melhorn, J. M., Wilkinson, L. K., & Riggs, J. D. (2001). Management of musculoskeletal pain in the workplace.

Journal of Occupational and Environmental Medicine, 43, 83–93.

Nathan, P. A., Keinston, R. C., & Meadows, K. D. (1993). Keyboarding as a risk factor for carpal tunnel syndrome: comparing clerical workers to managers in eight industries. In *American Society for Surgery of the Hand annual meeting* (93 ed., pp. 78–79). Englewood, CO: American Society for Surgery of the Hand.

Nathan, P. A., & Keniston, R. C. (1993). Carpal tunnel syndrome and its relation to general physical condition. *Hand Clinics, 9*, 253–261.

Nathan, P. A., Keniston, R. C., Myers, L. D., & Meadows, K. D. (1992). Obesity as a risk factor for slowing of sensory conduction of the median nerve in industry. A cross-sectional and longitudinal study involving 429 workers. *Journal of Occupational and Environmental Medicine, 34*, 379–383.

Nathan, P. A., Meadows, K. D., & Istvan, J. A. (2002). Predictors of carpal tunnel syndrome: An 11-Year study of industrial workers. *Journal of Hand Surgery. American Volume, 27A*, 644–651.

National Practitioner Data Bank. (1994). O. O021.

NIOSH. (1979). *A guide to the work relatedness of disease (revised)*. DHEW (NIOSH) Publication No. 79-116 ed. Washington, DC: U.S. Department of Health, Education, and Welfare.

Nordstrom, D. L., Vierkant, R. A., DeStefano, F., & Layde, P. M. (1997). Risk factors for carpal tunnel syndrome in a general population. *Occupational and Environmental Medicine, 54*, 734–740.

O'Keefe, R. J., Huffman, G. R., & Bukata, S. V. (2008). Orthopaedic research: Clinical epidemiology and biostatistics. In J. S. Fischgrund (Ed.), *Orthopaedic knowledge update* (9th ed., pp. 173–185). Chicago, IL: American Academy of Orthopaedic Surgeons.

Oakley, C. (2011). Sunny side up. *Parade*. (Jul 30, 2011)

Oklahoma. (2011). *Oklahoma SB878 enrolled May 2011 Workers Compensation*.

Rempel, D., Tittiranonda, P., Burastero, S., Hudes, M., & So, Y. (1999). Effect of keyboard keyswitch design on hand pain. *Journal of Occupational and Environmental Medicine, 41*, 111–119.

Ring, D. (2007). Carpal tunnel syndrome causation. In *74th Annual meeting of the American Academy of Orthopaedic Surgeons at San Diego, CA, 16 Feb 2007* (pp. 1–2). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Sackett, D. L., Rosenberg, W. M., Gray, J. A., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: What it is and what it isn't. *British Medical Journal, 312*, 71–72.

Talmage, J. B., & Melhorn, J. M. (2005). *A physician's guide to return to work*. Chicago, IL: AMA Press.

U.S. Department of Labor. (2006a). *OSHA occupational safety and health administration home page*. Washington, DC: U.S. Department of Labor.

U.S. Department of Labor. (2006b). *Workplace injuries and illnesses in 2005*. Washington, DC: Bureau of Labor Statistics.

United States Bureau of Labor Statistics. (1997). *Occupational injuries and illnesses: Counts, rates, and characteristics, 1994*. Washington, DC: United States Government Printing Office.

Wikipedia. (2011). *Wikipedia the free encyclopedia.*

Zeppieri, J. P. (1999). The physician, the illness, and the workers' compensation system. In J. H. Beaty (Ed.), *Orthopaedic knowledge update 6* (pp. 131–137). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Zeppieri, J. P., & Melhorn, J. M. (2000). The great debate: Cumulative trauma and repetitive strain—A major cause of disabling work related musculoskeletal disorders. the pro and con based on science. In *Threading the needle: Partnership for progress. The 86th IAIABC annual convention* (pp. 1–41). Lawrence, KS: International Association of Industrial Accident Boards and Commissions.

11

From Acute Pain to Chronic Disability: Psychosocial Processes in the Development of Chronic Musculoskeletal Pain and Disability

K. Boersma, J. Carstens-Söderstrand, and S.J. Linton

Overview

In the last decades, there has been a clear recognition of the importance of psychosocial factors in the explanation of chronic musculoskeletal pain. It is generally accepted that chronic musculoskeletal pain and disability has multiple causes, a view that is summarized in the so-called biopsychosocial models (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). However, psychosocial factors have proven to be important predictors of chronic pain and disability already early on in acute and subacute stages of pain. A range of reviews conclude that factors, such as depression, anxiety, pain beliefs, catastrophizing, and coping behaviors, play a primary role in the transition from acute to chronic pain and disability (Linton, 2002; Main, Sullivan, & Watson, 2007; Nicholas, Linton, Watson, & Main, 2011). This supports the notion that psychosocial factors are preferably viewed as an integrated part of musculoskeletal pain, not only in the rehabilitation of chronic problems but also in prevention in the subacute stages.

The aim of this Chapter is to interpret the development of chronic musculoskeletal pain from a psychosocial perspective. From the framework of the biopsychosocial model, we review the psychosocial predictors and processes involved in the development of long-term disability. We highlight how an understanding of the psychology of pain may provide general guiding principles that can inform clinical management and prevention. Specifically, we focus on early identification, based on psychosocial factors, as a stepping stone for a systematic clinical approach to prevent chronicity. This chapter is written from the perspective that, seen through the eyes of the patient, persistent pain is a naturally taxing experience that drains resources and requires adaptation and flexibility. Pain is a stressor that draws an individual's attention and motivates an automatic search for solutions and relief from it. Also, due to its aversive nature, the pain promotes a surge of immediate avoidant and protective behaviors. Naturally, persistent pain leads to emotional and behavioral consequences. It is, therefore, from a psychosocial perspective, not surprising that dealing with persistent pain can prove to be problematic and may lead to a trajectory of long-term suffering and disability. Indeed, psychosocial factors have been shown to predict and drive unfavorable trajectories, and our knowledge of psychosocial processes can be used to prevent or alter suffering and disability.

A fundamental aspect of a preventive approach is early identification of patients who likely will

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develop chronic pain and disability. To this end, we will review psychosocial prognostic factors that have been shown to be related to persistent pain, long-term functional disability, and work absence. These prognostic factors provide us with the opportunity to use them as parameters for early identification so as to alter the trajectory toward chronic pain and disability. However, in order to be able to intervene, it is also important to understand the interrelationship between risk factors and the mechanisms that drive the process of chronification. In recent years, powerful psychosocial models have been developed to theoretically map the development of a chronic pain and disability problem. After introducing a generic model of the psychology of pain experience and behavior, we will focus on the most prominent models, such as the fear-avoidance model and the misdirected problem-solving model, because they have an ample evidence base. These models are good examples of how psychosocial factors can be related to one another to "make sense" of the process of chronification. These models also point out commonalities. Cognitive-behavioral processes, such as catastrophic worry and avoidance, are common to pain, but also other problems. While diagnostics are concerned with what is distinct between disorders, these so-called transdiagnostics seek to highlight the underlying processes that are common between comorbid problems (Harvey, Watkins, Mansell, & Shafran, 2004). Identifying common processes has clear clinical advantages because people in pain often also have other problems (e.g., insomnia, anxiety, and depression; Asmundson & Katz, 2009; Linton & Bergbom, 2011; Linton & MacDonald, 2008). Identifying shared underlying mechanisms may offer opportunities for intervention that could address these. Consequently, we will highlight some pertinent commonalities.

A final aim of this chapter is to translate the existing knowledge about psychosocial processes into guidance for intervention and prevention of the development of chronic pain and disability. Psychosocial factors that may affect pain outcomes are not yet routinely assessed by many treating clinicians, but they could be implemented in practice in order to assist clinicians in allocating care to those that need it most. Several self-report screening instruments show predictive and clinical validity. The *Örebro Musculoskeletal Screening Questionnaire* will be described as one example of a screening instrument which can be used to identify individuals at risk for the development of chronic musculoskeletal pain and disability. Screening can also be used as a "stepping stone" for further, personalized intervention. We will conclude the chapter with guidelines for a systematic clinical approach to prevent chronicity. These guidelines can assist clinicians in their approach to their pain patients and can help structure and guide intervention steps.

Psychosocial Predictors and Mechanisms

While musculoskeletal pain is a very common problem, many episodes that people encounter denote minor problems, with low pain intensity and little disability (Linton & Ryberg, 2000; von Korff, 1999). Recovery is usually fast, especially with respect to regaining the working role. However, pain fluctuates over time, with frequent recurrences or exacerbations (Linton et al., 2005; Pengel, Herbert, Maher, & Refshauge, 2003). Thus, the course of pain is typically characterized by variability and change rather than by clear-cut distinctions in acute, subacute, and chronic stages of chronicity (van Tulder, Koes, & Bombardier, 2002). Moreover, although musculoskeletal pain is common, only a small minority of people (about 5–10 %) run the risk of developing a long-term disability including extensive functional problems, healthcare seeking, and sick listing (Dionne et al., 1999; Reid, Haugh, Hazard, & Tripathi, 1997). In sum, a small minority of the large number of people who experience pain develop a debilitating pain problem.

Much research has been devoted to understanding why recovery from an acute episode of musculoskeletal pain may be hampered, and psychosocial factors are consistently highlighted. There is good evidence, for example, that psychosocial factors play an important role in the development of chronic back pain and disability, especially in the development of functional disability and sick leave (Burton, Tillotson, Main, & Hollis, 1995; Iles, Davidson, & Taylor, 2008; Pincus, Burton, Vogel, & Field, 2002). The key risk factors that emerge include emotional factors, such as stress, anxiety, and depressed mood; cognitive factors, such as beliefs, expectations, and catastrophic interpretations; and behavioral factors, such as passive, avoidant coping responses (Foster, Thomas, Bishop, Dunn, & Main, 2010; Nicholas et al., 2011). For example, clients who are depressed, or who have a history of depression, may have more difficulty dealing with pain (Ang et al., 2010; Linton & Bergbom, 2011). Also, it is apparent that individuals hold very different attitudes and beliefs about the origins and the seriousness of the pain that influence personal recovery expectations and other reactions to pain (Boersma & Linton, 2006a, 2006b; Main, Foster, & Buchbinder, 2010). Not least, catastrophic interpretations about pain have an important influence on the development of long-term pain problems, as well as poor treatment outcome (Flink, 2011). More so, combinations of these risk factors within individuals have been shown to increase the likelihood of long-term problems (Bergbom, Boersma, Overmeer, & Linton, 2011; Boersma & Linton, 2006a, 2006b; Westman, Boersma, Leppert, & Linton, 2011). Individuals with risk profiles, combining high levels of fear-avoidance beliefs, pain catastrophizing, and general emotional distress, show by far the highest levels of disability. These patterns and associated disability appear to be relatively stable over time, unaffected by the interventions provided (Bergbom et al., 2011; Westman et al., 2011). Of course, contextual factors in the workplace, especially those of a psychosocial nature (such as organizational support, job stress, and workplace communication), may represent barriers for return to work (Linton, 2004, 2005). In summary, all of these factors have been shown to predict long-term functional disability and sick leave in individuals who experience an acute episode, and they are strongly associated with disability in individuals with chronic pain.

A Generic Model of the Psychology of Pain

While numerous studies underscore the importance of psychosocial factors, most studies do not explicitly propose the mechanisms of *how* these variables might be related. In order to understand how acute pain could develop into a chronic problem, it is important to get a general picture of how pain is psychosocially processed. Figure 11.1 presents a model of the psychology of pain, where the role of attentional, cognitive, and behavioral processes in pain perception and pain behavior is integrated (Linton, 2005). This model underscores the fact that the interpretation of the pain stimulus (whether pain is appraised as harmful, unusual, or irrelevant) plays an influential role in directing attention and in steering behavior. For example, if a person interprets pain as a sign

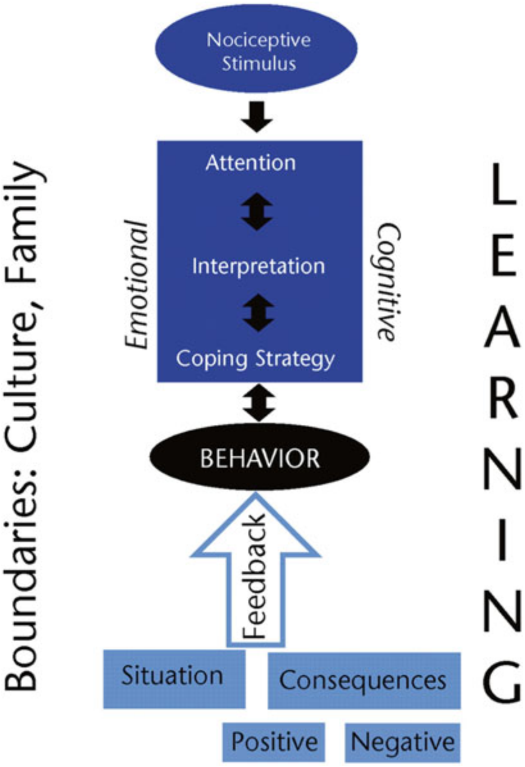

Fig. 11.1 Pain experience and behavior from a psychological perspective (Linton, 2005)

of serious harm, it is likely that attention will be turned inward (to the source of threat) and that actions will be taken to minimize or to eliminate damage, such as through resting and doctor visits. Likewise, the consequences of these behavioral actions play an instrumental role in directing future behavioral efforts. For example, if resting leads to a reduction or elimination of pain, resting will increase in frequency (i.e., it will be reinforced). On the other hand, if bending or twisting the back will increase pain, bending and twisting will decrease in frequency (i.e., it will be avoided). In the same fashion, if doctor visits result in extensive attention to diagnostic details or exclusively biomedical explanations of pain, this may reinforce futile searches for a "cure" and a delay of self-management strategies.

Learning processes are intricate and complicated, and they may occur at physiological, emotional, cognitive, as well as behavioral levels. For instance, classical conditioning may occur so that a certain, previously neutral, event comes to elicit a conditioned response of fear and heightened muscle tension in the back (Gatzounis, Schrooten, Crombez, & Vlaeyen, 2012; Vlaeyen & Linton, 2012). In this way, lifting a box may come to elicit a tension and fear reaction because of previous co-occurrence with pain. Besides prompting operant learning processes, such as avoidance, this reaction may also directly influence the experience of pain, through muscle tension and hypervigilance. Indeed, some experimental studies testify to the fact that neutral stimuli can come to elicit a muscle tension reaction after having been paired with aversive experiences, and it was also found that persons who experienced back and/or neck pain acquired this conditioned response faster than did pain-free controls (Flor and Birbaumer, 1994; Schneider et al., 2004). Moreover, the conditioned muscle tension was more resistant to extinction in the pain group than in the pain-free controls. This suggests that conditioned responses in anticipation of pain might play a role in the perpetuation of the pain experience. Not only do directly pain-related consequences operate on pain behavior, but so do social consequences, such as responses from spouses or other significant persons in the environment Linton & Götestam, 1985; Leonard, Cano, & Johansen, 2007; Romano et al., 1992). For example, in the study of Linton and Götestam, pain-free subjects were required to report their level of pain while undergoing a pain-inducing procedure. In one condition, participants were rewarded when they reported the same or an increased level of pain as compared to the previous trial. It was shown that participants increased their report of pain across these trials, even though the painful pressure was actually systematically decreased.

Lastly, the role of cognitive processes in learning is becoming increasingly recognized, especially in the conditioning of fear and in the relationship between fear and avoidance (see, for an overview, Goubert, Crombez, & Peters, 2004). For example, the conditioning of fear seems to be facilitated by verbal information about the co-occurrence of events. Cultural beliefs about, say, an invasive dental treatment and pain facilitate fearful apprehension for the dental treatment, even though it may not have been previously experienced. Moreover, the meaning of an aversive experience such as pain is not static, but varies between individuals and is dependent on information from different sources. For example, seeing a person in the nearby environment become severely disabled from back pain may, in some individuals, increase fear of back pain. Finally, people generate rules regarding the relationships between events, and these rules seem to govern behavior many times irrespective of actual contingencies between behavior and outcome. People with back pain may develop rules such as *One should never give up trying to find a cure for the back pain* while, at the same time, this persistence in finding a cure is unsuccessful and increases distress and frustration (McCracken, 1998; McCracken & Eccleston, 2003).

In summary, the psychology of pain ascribes an important role to cognitive processes, as well as experiential and observational learning. These processes are viewed as intricately linked to one another. Basic learning conditioning paradigms have started to include cognitive processes to explain, for example, why the valence of aversive stimuli differ across individuals and why people fear and avoid events that they have never experienced. These processes, then, give important cues for understanding why and how some people develop a chronic back pain disability.

The Fear-Avoidance Model

In an attempt to describe the mechanism, whereby acute pain develops into a chronic pain problem more specifically, the "fear-avoidance model" was developed. The fear-avoidance model is a specification of the above-mentioned model. Both models stress the role of cognitions and behavior, but the fear-avoidance model is more explicitly tailored to explain a possible road to chronicity and has a specific and exclusive focus on the role of pain-related fear. This model is based on the work of Lethem, Slade, Troup, and Bentley (1983), Philips (1987), and Waddell, Newton, Henderson, Somerville, and Main (1993) and was expanded on by Vlaeyen and Linton (2000, 2012). It has been successfully applied to explain pain and disability in the subgroup of people experiencing a considerable amount of fear across a wide range of pain problems. While the exact sequence of interrelationships between the variables in the fear-avoidance models has been contended (Bergbom, Boersma, & Linton, 2012; Wideman, Adams, & Sullivan, 2009), there is ample evidence supporting the validity of the model (Leeuw et al., 2007; Vancleef, Flink, Linton, & Vlaeyen, 2012; Vlaeyen & Linton, 2000, 2012).

In summary, the model (see Fig. 11.2) poses that, for most people, pain is appraised as an undesirable and unpleasant but, nonetheless, a nonthreatening experience ("no fear"). This judgment makes it likely that the individual engages in appropriate behavioral restrictions after injury, but also that painful movements are gradually confronted. Gradual confrontation of painful movements is then thought to increase the likelihood of healing and recovery. On the other hand, in a significant minority of people confronted with pain, the pain experience is interpreted as a serious threat. In other words, these individuals appraise the pain in a catastrophic way. Tendencies to engage in catastrophic thinking about pain are central in this model and are thought to be the result of multiple influences, such as predisposing factors (e.g., negative affectivity), as well as environmental influences (e.g., threatening illness information and observational learning). A catastrophic interpretation of pain is thought to lead to pain-related fear, such as fear of the pain itself or fear of (re) injury. Fear, in turn, promotes hypervigilance to pain and behavioral avoidance, fueled

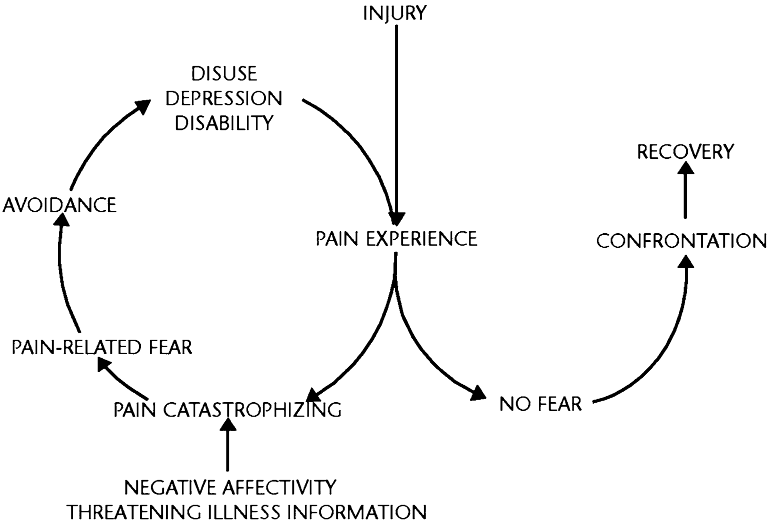

Fig. 11.2 The fear-avoidance model of pain (adapted from Vlaeyen & Linton, 2000)

by beliefs that activity may cause damage and will exacerbate the pain. Lastly, long-term avoidance of activity can have a negative impact on physiological processes, and it can result in a more general withdrawal from positive reinforcers, leading to mood disturbances such as irritability, frustration, and depression. Both depression and disuse are associated with decreased pain thresholds and tolerance levels and might, in that way, promote the painful experience.

Common Psychosocial Processes Across Models

While the fear-avoidance model places a specific emphasis on the cognitive (negative thoughts such as catastrophizing) and behavioral (avoidance) processes in relation to pain-related fear, these processes may, in fact, cut across most psychosocial and somatic disorders, where individuals are confronted to deal with (persistent or recurrent) aversive inner states, such as anxiety and depression, or health-related complaints such as fatigue and sleep problems (Harvey, 2008). These processes have been coined *transdiagnostic processes*, and they appear to have in common the fact that they function to regulate negative-affective experiences. Indeed, recently, these processes have been put forward as a possible explanation of the high degree of co-occurrence that has been found between pain and anxiety disorders (Asmundson & Katz, 2009; Sharp & Harvey, 2001). Specifically, there is evidence that relationships between pain and emotional disorders can be explained by shared vulnerability, such as anxiety sensitivity, and by maintaining cognitive and behavioral factors, such as negative cognitive appraisal, worry, covert, and overt avoidance (Asmundson & Katz, 2009).

Recent developments in pain psychology research extend the possible emotional regulatory function of cognitive and behavioral processes by emphasizing contextual factors (Hadjistavropoulos et al., 2011). For example, while the fear-avoidance model highlights the close interrelationship among catastrophizing, fear, and avoidance behavior, another model (the *communal coping model*) highlights how catastrophizing may perform a regulatory function in the interpersonal and communicative context. In this model, an important function of catastrophizing is thought to be to elicit support and reassurance. Several studies have confirmed that people high on catastrophizing are more interpersonally expressive concerning their pain, possibly with the function to seek support and reassurance and, through this, find emotional relief (Cano, Leong, Williams, May, & Lutz, 2012; Thibault, Loisel, Durand, Catchlove, & Sullivan, 2008). Eccleston and Crombez (2007) presented a reorientation of the fear-avoidance and communal coping models that attempts to take the functions of catastrophizing into account. Their "misdirected problem-solving" model largely reframes pain catastrophizing as worry and focuses on the function of worry in the context of persisting pain. While they describe worry as a generally adaptive mental problem-solving process, they stress that, in the context of chronic pain, worry can become maladaptive and "misdirected." Specifically, if individuals define their persisting pain as a biomedical problem that needs to be cured, this narrow problem definition, and the consequent goal orientation and pursuit of pain relief, may actually increase the likelihood that individuals get "stuck" in a loop of mental, as well as behavioral, problem-solving. This loop is easily characterized by failure because the goal is diffuse or, in fact, impossible to attain. In the end, a situation may arise where an individual is trapped in a state where, on the one hand, progress toward a goal is not being made while, on the other hand, the individual is not able to abandon the goal. This may then lead to negative, persistent, and unconstructive worry in the form of pain catastrophizing, as well as behavioral avoidance. In other words, besides a threat appraisal and an interpersonal mode of communication, pain catastrophizing in this framework is seen as perseverant and inflexible cognitive attempts to solve an insoluble problem (Aldrich, Eccleston, & Crombez, 2000).

Indeed catastrophizing can, in general, be conceptualized as a form of negative repetitive thinking about a current concern which is abstract, intrusive, and difficult to disengage from (Flink et al., 2013). This account of the function of repetitive thought in the form of worry, behavioral avoidance, and safety seeking seems indeed shared across a wide range of problem areas (Mansell, Harvey, Watkins, & Shafran, 2008; Sharp & Harvey, 2001; Smith & Alloy, 2009; Watkins, 2008). These transdiagnostic processes may be powerful drivers of the chronification process, and they have clear implications for clinical management.

How Can Knowledge on Psychosocial Processes Influence Management?

Improving our understanding of the mechanisms that underlie the development of chronicity has implications for clinical management and prevention. The importance of emotional, cognitive, and behavioral factors in the developmental process, from acute pain to a chronic disability, implies that assessing as well as addressing these factors is pivotal. However, while psychosocial theories and models about pain have provided a better understanding about the development of a chronic problem, they are abstract, and the immediate implications for clinical management may be less clear. Therefore, Table 11.1 summarizes some important general implications that can be extracted from the above account of psychosocial processes and models of pain experience.

As highlighted in Table 11.1, the possibility for prevention of chronicity would be enhanced if the psychosocial factors that impact on pain outcomes would be routinely assessed when they are already in the acute and subacute stages of development. In several ways, early screening for risk could play a key role in secondary prevention. First, it may be beneficial in directing preventive interventions, specifically to those who need it the most. Second, it might direct attention to those factors that are most pertinent and modifiable. It would help clinicians and researchers to target and develop the content of the intervention to the actual problems, fueling the development of a specific individual. Third, it might provide primary care facilities that often do not have the resources for assessing psychosocial factors with a simple routine for ensuring assessment. Because psychosocial factors have been shown to predict the development of future pain and disability problems, they form the basis in screening procedures (Nicholas et al., 2011). However, note that many other factors (e.g., specific work-related factors, such as organizational support, job stress, and perceived workplace communication) predict the development of chronic (work) disability and may be included in screening procedures, not in the least in a return-to-work context (Shaw, van der Windt, Main, Loisel, & Linton, 2009). Choice of a screening tool may well be dependent on the purpose and setting. In order to aid in the assessment of psychosocial factors, as well as to communicate with patients and implement early intervention, the *Örebro Musculoskeletal Pain Screening Questionnaire* (ÖMSPQ) was developed and psychometrically tested (Ektor-Andersen, Örbaek, Ingvarsson, & Kullendorff, 2000; Hockings, McAuley, & Maher, 2008; Hurley et al., 2000; Hurley, Dusoir, McDonough, Moore, & David Baxter, 2001; Melloh et al., 2009). About 80 % of the people presenting with a (sub) acute back pain problem can be correctly classified using this screening instrument. This Questionnaire is a self-administered screening instrument for individuals with acute or subacute musculoskeletal pain, containing 25 (Boersma & Linton, 2002) or 10 (Linton, Nicholas, & MacDonald, 2011) questions, covering the most important psychosocial risk factors, including questions such as work-related variables, coping, function, stress, mood, and fear-avoidance beliefs. Table 11.2 presents the short, ten-item version. The ÖMSPQ screening tool could, in addition to providing a rough estimate of prognosis, be used to aid in clinical management and a more precise targeting of treatment. For example, while the scoring pattern can give a risk estimate, it can also be used to discuss specific problems with the patient and identify individual problem areas and planning intervention strategies.

The ÖMSPQ is but one example of several screening instruments that have been developed in recent years to aid clinicians in clinical judgment

Table 11.1 Guiding principles relating psychosocial factors to the treatment of pain

Number	Guiding principle	Clinical implication
1	Psychosocial factors that may impact pain outcomes are not routinely assessed by many treating clinicians	Better methods of screening and early intervention are needed to improve feasibility and utility in usual care settings
2	Persistent pain naturally leads to emotional and behavioral consequences for the majority of individuals	Psychosocial concepts of learning can be useful to provide empathy and support without reinforcing pain behavior
3	Clients who are depressed or have a history of depression may have more difficulty dealing with pain	A brief assessment of mood symptoms should be part of routine screening and intake procedures for pain conditions
4	Persistent pain problems can lead to hypervigilance and avoidance, but simple distraction techniques are not enough to counter this	Clinicians should avoid inadvertent messages that escape or avoidance from pain is necessary in order to preserve function. Instead, show understanding of the problem and support reactivation in the context of the presence of pain
5	Individuals hold very different attitudes and beliefs about the origins of pain, the seriousness of pain, and how to react	Individual differences in pain beliefs and attitudes should be assessed and taken into account in treatment planning
6	Personal expectations about the course of pain recovery and treatment benefits are associated with pain outcomes	Providing realistic expectations (positive, but frank and not overly reassuring) may be a very important aspect of treatment
7	Catastrophic thinking about pain is an important marker for the development of long-term pain problems as well as for poor treatment outcome	Clinicians should listen for expression of catastrophic thoughts and offer less exaggerated beliefs as an alternative. A brief assessment might be part of routine intake procedures
8	Personal acceptance and commitment to self-manage pain problems is associated with better pain outcomes	Overattention to diagnostic details and biomedical explanations may reinforce futile searches for a cure and delay pain self-management
9	Psychosocial aspects of the workplace may represent barriers for returning to work while pain problems linger	RTW planning should include attention to aspects of organizational support, job stress, and workplace communication
10	With proper instruction and support, psychological interventions can improve pain treatment outcomes	Psychosocial approaches can be incorporated into conventional treatment methods, but this requires special training and support

These provide guidance for a patient-centered approach during assessment, treatment planning, and implementation (based on Linton & Shaw, 2011)

and decision making when it comes to treatment allocation. For example, the *Startback Screening Tool* was specifically designed to classify primary-care patients into categories based on low, medium, and high levels of risk for future disability (Hay et al., 2008; Hill et al., 2008). This screening tool consists of nine items, covering the constructs of bothersomeness, referred leg pain, comorbid pain, disability, catastrophizing, fear, anxiety, and depression. The low-risk stratum consists of patients with little or no self-reported indicators for poor outcome. The medium-risk stratum consists of patients who, while reporting high levels of physical and psychosocial risk factors, display low levels on psychosocial risk factors. The high-risk stratum consists of patients with high levels of psychosocial prognostic indicators with or without physical or psychosocial indicators. The *Startback Tool* has been successfully used to stratify the amount of treatment and resources allocated to the degree of risk that patients present with (Hill et al., 2008). Application of treatment levels based on this classification has aided in preventing low-risk patients from getting over treated and promoted, in this way, cost-effective care (Hill et al., 2011). This stresses that it is not just important to identify those at risk but also those not at risk.

Table 11.2 Items in the short version of the Örebro Musculoskeletal Pain Screening Questionnaire (Linton et al., 2011)

	Item	Concept
1	How long have you had your current pain problem?	Pain
2	How would you rate the pain that you have had during the past week?	Pain
3	*Please circle the one number which best describes your current ability to participate in each of these activities* I can do light work for an hour	Self-perceived Function
4	*Please circle the one number which best describes your current ability to participate in each of these activities* I can sleep at night	Self-perceived Function
5	How tense or anxious have you felt in the past week?	Distress
6	How much have you been bothered by feeling depressed in the past week?	Distress
7	In your view, how large is the risk that your current pain may become persistent?	Return to work expectancy
8	In your estimation, what are the chances you will be working your normal duties in 3 months?	Return to work expectancy
9	An increase in pain is an indication that I should stop what I'm doing until the pain decreases	Fear-avoidance beliefs
10	I should not do my normal work with my present pain	Fear-avoidance beliefs

The Tool's short and concise nature makes it economical to administer in busy clinical settings. Comparisons between the ÖMPSQ and Startback have shown that there is a high correlation (0.80) between the two screening tools (Hill, Dunn, Main, & Hay, 2010). There was great overlap in identification of low-risk patients, but the Startback screening allocated fewer people to the high-risk stratum. All in all, the specific choice of screening instrument may depend on the principle objective of screening. In fact, screening can be used as a first step in a systematic clinical approach to prevent pain and disability. Table 11.3 provides an overview of six steps that can aid clinicians in systematically

Table 11.3 Six systematic steps that can aid clinicians in managing pain problems

	Recommendation	Clinical description
1.	Identification of people who likely will develop disability	Use a brief screening interview and/or screening tool to sort patients likely to develop disability from those unlikely to develop such a problem. This procedure may be "over inclusive" to ensure identification and should take little resources
2.	Further assessment of patients aimed at identifying specific mechanisms driving the development of disability	Utilize existing psychosocial knowledge and assessment routines to isolate mechanisms driving or maintaining the disability. Specific factors, such as fear-avoidance beliefs, catastrophic worry, and depressed mood, should be identified so that targets for intervention can be based on them
3.	Coordinate assessment with other professionals	If further medical, organizational, ergonomic, or other assessments are being conducted, coordinate with these professionals in order to develop a consistent approach. This includes the information that will be presented to the patient as well as the development of the intervention
4.	Engage the patient	Use client-centered communication to engage the patient. Develop clear goals that are important to the patient. Provide clear information about the results of the assessment and discuss what it means for intervention
5.	Tailor the intervention to address the mechanisms	Rather than providing a standard "one-size" intervention, select methods that target the identified mechanisms and are evidence based
6.	Test the intervention and recycle if necessary	Evaluate the intervention objectively with appropriate measures (e.g., of activity levels, pain intensity, and distress), as well as subjectively via an interview with the patient. Recycle any parts that are not working to further tailor the intervention to the patient's needs

managing pain problems. In this system, screening has the purpose to roughly identify those at risk. Using knowledge of psychosocial mechanisms, this rough identification is then recommended to be followed up by further assessment in order to identify the specific processes and interactions at the individual level (Linton & Nicholas, 2008). This is important as, while there are commonalities across individuals on dimensions of cognition, emotion, and behavior, there are also personal intricacies that require individualization. A tailored treatment that targets these personal concerns is then provided. Of course, it is important that this treatment is coordinated with other professionals and, not in the least, a client-centered communication is important to validate and engage the patient. Thorough knowledge of basic psychosocial processes that operate in pain problems can give guidance to a personalized problem formulation. It provides an opportunity to understand and make sense of a patient's pain experience and to communicate this understanding to patients so as to validate their experience and actively engage them in treatment.

Conclusions

In conclusion, the evidence suggests that we can identify who is at risk to develop a long-term pain problem. Psychosocial factors are important predictors of unfavorable trajectories. Some powerful theoretical models have been developed in recent years that have a strong evidence base, such as the fear-avoidance model and the misdirected problem-solving model. These models assist in understanding why and how the development from an acute pain to a chronic pain problem may unfold. Not the least, these models underscore a set of psychosocial processes that are shared, such as catastrophic worry, avoidance behavior, and the (misdirected) pursuit for a medical solution to pain. These cognitive-behavioral processes may function to regulate the various negative emotions that are triggered by the pain experience. While these reactions are natural, they may inadvertently come to play an important role in catalyzing the development toward a chronic pain problem. On the other hand, while there are commonalities across individuals in pain on dimensions of cognition, emotion, and behavior, there are also individual intricacies that call for individualization of treatment. It is important to first identify the specific processes that operate on the individual level and then to target these with appropriate intervention. Lastly, there is a need to translate the above ideas into interventions for widespread application in the clinic. Psychosocial interventions may range from simple communication techniques to advanced cognitive-behavioral methods that require considerable training and supervision. While screening is one important aspect, and can be used a "stepping stone" for preventive intervention, it may involve considerable professional competency to apply psychosocial interventions. Future challenges include issues such as the specific content of treatments that can be provided to target the individual problem profile, as well as the skills that are necessary to successfully apply these interventions.

References

Aldrich, S., Eccleston, C., & Crombez, G. (2000). Worrying about chronic pain: Vigilance to threat and misdirected problem solving. *Behavior Research and Therapy, 38*(5), 457–470.

Ang, D. C., Bair, M. J., Damush, T. M., Wu, J., Tu, W., & Kroenke, K. (2010). Predictors of pain outcomes in patients with chronic musculoskeletal pain co-morbid with depression: Results from a randomized controlled trial. *Pain Medicine, 11*(4), 482–491.

Asmundson, G. J., & Katz, J. (2009). Understanding the co-occurrence of anxiety disorders and chronic pain: State-of-the-art. *Depression and Anxiety, 26*, 888–901.

Bergbom, S., Boersma, K., & Linton, S. J. (2012). Both early and late changes in psychological variables relate to treatment outcome for musculoskeletal pain patients at risk for disability. *Behaviour Research and Therapy, 50*(11), 726–734.

Bergbom, S., Boersma, K., Overmeer, T., & Linton, S. J. (2011). The relationship between pain catastrophizing, depressed mood and outcome across physical therapy treatment. *Physical Therapy, 91*(5), 1–11.

Boersma, K., & Linton, S. J. (2002). Early assessment of psychological factors: The Örebro screening questionnaire for pain. In S. J. Linton (Ed.), *New avenues for the prevention of chronic musculoskeletal pain and disability*. Amsterdam: Elsevier.

Boersma, K., & Linton, S. J. (2006a). Expectancy, fear and pain in the prediction of chronic pain and disability: A prospective analysis. *European Journal of Pain, 10*(6), 551–557.

Boersma, K., & Linton, S. J. (2006b). Psychological processes underlying the development of a chronic pain problem: A prospective study of the relationship between profiles of psychological variables in the fear-avoidance model and disability. *Clinical Journal of Pain, 22*(2), 160–166.

Burton, A. K., Tillotson, K. M., Main, C. J., & Hollis, S. (1995). Psychosocial predictors of outcome in acute and subchronic low back trouble. *Spine, 20*(6), 722–728.

Cano, A., Leong, L. E. M., Williams, A. M., May, D. K. K., & Lutz, J. R. (2012). Correlates and consequences of the disclosure of pain-related distress to one's spouse. *Pain, 153*(12), 2441–2447.

Dionne, C. E., Von Korff, M., Koepsell, T. D., Deyo, R. A., Barlow, W. E., & Checkoway, H. (1999). A comparison of pain, functional limitations, and work status indices as outcome measures in back pain research. *Spine, 24*(22), 2339–2345.

Eccleston, C., & Crombez, G. (2007). Worry and chronic pain: A misdirected problem solving model. *Pain, 132*, 233–236.

Ektor-Andersen, J., Örbaek, P., Ingvarsson, E., & Kullendorff, M. (2000). *Psykosociala yellow flags: Screening för psykosociala faktorer vid smärta från rörelseapparaten*. Malmö: Malmö Multidisciplinära Smärtmottagning, University Hospital Malmö, Sweden.

Flink, I. (2011). *Stuck in mind. The role of catastrophizing in pain.* Doctoral dissertation, Örebro University, Örebro.

Flink, I., Boersma, K. & Linton, S.J. (2013). Pain Catastrophizing as Repetitive Negative Thinking: A Development of the Conceptualization, *Cognitive Behaviour Therapy, 42*(3), 215–223.

Flor, H. & Birbaumer, N. (1994). Acquisistion of chronic pain. Psychophysiologic mechanisms. *APS Journal, 3*, 119–127.

Foster, N. E., Thomas, E., Bishop, A., Dunn, K. M., & Main, C. J. (2010). Distinctiveness of psychological obstacles to recovery in low back pain patients in primary care. *Pain, 148*(3), 398–406.

Gatchel, R. J., Peng, Y. B., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin, 133*(4), 581.

Gatzounis, R., Schrooten, M. G. S., Crombez, G., & Vlaeyen, J. W. S. (2012). Operant learning theory in pain and chronic pain rehabilitation. *Current Pain and Headache Reports, 16*, 117–126.

Goubert, L., Crombez, G., & Peters, M. L. (2004). Pain-related fear and avoidance: A conditioning perspective. In G. J. Asmundson, J. W. S. Vlaeyen, & G. Crombez (Eds.), *Understanding and treating fear of pain*. New York: Oxford University Press.

Hadjistavropoulos, T., Craig, K. D., Duck, S., Cano, A., Goubert, L., Jackson, P. L., et al. (2011). A biopsychosocial formulation of pain communication. *Psychological Bulletin, 137*(6), 910–939.

Harvey, A. G. (2008). Insomnia, psychiatric disorders, and the transdiagnostic perspective. *Current Directions in Psychological Science, 17*(5), 299–303.

Harvey, A., Watkins, E., Mansell, W., & Shafran, R. (2004). *Cognitive behavioural processes across psychological disorders: A transdiagnostic approach to research and treatment*. Oxford: Oxford University Press.

Hay, E. M., Dunn, K. M., Hill, J. C., Lewis, M., Mason, E. E., Konstantinou, K., et al. (2008). A randomised clinical trial of subgrouping and targeted treatment for low back pain compared with best current care. The STarT Back Trial Study Protocol. *BMC Musculoskeletal Disorders, 9*, 58.

Hill, J. C., Dunn, K. M., Lewis, M., Mullis, R., Main, C. J., Foster, N. E., et al. (2008). A primary care back pain screening tool: Identifying patient subgroups for initial treatment. *Arthritis Care & Research, 59*(5), 632–641.

Hill, J. C., Dunn, K. M., Main, C. J., & Hay, E. M. (2010). Subgrouping low back pain: A comparison of the STarT Back Tool with the Orebro Musculoskeletal Pain Screening Questionnaire. *European Journal of Pain, 14*(1), 83–89.

Hill, J. C., Whitehurst, D. G. T., Lewis, M., Bryan, S., Dunn, K. M., Foster, N. E., et al. (2011). Comparison of stratified primary care management for low back pain with current best practice (STarT Back): A randomised controlled trial. *The Lancet, 378*(9802), 1560–1571.

Hockings, R. L., McAuley, J. H., & Maher, C. G. (2008). A systematic review of the predictive ability of the Orebro musculoskeletal pain questionnaire. *Spine, 33*(15), 494–500.

Hurley, D. A., Dusoir, T. E., McDonough, S., Moore, A., & David Baxter, G. (2001). How effective is the acute low back pain screening questionnaire for predicting 1-year follow-up in patients with low back pain? *The Clinical Journal of Pain, 17*, 256–263.

Hurley, D., Dusoir, T., McDonough, S., Moore, A., Linton, S. J., & Baxter, G. (2000). Biopsychosocial screening questionnaire for patients with low back pain: Preliminary report of utility in physiotherapy practice in Northern Ireland. *Clinical Journal of Pain, 16*(3), 214–228.

Iles, R. A., Davidson, M., & Taylor, N. F. (2008). Psychosocial predictors of failure to return to work in non-chronic non-specific low back pain: A systematic review. *Occupational and Environmental Medicine, 65*(8), 507–517.

Leeuw, M., Goossens, M. E. J. B., Linton, S. J., Crombez, G., Boersma, K., & Vlaeyen, J. W. (2007). The fear-avoidance model of musculoskeletal pain: Current state of scientific evidence. *Journal of Behavioral Medicine, 30*, 77–94.

Leonard, M. T., Cano, A., & Johansen, A. B. (2007). Chronic pain in a couples context: A review and integration of theoretical models and empirical evidence. *The Journal of Pain, 7*(6), 377–390.

Lethem, J., Slade, P. D., Troup, J. D. G., & Bentley, G. (1983). Outline of a fear-avoidance model of exaggerated pain perceptions. *Behavior Research and Therapy, 21*, 401–408.

Linton, S. J. (Ed.). (2002). *New avenues for the prevention of chronic musculoskeletal pain and disability* (Vol. 1). Amsterdam: Elsevier Science.

Linton, S. J. (2004). Environmental and learning factors in the development of chronic pain and disability. In D. D. Price & M. K. Bushnell (Eds.), *Psychological methods of pain control: Basic science and clinical perspectives* (pp. 143–167). Seattle, WA: IASP Press.

Linton, S. J. (2005). *Understanding pain for better clinical practice*. Edinburgh: Elsevier.

Linton, S. J., & Bergbom, S. (2011). Understanding the link between depression and pain. *Scandinavian Journal of Pain, 2*(2), 47–54.

Linton, S. J., & Götestam, G. K. (1985). Controlling pain reports through operant conditioning: A laboratory demonstration. *Perceptual and Motor Skills, 60*, 427–437.

Linton, S. J., Gross, D., Schultz, I. Z., Main, C. J., Côté, P., Pransky, G., et al. (2005). Prognosis and the identification of workers risking disability. *Journal of Occupational Rehabilitation, 15*(4), 459–474.

Linton, S. J., & MacDonald, S. (2008). Pain and sleep disorders: Clinical consequences and maintaining factors. In G. J. Lavigne, B. J. Sessle, M. Choinière, & P. J. Soja (Eds.), *Sleep and pain* (Vol. 1, pp. 417–437). Seattle: IASP Press.

Linton, S. J., & Nicholas, M. K. (2008). After assessment then what? Integrating findings for successful case formulation and treatment tailoring. In H. Breivik, W. I. Campbell, & M. K. Nicholas (Eds.), *Clinical pain management: Practice and procedures* (2nd ed., pp. 95–106). London: Hodder & Stoughton.

Linton, S. J., Nicholas, M., & MacDonald, S. (2011). Development of a short form of the Örebro musculoskeletal pain screening questionnaire. *Spine, 36*(22), 1891–1895.

Linton, S. J., & Ryberg, M. (2000). Do epidemiological results replicate? The prevalence and health-economic consequences of back and neck pain in the general public. *European Journal of Pain, 4*, 1–8.

Linton, S. J., & Shaw, W. S. (2011). Impact of psychological factors in the experience of pain. *Physical Therapy, 91*(5), 700–711.

Main, C., Foster, N., & Buchbinder, R. (2010). How important are back pain beliefs and expectations for satisfactory recovery from back pain? *Best Practice & Research. Clinical Rheumatology, 24*(2), 205–217.

Main, C. J., Sullivan, M. J. L., & Watson, P. J. (2007). *Pain management: Practical applications of the biopsychosocial perspective in clinical and occupational settings*. London: Churchill-Livingstone.

Mansell, W., Harvey, A., Watkins, E., & Shafran, R. (2008). Cognitive behavioral processes across psychological disorders: A review of the utility and validity of the transdiagnostic approach. *International Journal of Cognitive Therapy, 1*, 181–191.

McCracken, L. M. (1998). Learning to live with the pain: Acceptance of pain predicts adjustment in persons with chronic pain. *Pain, 74*(1), 21–27.

McCracken, L. M., & Eccleston, C. (2003). Coping or acceptance: What to do about chronic pain? *Pain, 105*(1–2), 197–204.

Melloh, M., Elfering, A., Egli-Presland, C., Roeder, C., Barz, T., Rolli-Salathé, C., et al. (2009). Identification of prognostic factors for chronicity in patients with low back pain: A review of screening instruments. *International Orthopaedics (SICOT), 33*, 301–313.

Nicholas, M. K., Linton, S. J., Watson, P. J., & Main, C. J. (2011). Early identification and management of psychological risk factors ("Yellow Flags") in patients with low back pain: A reappraisal. *Physical Therapy, 91*(5), 737–753.

Pengel, L. H. M., Herbert, R. D., Maher, C. G., & Refshauge, K. M. (2003). Acute low back pain: Systematic review of its prognosis. *British Medical Journal, 327*(7410), 323.

Philips, H. C. (1987). Avoidance behaviour and its role in sustaining chronic pain. *Behavior Research and Therapy, 25*, 273–279.

Pincus, T., Burton, A. K., Vogel, S., & Field, A. (2002). A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. *Spine, 27*(5), 109–120.

Reid, S., Haugh, L. D., Hazard, R. G., & Tripathi, M. (1997). Occupational low back pain: Recovery curves and factors associated with disability. *Journal of Occupational Rehabilitation, 7*(1), 1–14.

Romano, J.M., Turner, J.A., Jensen, M.P., Friedman L.S., Bulcroft, R.A., Hops, H. et al. (1992). Chronic pain patient-spouse behavioral interactions predict patient disability. *Pain, 63*(3), 353–360.

Schneider, C., Palomba, D. & Flor, H. (2004). Pavlovian conditioning of muscular responses in chronic pain patients: central and peripheral correlates. *Pain, 112*, 239–247.

Sharp, T. J., & Harvey, A. G. (2001). Chronic pain and posttraumatic stress disorder: Mutual maintenance? *Clinical Psychology Review, 21*(6), 857–877.

Shaw, W., van der Windt, D., Main, C., Loisel, P., & Linton, S. (2009). Early patient screening and intervention to address individual-level occupational factors ("Blue Flags") in back disability. *Journal of Occupational Rehabilitation, 19*(1), 64–80.

Smith, J. M., & Alloy, L. B. (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. *Clinical Psychology Review, 29*, 116–128.

Thibault, P., Loisel, P., Durand, M. J., Catchlove, R., & Sullivan, M. J. L. (2008). Psychological predictors of pain expression and activity intolerance in chronic pain patients. *Pain, 139*(1), 47–54.

van Tulder, M. W., Koes, B. W., & Bombardier, C. (2002). Low back pain. *Best Practice & Research. Clinical Rheumatology, 16*(5), 761–775.

Vancleef, L., Flink, I., Linton, S. J., & Vlaeyen, J. (2012). Fear-avoidance as a risk factors for the development of chronic back pain and disability. In M. Hasenbring & D. C. Turk (Eds.), *From acute to chronic back pain. Risk factors, mechanisms and clinical implications* (pp. 269–294). Oxford: Oxford University Press.

Vlaeyen, J. W. S., & Linton, S. J. (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: A state of the art. *Pain, 85*, 317–332.

Vlaeyen, J. W. S., & Linton, S. J. (2012). Fear-avoidance model of chronic musculoskeletal pain: 12 years on. *Pain, 153*(6), 1144–1147.

von Korff, M. (1999). Pain management in primary care: An individualized stepped/care approach. In R. J. Gatchel & D. C. Turk (Eds.), *Psychosocial factors in pain* (1st ed., pp. 360–373). New York: Guilford Press.

Waddell, G., Newton, M., Henderson, I., Somerville, D., & Main, C. J. (1993). A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain, 52*, 157–168.

Watkins, E. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*(2), 163–206.

Westman, A., Boersma, K., Leppert, J., & Linton, S. J. (2011). Fear-avoidance beliefs, catastrophizing and distress—A longitudinal subgroup analysis on patients with musculoskeletal pain (MSP). *The Clinical Journal of Pain, 27*(7), 561–653.

Wideman, T. H., Adams, H. E., & Sullivan, M. J. L. (2009). A prospective sequential analysis of the fear-avoidance model of pain. *Pain, 145*, 45–51.

Psychosocial and Psychiatric Sequelae of Chronic Musculoskeletal Pain and Disability Disorders

12

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Overview

As recently noted by Dewa, Corbière, Durand, and Hensel (2013), there have been many studies revealing a close association between musculoskeletal disorders and mental health disorders. For example, Buist-Bouwman, de Graaf, Vollebergh, and Ormel (2005) reported that workers with chronic physical disorders, such as chronic back problems, were significantly more likely to have a mood or anxiety disorder. In addition, Franche et al. (2009), in following a group of Canadian workers who had an occupational-related musculoskeletal disorder, noted that about 43 % of these workers had much higher levels of depressive symptoms that persisted among 27 % of these workers 6 months later. As Dewa et al. (2013) note:

> …, while mental disorders are not necessarily the leading disorders experienced by workers, they appear to be among the top 10. In addition, they are often simultaneously present with physical disorders. This suggests that although the primary reason for treatment may be a physical disorder, there may also be a mental disorder that may or may not be recognized and vice-versa.

The major focus of the present chapter will be to review and discuss data demonstrating the close comorbidity between chronic musculoskeletal and mental health disorders. As will be highlighted, as the pain associated with musculoskeletal disorders become more chronic in nature, psychosocial/psychiatric variables play an increasingly dominant role in the maintenance of pain behavior, suffering, and disability. A conceptual model of the transition from acute to chronic pain will also be presented later in this chapter.

Early Work Evaluating Psychosocial Factors Involved in the Pain Perception Process

As reviewed by Gatchel and Dersh (2002), with the introduction of the *gate control theory of pain* by Melzack and Wall (1965), the clinical and scientific community began to accept the potential importance of central, psychosocial factors in the pain perception process. As a consequence, a great deal of clinical research was generated in trying to isolate the psychosocial characteristics associated with chronic pain patients. This early work focused on differentiating "functional" pain from "organic" pain, using the Minnesota Multiphasic Personality Inventory (MMPI), which has been traditionally widely used to delineate psychosocial characteristics of individuals. However, Sternbach (1974) challenged the validity and utility of the overly

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simplistic attempt to make a functional-organic dichotomy when trying to better understand chronic pain. In fact, today, chronic pain is viewed as a complex *biopsychosocial* phenomenon, which includes physical, psychological, and social elements that interact in ultimately determining the degree of chronic pain experienced by patients. This *biopsychosocial model of pain* has moved away from the earlier and overly simplistic biomedical disease model of pain and has replaced it with an alternative multidimensional perspective. In this biopsychosocial model, psychosocial factors are viewed as being intricately related to the pain perception process. Thus, as pain becomes more chronic in nature, the psychosocial variables play an increasingly dominant role in the maintenance of pain behaviors and suffering (e.g., Turk & Monarch, 2002). Indeed, recent clinical research results have revealed that one of the major consequences of dealing with chronic pain is the development of emotional reactions, such as anxiety and depression, produced by the long-term "wearing down" effects and drain on psychosocial resources. These data suggest that this may produce a layer of behavioral and psychosocial problems over the original nociception or pain experience itself. It is now generally accepted, for example, that chronic occupational low-back pain is a complex behavior that does not merely result from some specific structural cause. When the chronic pain is effectively treated, many of the problematic psychosocial symptoms tend to also be alleviated. Gatchel (2005) further reviews the well-documented clinical evaluations that have concluded that patients with chronic pain also manifest comorbid psychiatric disorders, most commonly depression, anxiety disorders, and substance abuse disorders. In addition, there are close associations among chronic pain, depression, and suicide. Patients with chronic pain are also at increased risk for depression, suicide, and sleep disorders. As occupational pain becomes more chronic in nature, emotional factors will start to play an increasingly dominant role in the maintenance of dysfunction and suffering. These emotional factors will be discussed next.

Emotional Factors and Pain

As was noted above, a new era in thinking about pain was ushered in by the *gate control theory of pain*, and a subsequent conceptualization underlying this theory discussed by Melzack and Casey (1968). It was suggested that the experience of pain was a composite of sensory-discriminative, cognitive-evaluative, and motivational features. In this perspective, although the three dimensions may be disentangled separately, they are interdependent. The integrative model postulated by Melzack and Wall (1965), and then subsequently expanded by Melzack and Casey (1968), has become the dominant paradigm in this specialized field of pain and pain management. Pain is ultimately a subjective, private experience, but it is invariably described in terms of sensory and affective properties. As earlier defined by the *International Association for the Study of Pain*, "pain is unquestionably a sensation in a part or parts of the body but it is always unpleasant and therefore also an *emotional experience*" (emphasis added, Merskey, 1986, p.1).

With the above model in mind, it is not at all surprising that there are many individual differences in how people respond in the face of painful nociception, as well as differences in methods used to understand and interpret the painful stimuli (Gatchel & Oordt, 2003). As noted by Turk and Monarch (2002), this makes the experience of pain dependent on *cognitive-evaluative* processes and on *affective-motivational* processes. Thus, in terms of the *cognitive-evaluative* processes, people evaluate pain in terms of the perception of the potential consequences of pain, the importance of the pain, and the ability to cope with the pain. These various factors are detailed in Table 12.1.

In terms of the *affective-motivational* processes, cognitive appraisal of pain can lead to an array of different affective or emotional responses. For example, some patients may perceive their pain as "out of control" or as a threat and, therefore, may become more prone to

Table 12.1 Various cognitive-evaluative processes associated with pain (adapted from Turk & Monarch, 2002)

- *Beliefs about pain*. Certain negative beliefs about pain (e.g., pain signifies ongoing tissue damage and some underlying disease; the pain is not going away; pain will increase during any physical activity) will result in ineffective/maladaptive coping, feelings of helplessness, the exacerbation of pain, etc.
- *Beliefs about controllability*. A person's belief that his/her pain cannot be controlled can lead to negative consequences (e.g., overreaction to even mild stimuli, decreased activity level in order to minimize any pain, inappropriate medication use, poor psychosocial functioning)
- *Self-efficacy*. In contrast to the perception that pain cannot be controlled, some patients believe that they can successfully control pain while performing certain activities of daily living and behaviors in particular situations. This self-efficacy construct has been demonstrated to be associated with positive therapeutic change
- *Cognitive errors*. Common cognitive errors include *catastrophizing* (anticipation that negative outcomes/aversive events will occur), *overgeneralization* (assuming that the outcome in one situation will automatically transfer to all similar or future events), and *selective abstraction* (paying attention only to the negative features of an experience and ignoring any positive features). Such cognitive errors can significantly and negatively influence the experience of pain and any concomitant depression
- *Coping*. There are a number of positive coping strategies that can significantly aid patients in dealing with, and adjusting to, pain, as well as minimizing the emotional distress caused by it: relaxation and stress management techniques, simple pacing of activities and rest, appropriate use of certain medications, and distraction techniques

emotional distress. This affect/emotion associated with pain can span a wide spectrum, from vague unpleasantness to more specific emotions such as anger, depression, and fear. This relationship between affect and pain can be quite complex and dynamic as described by Gatchel and Oordt in Table 12.2.

Table 12.2 Relationships between emotion and pain

- The emotion of anxiety can trigger pain
- Emotions such as anxiety are often a consequence of pain (the term emotional distress is often used in this context)
- Pain can be exacerbated by emotions (e.g., anger may cause tension, which then can aggravate an already existing pain, such as a muscle tension headache)
- Emotions can perpetuate pain. For example, if a patient receives a great deal of secondary gain (such as more nurturance and attention from others), then he/she may begin to use pain in order to continually get these needs met
- A high degree of preexisting emotional distress can predispose individuals to be more negatively affected by pain

Finally, the motivational aspects of the *affective-motivational* component of pain perception refer to the person's willingness to perform certain behaviors/activities. Because pain is a subjective, private, and unpleasant experience, various negative emotions are usually associated with it, as well as maintaining it. Emotion frequently leads to some form of action, such as approach and avoidance (which are the simplest forms of action). Turk and Monarch (2002) have described the following most common affective factors associated with pain: anxiety-/pain-related fear, anger/frustration, and depression/learned helplessness.

As comprehensively reviewed by Gatchel, Peng, Peters, Fuchs, and Turk (2007), these above central and interactive processes are supported by an overwhelming amount of evidence. The affective component of pain incorporates many different emotions, but they are primarily negative. Depression and anxiety have received the greatest amount of attention in chronic pain patients. However, anger has also recently received considerable interest as a significant emotion in chronic pain patients. As summarized by Gatchel et al. (2007):

> In addition to affect being one of the three interconnected components of pain, pain and emotions interact in a number of ways. Emotional distress may predispose people to experience pain, be a precipitant of symptoms, be a modulating factor amplifying or inhibiting the severity of pain, be a consequence of persistent pain, or be a perpetuating factor. Moreover, these potential roles are not mutually exclusive, and any number of them may be involved in a particular circumstance interacting with cognitive appraisals. For example, the literature is replete with studies demonstrating that current mood state modulates reports of pain as well as tolerance for acute pain… Levels of anxiety have been shown to influence not only pain severity but also complications following surgery and number of days of hospitalization… Individual difference variables, such as anxiety sensitivity…have also

> been shown to play an important predisposing and augmenting role in the experience of pain…Level of depression has been observed to be closely tied to chronic pain…and to play a significant role in premature termination from pain rehabilitation programs… (p. 599).

Gatchel et al. (2007) go on to highlight the fact that emotional distress is commonly observed in people with chronic pain. Workers with this comorbid emotional distress and chronic pain often feel rejected by the medical system and their employers because they perceive that they are being labeled as "symptom magnifiers" and complainers by these individuals when their pain and disability conditions do not respond to treatment. In fact, they may go on to see multiple physicians and undergo multiple laboratory tests and imaging procedures in an effort to have their pain diagnosed and "proven to be real." However, as treatments expected to alleviate pain are proven ineffective, these workers may soon lose faith and become frustrated and irritated with the entire medical system. Moreover, as their pain and disability worsen and persists, they may become unable to work at all, as well as having other difficulties such as financial problems, difficulty performing even the basic everyday activities of daily living, sleep disturbance, or treatment-related complications. They now may become even more fearful and have inadequate or maladaptive support systems or other coping resources available to them. They often will develop a sense of hostility toward the healthcare system and its inability to eliminate their pain, as well as start to feel resentment toward their significant others or their employers who they start to perceive as not providing adequate support for them. Also, they may even become angry with themselves for allowing their pain to take over their lives. Such emotional consequences of chronic pain can result in depression, anger, anxiety, self-preoccupation, and isolation that amount to an overall sense of demoralization. Because this chronic pain and disability may persist for long periods of time, emotional states will continue to play a role as the impact of pain and disability becomes to influence all aspects of the workers' lives.

A Conceptual Model of the Transition of Acute Occupational Pain into Chronic Occupational Pain and Disability

Gatchel (1991, 1996, 2004, 2005) has proposed a conceptual model of how acute musculoskeletal pain can progress into a chronic pain situation, using a three-stage model (see Fig. 12.1). In stage 1 of this model (referred to as the *acute phase*), normal emotional reactions, such as fear, anxiety, and worry, develop subsequent to the patient's perception of pain. This is a natural emotional reaction that often serves a protective function by prompting the worker to heed the pain signal and, if necessary, seek medical attention for it. For example, if workers injure their backs lifting a heavy load, their perception of pain will motivate them to seek medical attention and care. However, if the perception of pain persists beyond a 2- to 4-month period (which is usually considered a normal healing time for most pain syndromes), the pain begins to develop into a more chronic condition, leading to stage 2 of the model. During this stage 2, psychosocial and behavioral problems are frequently exacerbated, such as learned helplessness, anger, distress, and somatization. The extent of these symptoms usually depends on the worker's preexisting personality and psychosocial structure, in addition to socioeconomic and environmental conditions. For example, depressive symptoms will be greatly exacerbated during this stage for the worker if he/she has a premorbid depressive personality and is seriously affected economically by loss or absence of a job due to the pain and disability. In a similar fashion, if the worker had premorbid hypochondriacal characteristics and then also receives a great deal of secondary gain (e.g., sympathy from others), he/she will most likely display a great deal of somatization and symptom magnification, as well as being disabled from the workplace. In essence, this conceptual model takes a *diathesis-stress* perspective, in which the *stress* of coping with pain and disability can lead to exacerbation of the worker's underlying psychosocial characteristics (*diathesis*). However, this model does

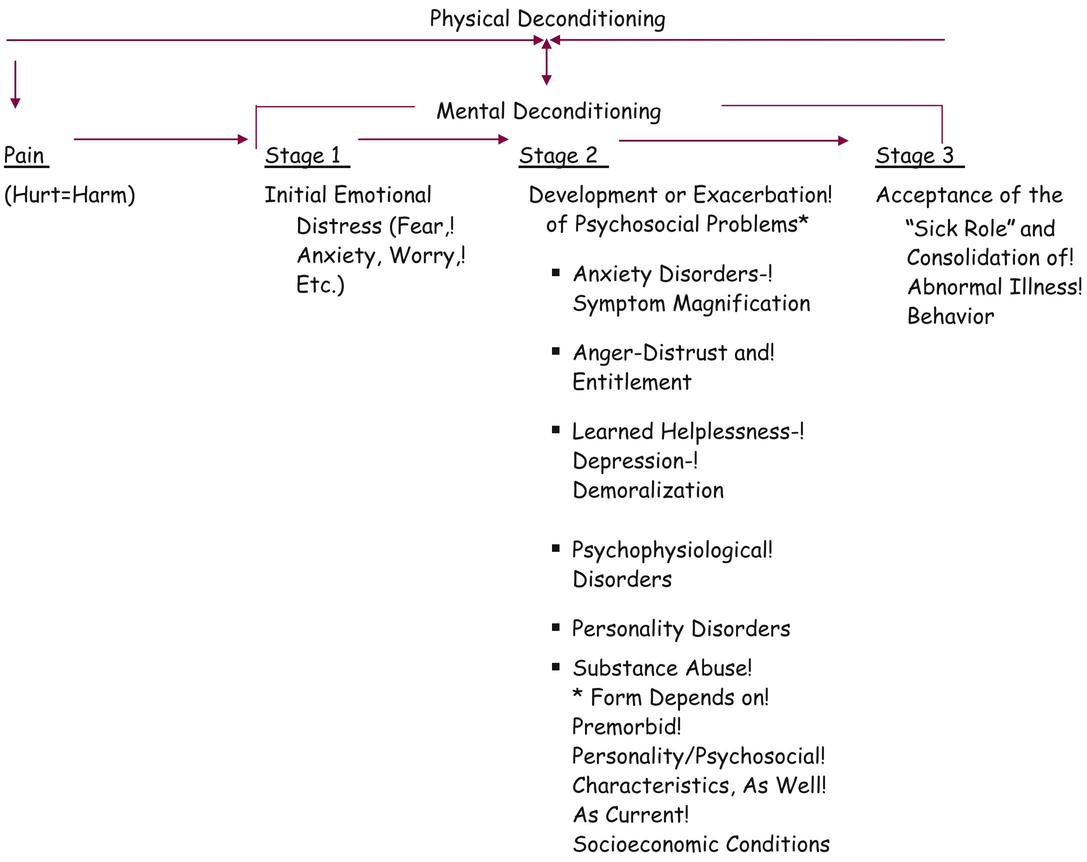

Fig. 12.1 Transition of acute occupational pain and disability to chronic occupational pain and disability (adapted from Gatchel, 2005)

not propose that there is a preexisting pain-prone personality. Rather, it proposes that patients "bring with them" certain predisposing personality and psychosocial characteristics (i.e., they have a *diathesis*) that is then exacerbated by the *stress* of attempting to cope with the now chronic nature of the pain and disability. Such a relationship between stress and the exacerbation of mental health problems has been well documented in the scientific literature (Gatchel, 2005). It should be clearly noted that this is not to say that predisposing factors make chronic pain a psychogenic disorder and that it is "all in the patient's head." Rather, the chronic pain and disability problems represent a complex interaction among physical, psychosocial, and economic variables.

In the past, this *diathesis-stress* perspective had also been applied to the development of musculoskeletal pain by other investigators (e.g., Flor & Turk, 1984; Turk & Flor, 1984). According to this perspective, chronic pain and disability disorders are a function of the interaction between a patient's premorbid biological and psychosocial predispositions (*diatheses*) and the stressors or challenges (*stress*) that occur as the result of some physical injury/impairment and possible tissue damage (Banks & Kerns, 1996). Thus, for example, patients who may have some premorbid diathesis will have a greater risk of developing pain and/or disability as a result of an occupational injury, relative to those who do not have such a diathesis (Flor & Turk, 1984; Turk & Salovey, 1984). These authors go on to give the example of low-back pain, which may occur if the patient has a diathesis or predisposition to develop hyperactive back muscles, as well as having poor coping skills and work-related stress. These underlying predispositions can be either genetic or early-learning experiences. Turk and Salovey (1984) also highlighted the fact that once stress and accompanying physiological activations stimulate these factors, then a pain cycle can begin. The pain, now acting as a new stressor, will then further increase muscle tension and tax-coping skills; this pain cycle then is further perpetuated.

Finally, the progression to more complex interactions among physical, psychological, and social processes characterizes stage 3, which represents the chronic phase of this model. As the result of the chronic nature of the pain experienced, and the stress, disability, and impairment that it may create, the patient's life now begins to revolve around the pain behaviors that maintain it. The patient may begin to adopt a "sick role," in which any excuse from social and occupational responsibilities become routine. As a result, the patient now becomes accustomed to the avoidance of responsibility and other reinforcers that maintain such maladaptive behavior, as well as his/her disability. For example, the hypothetical pain patient from above not only stops working or trying to maintain a job but he/she may also avoid other activities, such as walking in the park with a spouse or engaging in leisure-time activities like going to the movies, shopping, etc. At the same time, while receiving disability payments, he/she gets to sit at home watching the television all day, and family members and friends may run errands for him/her, thereby facilitating the disability.

In addition, superimposed on these three stages is what is referred to as the *physical deconditioning syndrome,* which was originally described in detail by Mayer and Gatchel (1988). This is a significant decrease in physical activity (such as strength, mobility, and endurance) because of the pain and disability that result from disuse and produce atrophy of the injured area. There is usually a two-way pathway between the physical deconditioning and the three stages described above. For example, physical deconditioning can feedback and negatively affect the emotional well-being and self-esteem of workers. This can lead to further negative psychosocial sequelae. Conversely, negative emotional reactions, such as depression, can feedback into physical functioning (e.g., by decreasing the motivation to get involved in work or recreational activities and thereby contributing further to physical deconditioning). Overall, this creates a vicious cycle between physical conditioning/disability and psychosocial/psychiatric issues. Of course, the important key in treating occupational pain is not let it to progress into stages 2 and 3 levels where more complex biopsychosocial interactions and problems develop. Early intervention for acute occupational pain problems is now the recommended treatment option (Gatchel, 2005).

Data Supporting the Above Conceptual Model

A great deal of clinical research data has been produced to support the above conceptual model. These studies have documented elevated rates of psychopathology in various types of chronic pain conditions, higher rates of psychopathology in chronic versus acute pain patients, and decreased rates of psychopathology after successful treatment of chronic pain conditions (Gatchel & Dersh, 2002). For example, Polatin, Kinney, Gatchel, Lillo, and Mayer (1993) documented high rates of psychopathology in chronic occupational low-back pain patients, relative to the general population. These results were consistent with previous clinical research conducted mostly on occupational chronic low-back pain patients who were shown to demonstrate an increased prevalence of depressive disorders, anxiety disorders, substance use disorders, "somatization," and personality disorders in this population. For example, rates of major depressive disorder ranged from 34 to 57 % in these studies, compared to rates of 5–26 % in the general population. The research has also documented higher rates of psychopathology in other types of chronic pain conditions, including fibromyalgia syndrome.

Also of relevance are studies evaluating the prevalence of psychiatric disorders and acute versus chronic pain patients. For example, Kinney, Gatchel, Polatin, and Fogarty (1993) evaluated this issue in acute versus chronic occupational low-back pain patients. They found much higher rates of psychopathology in the chronic low-back pain group. In particular, the chronic low-back pain patients had higher rates of major depressive disorders, substance abuse disorders, and personality disorders, relative to the acute low-back pain patients. In striking contrast, the acute patients were diagnosed with more anxiety disorders. Thus, the higher rates of psychiatric disorders are not totally related to the onset of acute pain per se, but are rather linked to the development of chronicity. Such results lend great support to Gatchel's three-stage model of progression from acute pain to chronic pain and disability, in which anxiety is considered to be a common reaction to acute pain, with more disabling and varied psychopathology associated with chronic pain. Finally, a series of studies by Gatchel and colleagues (Owen-Salters, Gatchel, Polatin, & Mayer, 1996; Vittengl, Clark, Owen-Salters, & Gatchel, 1999) reported that elevated rates of psychopathology significantly decreased following successful rehabilitation of occupational chronic low-back pain patients. In the Owen-Salters et al. (1996) study, occupational low-back pain patients were evaluated for current psychiatric disorders on admission to a comprehensive occupational rehabilitation program and then again at 6 months following completion of the program. The results revealed significant decreases in the prevalence of psychiatric disorders, particularly somatoform pain disorders and major depressive disorders. In a similar study, Vittengl et al. (1999) found significant decreases in the prevalence of personality disorders 6 months after completion of the treatment program in a sample of occupational chronic low-back pain patients. Thus, these two studies demonstrate that effective rehabilitation can significantly decrease the high rate of psychiatric comorbid disorders found in occupational chronic low-back pain patients.

The Psychosocial Disability Factor

Finally, results of a study by Gatchel, Polatin, and Mayer (1995) identified the presence of a robust "psychosocial disability factor" that was found to be associated with those occupationally injured workers who would likely develop chronic low-back pain disability problems. In that study, a comprehensive biopsychosocial assessment was conducted on acute occupational low-back pain patients who subsequently developed chronic pain disability problems (as measured by job-work status at 1-year post-evaluation). Those who developed chronic pain and disability at 1 year were compared to those who did not develop such problems at this 1-year post-injury time period. Analyses conducted to differentiate between these two groups of patients revealed the importance of two psychosocial measures: level of self-reported pain and disability and scores on scale 3 (hysteria) of the MMPI. Moreover, two other variables were found to be significant: gender of the patient and active workers' compensation/personal injury cases at the 1-year post-injury time period. The statistical model generated correctly identified 90.7 % of the cases in the two groups. It was of interest that there were not differences between these two groups when the physician-rated severity of the initial back injury, or the physical demands of the job to which patients had to return to, were taken into account. Thus, again there were strong psychosocial components related to occupational low-back pain injuries when they became chronic in nature.

It should also be pointed out that the lack of any physical factors that were predictive of chronic low-back pain development was not surprising. For example, early research has revealed that physical findings (such as radiographic results) have not been found to be reliable indices of low-back pain (Mayer & Gatchel, 1988). Moreover, most cases of low-back pain are classified as "soft-tissue injuries" because they are ill defined and unverified on physical examination. In fact, the presence of pathology has been found in the absence of pain. A study of magnetic resonance imaging by Jensen et al. (1994) found significant spinal abnormalities in patients who were *not* experiencing low-back pain, and similar results have been found in other chronic pain conditions (Gatchel & Epker, 1999).

The Comorbidity of Chronic Physical and Mental Health Disorders: The "Chicken-or-Egg" Question

There can be no doubt that as the vicious pain cycle (based on the earlier reviewed *diathesis-stress* model) becomes more chronic in nature, psychosocial/psychiatric variables begin to play an increasingly dominant role on the maintenance of pain and disability behavior and suffering (Gatchel, 2005). A major issue raised in the past has been the "chicken-or-egg" question: are the psychosocial/psychiatric problems secondary to the chronic pain, or are these problems the primary syndromes of which chronic pain is merely a symptom? In one of the first studies to evaluate this "chicken-or-egg" question, Polatin et al. (1993) evaluated 200 chronic occupational low-back pain patients for current and lifetime psychiatric syndromes (using a formal structured interview method for determining official Diagnostic and Statistical Manual Disorders) diagnoses. Their diagnostic results revealed that even when the controversial category of somatic pain disorder was excluded, 77 % of patients met lifetime diagnostic criteria, and 59 % had current symptoms for at least one psychiatric diagnosis. The most common psychiatric diagnoses were major depression, substance abuse, and anxiety disorders. Moreover, 51 % met criteria for at least one personality disorder. All of these prevalence rates were significantly greater than the base rates in the general population. Moreover, one of the most important findings of this study was that of those patients with a positive lifetime history for psychiatric syndromes, 54 % of those with depression, 94 % of those with substance abuse, and 95 % of those with anxiety disorders had experienced these syndromes *before* the onset of their chronic low-back pain. These were the first systematic results to objectively document that certain psychiatric syndromes appear to precede chronic low-back pain (substance abuse and anxiety disorders), whereas others (specifically, major depression) can develop either before *or* after the onset of chronic low-back pain.

Subsequently, in a more large-scale study that assessed all types of chronic disabling occupational spinal disorders (and not only chronic low back), Dersh, Mayer, Theodore, Polatin, and Gatchel (2007) evaluated 1,323 patients in order to further clarify the temporal relationship between psychiatric disorders and occupationally related injury claims. Results of this investigation revealed that 38.7 % of this patient cohort had at least one *preexisting* major psychiatric disorder. Moreover, 98.9 % had developed one or more psychiatric disorders for the first time *after* the onset of the injury (57.9 % when the pain disorder diagnosis was excluded). Again, the percentage of patients with a preexisting psychiatric disorder was higher than general population base rates (48 %). Of great interest for the present discussion was that the *first onset* of certain psychiatric disorders was found to be elevated in those patients *after* the work-related injury, including pain disorders (95.7 %), major depressive disorders (49.7 %), and opioid dependence (15 %). Relatedly, *five times* as many patients with major depressive disorder and *ten times* as many with opioid dependence developed these disorders for the first time *after* the occupational injury.

These above findings indicate that the answer to the "chicken-or-egg" question (of what comes first, the chronic occupational pain disability or the psychopathology?) is not as straightforward as one would assume. As revealed in the Dersh et al. (2007) study, although more than one-third (38.7 %) of the chronic occupational pain disability patients had at least one preexisting psychiatric diagnoses, the prevalence of such diagnoses was actually dramatically higher (relative to the general population) only *after* these patients developed a chronic spinal injury and resultant disability. Indeed, 98.99 % had at least one *post-injury* diagnosis (57.9 % when pain disorder was excluded). One can therefore argue that, because the prevalence of these psychiatric disorders was much greater *after* the injury, then it may be due to the fact that the stress associated with the occupational injury is a vital factor in better understanding the high rates of such psychiatric disorders. However, it should also be noted that these findings do not necessarily suggest that the stress associated with the chronic occupational pain and disability, by itself, is totally sufficient to explain the elevated psychiatric prevalence rates. Rather, preexisting *diatheses* (such as those highlighted earlier in this chapter when discussing the *diathesis-stress model* of pain and disability) can also play significant roles in the complexity of chronic occupational pain and disability disorders.

Finally, one additional intriguing result of the Dersh et al. (2007) study was that the only *preexisting* psychiatric diagnosis that was more prevalent for the occupational pain and disability patients, relative to the general population, was drug dependence (i.e., all substances except alcohol). Such findings suggest that this particular type of psychiatric disorder may be a unique risk factor for the development of chronic occupational spinal pain and disability. Moreover, it is more difficult to treat such patients when they become chronic (Kidner, Mayer, & Gatchel, 2009). It would, therefore, follow that it may be wise to screen for possible opioid use, as well as carefully monitoring its use, during the acute phase of an occupational injury in order to prevent the further progression into chronicity and resultant drug dependence.

Overall, then, the fact that no other preexisting psychiatric disorder (other than opioid dependence) is more prevalent in chronic occupational pain and disability patients suggests that psychopathology, in general, is not a risk factor in itself for the development of chronicity. Thus, along with other clinical research (Gatchel, 2005), there is no strong evidence to support the outdated notion of a “pain-prone” patient profile based upon some preexisting psychopathology or personality disorder. Rather, most occupational pain and disability patients have psychiatric disorders, and most of these disorders develop *after* the inciting occupational-related injury. The important implications of such findings are that occupational health-care providers need to focus more attention during the acute phase of injury to allay any potential emotional distress caused by the injury, in order to prevent the subsequent development of chronicity. An increased focus on early assessment and treatment at the acute phase will likely result in decreased chronic physical and mental health problems. Indeed, in a series of studies by Gatchel and colleagues of musculoskeletal disorders, it was found that early intervention dramatically decreased the development of chronicity, as well as the increased costs of treating such chronicity (Gatchel et al., 2003; Gatchel, Stowell, Wildenstein, Riggs, & Ellis, 2006; Rogerson, Gatchel, & Bierner, 2010; Stowell, Gatchel, & Wildenstein, 2007; Whitfill et al., 2010).

Treatment Approaches to Chronic Comorbid Musculoskeletal and Mental Health Disorders: Functional Restoration as an Example

In Chap. 1 of this handbook, strong evidence for the treatment- and cost-effectiveness of comprehensive interdisciplinary treatment programs (such as functional restoration) for chronic occupational musculoskeletal pain and disability disorders was presented. The major therapeutic elements of such functional restoration programs include the following:

- An interdisciplinary treatment team consisting of a physician, nurse, psychologist or psychiatrist, physical therapist, and occupational therapist. This medically directed team approach involves formal staffing of patients, frequent team conferences, and a low staff-to-patient ratio.
- Formal, repeated quantification of physical injury-related deficits (such as range of motion, strength, endurance, etc.) for use in individualizing and monitoring progress toward occupational rehabilitation and eventual return to work.
- A multimodal occupational pain and disability management program, using cognitive-behavioral approaches (such as biofeedback, stress management, and positive coping skills) to help in the rehabilitation process.
- Medication interventions, whenever needed, for detoxification and use in psychosocial/psychiatric treatment.
- Ongoing assessments of important socioeconomic variables for monitoring occupational rehabilitation outcomes (such as return to work, work retention, any injury recurrence, surgery, etc.).

Again, this above interdisciplinary approach has been proven to be the most treatment- and cost-effective method for rehabilitating chronic occupational pain and disability patients (e.g., Gatchel, 2005; Gatchel & Okifuji, 2006; Mayer & Polatin, 2000). Health-care professionals now, fortunately, have in their treatment armamentarium the ability to effectively manage these often recalcitrant chronic pain and disability syndromes. Such a comprehensive treatment approach is required because of the significant physical deconditioning and psychiatric sequelae that need to be addressed when an occupational injury becomes chronic (as discussed earlier in this chapter). In terms of the health-care professionals involved in this treatment team, Gatchel (2005) has reviewed the important requirements for each team member. The *physician* serves as a medical director of the pain/disability management plan, and he or she must have a firm background in providing medical rehabilitation for the types of occupational injuries frequently encountered. Formal training may vary from anesthesiology, orthopedic surgery, psychiatry to occupational medicine, and even internal medicine. The physician is required to assume a direct role in the medical management of the patient's pain and disability by providing the medical history to the treatment team and by taking direct responsibility for any medication management needed, as well as for any other medical interventions required. Often, other team members and outside consultants may be involved in the medical treatment of the patient, but it is the physician's responsibility to coordinate these medical contributions to the patient's care. It should also be noted that, although not all programs use nursing services, any pain management program that provides anesthesiology services (involving injections, nerve blocks, and other medical procedures) will require a *nurse*. The nurse assists the physician; follows up any of the procedures, and may also interact with patients in the role of case manager; and provides patient education. The nurse may be viewed as a "physician extender" and educator.

Although the physician-nurse team plays a major role in managing the physical status of patients, the *psychologist* or *psychiatrist* plays the leading role in the day-to-day maintenance of the psychosocial aspects and status of the patient's care. Indeed, significant psychosocial barriers to positive outcomes of the treatment may develop as a patient progresses from acute through subacute to the chronic stage of a pain and disability syndrome (as reviewed earlier in this chapter). The psychologist/psychiatrist is responsible for performing a full psychosocial evaluation, which includes identification of psychosocial barriers to recovery and the assessment of the patient's psychosocial strengths and weaknesses, including preexisting psychopathology and diathesis risk factors. Indeed, a cognitive-behavioral treatment approach can then be used to address important psychosocial issues, such as pain-related depression, anxiety, fear, as well as psychopathology. A cognitive-behavioral treatment approach has been found to be the most appropriate modality to use with patients in a program such as this (Gatchel, 2005). The *physical therapist* also interacts daily with the patient regarding any issues associated with physical progression toward recovery. Effective communication with other team members is crucial so that the patient's fear of exercise will not interfere with his or her reconditioning efforts in helping them to get ready to return to work. The physical therapist also aids in educating the patient by addressing the physiological bases of pain and disability, as well as teaching ways of reducing the severity of such episodes through the use of appropriate body mechanics and pacing. Finally, whenever possible, an *occupational therapist* can become involved in both physical and vocational aspects of the patient's treatment. The great majority of patients participating in an interdisciplinary program are likely to not be currently working because of their pain and disability. Quite frequently, they may have become pessimistic about the prospect of returning to work. The occupational therapist will be important in addressing these vocational issues and the physical determinants of the underlying disability. This therapist also plays a significant educational role in teaching patients techniques for managing pain and disability on the job in ways that do not jeopardize their employment status. Moreover, he/she can play an important role as a case manager in contacting employers in order to obtain job descriptions and other information, as well as vocational retraining if needed.

In order for an interdisciplinary treatment program to be effective, it is *essential* that there is constant and successful communication among all treatment personnel, during which patient progress can be openly discussed and evaluated. This is important so that patients hear the *same treatment philosophy and message* from each of the treatment team members. Indeed, many times, patients are in conflict about their own future treatment and may seek out any conflict among team members and use it to compromise treatment goals (these attempts are often called *splitting* of treatment team members). For example, a patient may want a "quick fix" and views surgery as a better treatment option than active rehabilitation. Such a patient may then attempt to "play team member off of one another," in order to get them frustrated enough so that they start to perceive him/her as noncompliant and, thus, not a good candidate for rehabilitation. The patient is then discharged from the program and is allowed to seek alternative care, in this case surgery. In order to avoid this, a formal interdisciplinary treatment team meeting should occur at least once a week to review patient progress and to make any modifications in the treatment plan for each patient. Individually tailoring treatment for patients is essential. Also, evaluating and monitoring treatment outcomes in a systematic fashion is essential, not only for treatment outcome evaluations, but also for quality assurance purposes for the treatment team. Therefore, functional restoration is a prime model for treating disability associated with not only chronic musculoskeletal pain but also its concomitant psychosocial sequelae.

Summary and Conclusions

The manifestation and treatment of chronic pain and psychosocial comorbidity are multifaceted, biopsychosocial phenomenon. Gatchel et al. (2012) have again reviewed the clinical research evidence that has clearly demonstrated that the most successful treatment model for comorbid pain and medical health disorders is an interdisciplinary treatment program, based on the *biopsychosocial model* of pain and disability. This model takes into account physical and mental health and social issues in successfully managing the pain and disability in chronically injured patients. There is a great deal of evidence demonstrating the effectiveness of this type of program for various types of musculoskeletal pain and disability disorders, widespread pain, fibromyalgia, temporomandibular disorders, and headaches. The most recognized and successful type of interdisciplinary pain program is *functional restoration*, which was originally developed for chronically disabled occupational spinal patients (Mayer & Gatchel, 1988). This functional restoration program is implemented by an interdisciplinary team of health-care professionals operating together to achieve a unified treatment plan that can be individualized to meet specific patient needs. This interdisciplinary team is led by a supervising physician, who coordinates patient care with an emphasis on return to functioning. In the present chapter, we have delineated the specific important components of such an interdisciplinary pain management program (such as functional restoration) which has, as its main goal, the return of the injured worker to work and productivity. This heuristic biopsychosocial model of pain and disability, which stimulated the development of functional restoration, was the result of decades' worth of clinical research examining the complex elements and their interactions that result in chronic pain and disability. Much of this early work was initially stimulated by the *gate control theory of pain* initially introduced by Melzack and Wall (1965). With this hallmark research, the scientific community began to accept the potential importance of central, psychosocial factors in the pain perception process. This, in turn, then stimulated a great deal of clinical research attempting to isolate the psychosocial characteristics associated with chronic pain patients. Although this early work focus on trying to differentiate "functional" pain from "organic" pain, using the MMPI, Sternbach (1974) was the first to challenge the validity and utility of the overly simplistic attempt to make a functional-organic dichotomy when trying to better understand chronic pain. Today, with the broad acceptance of the biopsychosocial model of pain, chronic pain is perceived as a complex phenomenon, which includes physical, psychological, and social elements that interact in ultimately determining the degree of chronic pain experienced by patients. This biopsychosocial model has moved away from the early and overly simplistic biomedical disease model of pain, in its attempt to differentiate "functional" from "organic" pain, and has replaced it with an alternative multidimensional perspective. In this new perspective, psychosocial factors are viewed as being intricately related to the pain perception process. Thus, as pain becomes more chronic in nature, psychosocial variables play an increasingly dominant role in the maintenance of pain behaviors and suffering (e.g., Turk & Monarch, 2002). Indeed, it has been shown that one of the major consequences of attempting to deal with chronic pain and disability is the development of emotional reactions (such as anxiety, anger, and depression) that can produce a "wearing down" effect and "drain" on psychosocial resources as the pain becomes more chronic in nature. With this perspective in mind, it is now generally accepted that chronic occupational low-back pain is a complex behavior that does not merely result from some specific structural cause. Rather, it has been demonstrated that patients with chronic pain also manifest comorbid psychiatric disorders, the most common of which are depression, anxiety disorders, and substance abuse disorders. It has also been found that, when the chronic pain is effectively treated, many of these problematic psychiatric/psychosocial symptoms are alleviated (Gatchel, 2005).

Throughout this chapter, pain was viewed as ultimately a subjective, private experience, but one which is invariably described in terms of sensory and affective properties. In fact, one of the most widely accepted definitions of pain (introduced by the *International Association for the Study of Pain*) emphasized that "even though pain is unquestionably a sensation in a part or different parts of the body, it is ultimately always unpleasant and, therefore, should also be viewed as an *emotional experience*" (Merskey, 1986). This helps to better understand the fact that there are many individual differences in how people respond in the face of a painful nociception/injury, as well as differences in methods used to interpret the painful stimuli. As we reviewed, this makes the experience of pain dependent on cognitive-evaluative processes, as well as on affective-motivational processes (Gatchel & Oordt, 2003; Turk & Monarch, 2002). These central interactive processes have been overwhelmingly supported by a great deal of clinical evidence (Gatchel et al., 2007). Indeed, Gatchel et al. (2007) go on to highlight the fact that emotional distress is commonly observed in people with chronic pain. Workers with this comorbid emotional distress, in combination with their chronic pain and disability, often feel rejected by the medical system and their employers because they perceive that they are being labeled as "symptom magnifiers" and complainers by these individuals when their pain and disability conditions do not respond to treatment. This helps to better understand why many of them go on to seek multiple physicians and undergo multiple laboratory tests and imaging procedures in an effort to have their pain and disability diagnosed and "proven to be real." Unfortunately, as treatments that are expected to alleviate their pain and disability are proven ineffective, these workers may soon lose faith in the medical system and become frustrated and irritated with the entire medical system. As their chronic pain and disability worsen and persist, their lives start to "spin out of control" because they are unable to return to work at all, as well as having other difficulties such as financial problems, difficulty performing even the very basic everyday activities of daily living, sleep disturbance, treatment-related complications, etc. It is not surprising, then, when these injured workers start to develop a sense of hostility toward a health-care system, as well as toward the workplace at which the injury first occurred.

Gatchel (1991, 1996, 2004, 2005), in an attempt to conceptualize how acute musculoskeletal pain can progress into a more chronic pain and disability situation, proposed a three-stage model to capture this transition process. The important feature of this model was the emphasis that during the acute phase of an injury, normal emotional reactions (such as fear, anxiety, and worry) naturally occur as a result of the patient's perception of pain. It is at this point in time that an early and well-thought-out intervention is most needed in order to relieve any of the emotional distress caused by it and to prevent that emotional distress to worsen over time. However, if this is not accomplished early, and the perception of pain persists beyond a 2- to 4-month period (which is usually considered a normal healing time for most pain syndromes), then the pain may begin to develop into a more chronic condition, leading into stage 2 of the model. During this second stage, more pronounced psychosocial and behavioral problems may be exacerbated (such as anger, helplessness, somatization, and distress) that now adds more stress becoming associated with the lingering injury. Also, it is at this stage that the worker may become affected economically by loss or absence of a job due to the now growing chronic nature of the pain and disability. It is at this point that a *diathesis-stress* process may develop, in which the *stress* of coping with the pain and disability can lead to the exacerbation of the worker's underlying psychosocial characteristics (*diathesis*). Finally, if the pain and disability are not adequately managed, the patient will progress into stage 3, where there are now much more complex interactions among physical, psychological, and social processes, combined with socioeconomic causes. As a result of the chronic nature of the pain experienced, and the stress, disability, and impairment that it creates becomes greater, a patient's life begins to revolve around pain behaviors that maintain it. It is at this chronic stage that more comprehensive treatment programs (such as functional restoration) must be employed in order to effectively deal with the complex biopsychosocial factors that are involved in the chronic pain and disability syndrome. Such a comprehensive treatment approach needs to be used because superimposed on the three stages described is what is referred to as the physical deconditioning syndrome, which is the result of a significant decrease in physical activity (such as strength, mobility, and endurance) that results from disuse and results in atrophy of the injured area. Any comprehensive program will now have to deal with not only the psychiatric/psychosocial sequelae of the injury but also the comorbid physical deconditioning (i.e., decrease in physical activity, such as strength, mobility, and endurance) because of the pain and disability. This results from disuse and produces atrophy of the original injured area. With this transitional model in mind, the important "take-home" message is that occupational pain and disability need to be treated early in order to prevent it from progressing into stages 2 and 3, where there are now much more complex biopsychosocial interactions and problems that have developed. Indeed, early intervention for acute occupational pain problems is now the recommended treatment option (Gatchel, 2005). A great deal of scientific support has been developed for this transitional model, as well as for the great need of early intervention to produce the transition into chronic pain disability.

Finally, as we have discussed in this chapter, once pain and disability become chronic in nature, significant comorbid psychiatric disorders will occur. This has led to the long-lasting "chicken-or-egg" question: Are the psychosocial/psychiatric problems being experienced by these patients due to the chronic pain, or are these problems the primary syndromes of which chronic pain and disability are merely symptoms? This question often "rears its ugly head" when insurance companies and third-party payers do not want to pay for the necessary psychiatric treatment that now accompany the original injury. It is argued that these workers must have had some psychiatric problem or "pain-prone personalities" which led them to become injured in the first place. They go on to argue that the medical costs of the original injury will be paid for, but not the psychosocial/psychiatric sequelae which they do not believe is "part and parcel" of the original injury. However, there can be no doubt that the psychiatric sequelae of the original injury is part of the now chronic biopsychosocial syndrome being presented by the worker. It is now clear that many of the psychiatric disorders displayed by chronic occupational pain and disability patients can occur either before or after the injury takes place.

In fact, it was found by Dersh et al. (2007) that the first onset of certain psychiatric disorders was found to be elevated in those patients *after* the work-related injury. Thus, even though third-party payers and insurance companies do not want to "open up a can of worms" in having to pay for the cost of managing the current psychiatric disorders displayed by chronic pain and disability patients, there is no doubt that they *cannot* unequivocally argue that these psychiatric disorders must have occurred before the injury. In fact, such psychiatric disorders can be effectively managed during the successful treatment of chronic occupational pain and disability disorders (Gatchel, Polatin, Mayer, & Garcy, 1994).

References

Banks, S. M., & Kerns, R. D. (1996). Explaining the high rates of depression in chronic pain: A diathesis-stress framework. *Psychological Bulletin, 119*(1), 95–110.

Buist-Bouwman, M. A., de Graaf, R., Vollebergh, W. A., & Ormel, J. (2005). Comorbidity of physical and mental disorders and the effect on work-loss days. *Acta Psychiatrica Scandinavica, 111*(6), 436–443.

Dersh, J., Mayer, T. G., Theodore, B., Polatin, P., & Gatchel, R. J. (2007). Do psychiatric disorders first appear preinjury or postinjury in chronic disabling occupational spinal disorders? [Miscellaneous]. *Spine, 32*(9), 1045–1051.

Dewa, C. S., Corbière, M., Durand, M., & Hensel, J. (2013). Challenges related to mental health in the workplace. In R. J. Gatchel & I. Z. Schultz (Eds.), *Handbook of occupational health and wellness*. New York: Springer.

Flor, H., & Turk, D. C. (1984). Etiological theories and treatments for chronic back pain: I. Somatic models and interventions. *Pain, 19*, 105–121.

Franche, R. L., Carnide, N., Hogg-Johnson, S., Cote, P., Breslin, F. C., Bultmann, U., et al. (2009). Course, diagnosis, and treatment of depressive symptomatology in workers following a workplace injury: A prospective cohort study. *Canadian Journal of Psychiatry, 54*(8), 534–546.

Gatchel, R. J. (1991). Psychosocial assessment and disability management in the rehabilitation of painful spinal disorders. In T. Mayer, V. Mooney, & R. Gatchel (Eds.), *Contemporary conservative care for painful spinal disorders*. Philadelphia: Lea & Febiger.

Gatchel, R. J. (1996). Psychological disorders and chronic pain: Cause and effect relationships. In R. J. Gatchel & D. C. Turk (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (pp. 33–52). New York: Guilford.

Gatchel, R. J. (2004). Comorbidity of chronic mental and physical health disorders: The biopsychosocial perspective. *American Psychologist, 59*, 792–805.

Gatchel, R. J. (2005). *Clinical essentials of pain management*. Washington, DC: American Psychological Association.

Gatchel, R. J., & Dersh, J. (2002). Psychological disorders and chronic pain: Are there cause and effect relationships? In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed.). New York: Guilford.

Gatchel, R. J., & Epker, J. T. (1999). Psychosocial predictors of chronic pain and response to treatment. In R. J. Gatchel & D. C. Turk (Eds.), *Psychosocial factors in pain: Critical perspectives* (pp. 412–434). New York: Guilford Publications, Inc.

Gatchel, R. J., & Okifuji, A. (2006). Evidence-based scientific data documenting the treatment and cost-effectiveness of comprehensive pain programs for chronic nonmalignant pain. [Journal Peer Reviewed Journal]. *The Journal of Pain, 7*(11), 779–793. doi:http://dx.doi.org/10.1016/j.jpain.2006.08.005.

Gatchel, R. J., & Oordt, M. S. (2003). *Clinical health psychology and primary care: Practical advice and clinical guidance for successful collaboration*. Washington, DC: American Psychological Association.

Gatchel, R. J., Peng, Y., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin, 133*, 581–624.

Gatchel, R. J., Polatin, P., & Mayer, T. (1995). The dominant role of psychosocial risk factors in the development of chronic low back pain disability. *Spine, 20*(24), 2702–2709.

Gatchel, R. J., Polatin, P. B., Mayer, T. G., & Garcy, P. D. (1994). Psychopathology and the rehabilitation of patients with chronic low back pain disability. *Archives of Physical Medicine and Rehabilitation, 75*, 666–670.

Gatchel, R. J., Polatin, P. B., Noe, C., Gardea, M., Pulliam, C., & Thompson, J. (2003). Treatment- and cost-effectiveness of early intervention for acute low-back pain patients: A one-year prospective study. *Journal of Occupational Rehabilitation, 13*(1), 1–9.

Gatchel, R. J., Stowell, A. W., Wildenstein, L., Riggs, R., & Ellis, E. (2006). Efficacy of an early intervention for patients with acute TMD-related pain: A one-year outcome study. *Journal of the American Dental Association, 137*, 339–347.

Gatchel, R. J., Worzer, W. E., Brede, E., Choi, Y., Asih, S., & Hartzell, M. (2012). The comorbidity of chronic pain and mental health disorders: How to manage both. *Practical Pain Management, Part 3, 12*, 60–80.

Jensen, M. C., Brant-Zawadzki, M. N., Obuchowski, N., Modic, M. T., Malkasian, D., & Ross, J. S. (1994). Magnetic resonance imaging of the lumbar spine in people without back pain. *The New England Journal of Medicine, 331*, 69–73.

Kidner, C. L., Mayer, T. G., & Gatchel, R. J. (2009). Higher opioid doses predict poorer functional outcome in chronic disabling occupational musculoskeletal disorders. *Journal of Bone and Joint Surgery America, 91*, 919–927.

Kinney, R. K., Gatchel, R. J., Polatin, P. B., & Fogarty, W. (1993). Prevalence of psychopathology in acute and chronic low back pain patients. [Journal Peer Reviewed Journal]. *Journal of Occupational Rehabilitation, 3*(2), 95–103. doi:http://dx.doi.org/10.1007/BF01078162.

Mayer, T. G., & Gatchel, R. J. (1988). *Functional restoration for spinal disorders: The sports medicine approach*. Philadelphia: Lea & Febiger.

Mayer, T. G., & Polatin, P. B. (2000). Tertiary nonoperative interdisciplinary programs: The functional restoration variant of the outpatient chronic pain management program. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders: Function, outcomes & evidence* (pp. 639–649). Philadelphia: Lippincott, Williams & Wilkins.

Melzack, R., & Casey, K. L. (1968). Sensory, motivational, and central control determinants of pain: A new conceptual model. In D. Kenshalo (Ed.), *The skin senses* (pp. 423–443). Springfield: Thomas.

Melzack, R., & Wall, P. D. (1965). Pain mechanisms: A new theory. *Science, 50*, 971–979.

Merskey, H. (1986). International association for the study of pain: Classification of chronic pain. Description of chronic pain syndromes and definitions of pain terms. *Pain, 3*(Suppl), 1–226.

Owen-Salters, E., Gatchel, R. J., Polatin, P. B., & Mayer, T. G. (1996). Changes in psychopathology following functional restoration of chronic low back pain patients: A prospective study. *Journal of Occupational Rehabilitation, 6*, 215–223.

Polatin, P. B., Kinney, R., Gatchel, R. J., Lillo, E., & Mayer, T. G. (1993). Psychiatric illness and chronic low back pain: The mind and the spine-which goes first? *Spine, 18*, 66–71.

Rogerson, M. D., Gatchel, R. J., & Bierner, S. M. (2010). Cost utility analysis of interdisciplinary early intervention versus treatment as usual for high risk acute low back pain patients. *Pain Practice, 10*, 382–395.

Sternbach, R. A. (1974). *Pain patients: Traits and treatment*. New York, NY: Academic Press.

Stowell, A. W., Gatchel, R. J., & Wildenstein, L. (2007). Cost analysis of temporomandibular disorders: Biopsychosocial intervention versus treatment as usual. *Journal of the American Dental Association, 138*, 202–208.

Turk, D. C., & Flor, H. (1984). Etiological theories and treatment for chronic back pain. II. Psychological models and interventions. *Pain, 19*, 209–233.

Turk, D. C., & Monarch, E. S. (2002). Biopsychosocial perspective on chronic pain. In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed.). New York: Guilford.

Turk, D., & Salovey, P. (1984). Chronic pain as a variant of depressive disease: A critical reappraisal. *Journal of Nervous and Mental Disease, 172*, 398–404.

Vittengl, J. R., Clark, L. A., Owen-Salters, E., & Gatchel, R. J. (1999). Diagnostic change and personality stability following functional restoration treatment in chronic low back pain patients. *Assessment, 6*(1), 79–92.

Whitfill, T., Haggard, R., Bierner, S. M., Pransky, G., Hassett, R. G., & Gatchel, R. J. (2010). Early intervention options for acute low back pain patients: A randomized clinical trial with one-year follow-up outcomes. *Journal of Occupation Rehabilitation, 20*, 256–263.

13

Pre-employment and Preplacement Screening for Workers to Prevent Occupational Musculoskeletal Disorders

Matthew T. Knauf, Sali R. Asih, and Glenn Pransky

Overview

As will be discussed in this chapter, functional capacity evaluations (FCEs) are often relied upon by employers, physicians, insurance agencies, and benefits adjudicators to determine an individual's musculoskeletal capacity to do physical labor, many times with legal and/or occupational consequences. We will also review a number of issues related to FCEs. For example, even though FCEs have been widely used for several decades, scientific, legal, and practical skill concerns remain. Because FCEs are based on a theoretical model of comparing physical job demands to worker capabilities, valid FCE results tend to be optimal when jobs are well defined and present constant, rather than varying, physical demands; work simulation is practical and valid; and serial examinations are employed. Validity of results is questionable when the FCE criteria are unrelated to the job-specific activities or actual job requirements and flexibility are poorly represented. We will also point out that, to date, the evidence concerning the practical reliability of FCE results is limited. Moreover, the evaluation of sincerity of effort, ability to perform complex or variable jobs, and prediction of injury based upon FCE data can also be problematic. Finally, it will be concluded that more research is needed in order to better define the appropriate role for these evaluations in clinical and administrative settings, especially studies linking FCE results to occupational outcomes.

At the outset, it should be noted that FCEs have existed in some form for approximately 40 years (Harten, 1998), and they are typically used in a number of ways to provide definitive information to the clinician, employer, insurer, and/or benefit adjudicator. Currently, there are many different versions of FCEs used in various rehabilitation and clinical settings, each having a separate but specific testing protocol. The results from these evaluations are commonly used to make informed decisions regarding future rehabilitation efforts, compensability determinations, disability determinations, and cash benefits (Wind, Gouttebarge, Kuijer, Sluiter, & Frings-Dresen, 2009). In addition, FCEs are used in conjunction with other factors in determining return-to-work status (Branton et al., 2010). This may be in part due to increasing amounts of evidence that not only physical but also psychosocial factors influence both FCE results and actual ability to return to work (Oesch et al., 2012). However, despite the widespread application of FCEs, there are a

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number of scientific, practical, and legal concerns regarding the administration and use of FCEs.

Current Scope and Use of FCEs

FCEs offer providers information regarding the physical work ability of an individual. They are also often intended to determine whether the individual in question will able to meet the physical demands of a job (Harten, 1998). FCEs include a wide range of activities, ranging from simple standardized tasks to more complex job-specific tasks (Simpson & Richlin, 2003). Simple or general FCEs include an individual performing more standardized tests using measured weights and distances while being observed by a trained specialist, and these tests may involve both upper- and lower-extremity activities. The simple or general FCEs may be used when an individual does not have a specific job to which to return (Harten, 1998). In the more complex FCEs, individuals may be asked to perform specific tasks using machines that measure peak force, velocity, and range of motion in several planes, including isometric and isokinetic techniques to measure arm/hand, back, and lower-extremity functions. In addition, the more complex FCEs may require an individual to exert a maximal effort. For a variety of legal and practical reasons, more FCEs are now job specific, simulating specific activities that are performed at a particular job. This may be partly due to the *American with Disabilities Act* (ADA), which requires valid testing to be job specific, focusing on comparing capacity to actual job demands (Hoffman & Pransky, 1998), as well as recognition that the "generic" tasks are not very predictive of the ability to return to work.

Early on, FCEs were used in the preplacement setting to identify individuals at an increase of injury in physically demanding jobs. Previous medical approaches (e.g., X-rays or lumbar range of motion) failed to provide useful information about the risk for future work injury (Bigos et al., 1992). Chaffin, Herrin, and Keyserling (1978) used an isometric FCE testing protocol based on biomechanical similarity to strenuous job tasks, in order to demonstrate that hired individuals who had marginal strength, relative to job demands, were three times more likely to have a back injury at work, in comparison to those who had the highest relative strength compared to job demands. This led to a proliferation of isometric testing devices and development of machines used to evaluate dynamic strength during movement for use in preplacement screening evaluations. Similar results were demonstrated by Harbin and Olson (2005). A derivation from this was the periodic use of FCEs to certify continued ability to perform infrequent but physically demanding tasks (e.g., fire fighting).

Subsequently, the principles of measuring the ability to perform a job were extended to post-injury populations. Post-injury evaluations were designed to determine work capacity in relation to a specific job or class of jobs, as well as the level of consistent effort and cooperation. Information obtained through these evaluations have been used to determine treatment and rehabilitation efforts and, in legal proceedings, to determine work capacity and eligibility for indemnity benefits.

Theoretical Basis of FCEs

In order to understand how the design of FCEs relates to their intended purposes and the scientific evaluations of these tests, a brief review of the theoretical basis of FCEs is important. One fundamental assumption underlying the application of FCEs is the concept of matching job demands to the capabilities and limitations of the individual. As illustrated in Fig. 13.1, there is a relationship between job demands and workers' capabilities and limitations within a work system (Dempsey et al., 2000). The components of the job demands include both physical (e.g., task, machinery) and environmental (e.g., work space, organization, environmental). The worker's capabilities and limitations are expressed as "limiting subsystems" including (1) anatomical (e.g., anthropometric, biomechanical), (2) physiological (e.g., cardiopulmonary), and (3) psychosocial (e.g., perceptual, cognitive, social) subsystems (Sinclair & Drury, 1979). As illustrated in Fig. 13.2, applications or interventions (at a worker or job level) may lead to

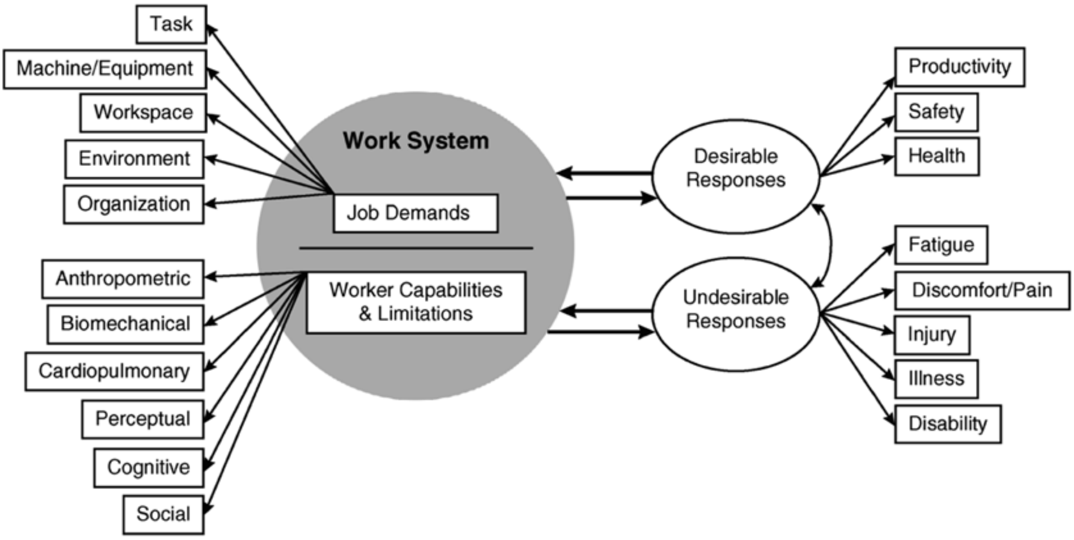

Fig. 13.1 Relationship between job demands and worker's capabilities and limitations within a work system (Dempsey et al., 2000)

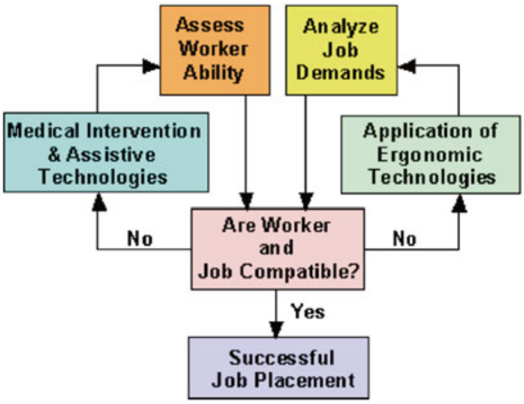

Fig. 13.2 Applications or interventions having an impact on successful job placement (Armstrong et al., 2001)

a more favorable ratio of worker capacity to job demands and, ultimately, successful job placement, providing a productive worker and a safe work environment (Armstrong et al., 2001).

One of the most important aspects of the FCE is the measurement of capacity specific to the actual physical demands as required by the job. While most capacity measures are highly specific to the task (i.e., whether it is a measure of aerobic capacity or muscle strength), it is implied that the test may need to consider multiple tasks within a job. Therefore, prior to administering any FCE, a job analysis should be performed. This is a crucial point, both from a legal and scientific perspective. This is further complicated by the fact that the task-specific nature of human capacity may change because of injuries, aging, other complications, etc.

While the concept of functional capacity relative to specific job demands appears to be straightforward, the actual evaluation of functional capacity is a technically challenging process that often occurs within a complex legal and medical context. Because most physical job demands are both dynamic and complex in nature, in addition to the dynamic of capacity caused by morbidity, functional capacity is inevitably dynamic as well. The potential for variation in functional capacity presents a challenge to another conceptual basis for the use and interpretation of FCE results—that of scientific certainty. FCEs are often erroneously regarded as capable of providing data that are definitive in both measurement of capability, as well as sincerity of effort, with accurate projections to actual ability to return to specific jobs. However, following the evaluation, questions about sincerity of effort and work capacity are appropriate. Therefore, the validity of FCE results and associated conclusions can present important limitations to the application of such results (Harten, 1998).

The Functional Capacity Evaluation: An Assessment Tool

The use of FCEs as an evaluation tool necessitates continued scrutiny of the FCE process, in order to ensure that it provides a useful measure in a particular situation. This section discusses validity and reliability of the FCE, which are two important measurement properties.

Validity

Validity is generally defined as the extent to which a test measures what it is intended to measure (Reneman, Wittink, & Gross, 2009). Furthermore, validity reflects the credibility of the test results. A valid test has dependable results, and inferences made from the results must be trustworthy, because a valid test measures what it is supposed to measure. There are several types of validity based on the theory of measurement, as depicted in Table 13.1. To date, the type of validity mostly researched in the FCE literature is *criterion validity*.

Table 13.1 Types of validity

Criterion validity	• The extent to which a performance on the test is related to a set of criterion. The criterion validity involves in comparing the test with external criterion or other measures (usually with the gold standard in the related area) proven to be valid • There are two subtypes of criterion validity: Concurrent validity: the extent to which a performance on test is related to the benchmark/gold standard test at the same time. Higher correlation indicates better criterion validity for the test. *For example,* how well the ERGOS™ Work Simulator correlates with conventional FCE in respect to dynamic lower and upper lifting (Dusik et al., 1993) Predictive validity: the extent to which performance on the test is accurately able to predict performance in the future. *For example,* performance on short-form FCE predicts time to recovery, but does not predict sustained return to work (Branton et al., 2010)
Construct validity	• The extent to which a test measures a theory-derived construct. For example, poor convergent validity of the five Ergo-kit FCE lifting tests with reported sleep pain intensity and disability suggests a poor construct validity of these lifting tests (Gouttebarge et al., 2004)
Content validity	• The extent to which a test covers domains that the test is intended to measure • For example, job-specific FCE
Face validity	• The extent to which a test measures what it supposes to measure at "face value"

Adapted from Anastasi and Urbina (1997); Nunnally and Bernstein (1994); Reneman et al. (2009)

Work return and the termination of a disability claim are criteria sometimes used to assess the predictive validity of a FCE [along with performance on various individual FCE tasks and overall performance during evaluation as the predictors (Kuijer, Gouttebarge, Brouwer, Reneman, & Frings-Dresen, 2012)]. For example, Mayer et al. (1986) evaluated the ability of an individual FCE task to predict work return. Results indicated that a positive change in trunk strength, as measured by a Cybex trunk strength tester (Lumex Corp, Ronkonkoma, NY), was associated with an increased likelihood of return to work, relative to negative change or no change. However, other factors are equally predictive of return-to-work outcomes. In addition to performance on the trunk strength test, performance on lifting tasks is also used as a predictor for work return. For example, greater ability on floor-to-waist lift, but not on shoulder-to-overhead lift, was associated with improved likelihood of return to work (Matheson, Isernhagen, & Hart, 2002). On the other hand, a lower amount of floor-to-waist lift and a lesser maximum ability were associated with a decreased likelihood for work return and increased likelihood for non-return to work (Streibelt, Blume, Thren, Reneman, & Mueller-Fahrnow, 2009; Vowles, Gross, & Sorrell, 2004). In addition, more weight lifted on an FCE's lift task was associated with a faster suspension of workers' benefits and claim closure (Gross & Battié, 2006). Also, better overall FCE performance, as measured by a lower number of failed tasks or passing all FCE tasks, was associated with increased likelihood of being employed, decreased likelihood of non-work return, and faster termination of disability claim (Branton et al., 2010; Gross & Battié, 2005; Streibelt et al., 2009). Similar conclusions may be applied to short-form FCEs: a better performance on the short-form FCE (consisting of floor-to-waist lifting task, crouching, and standing) has been associated with faster claim benefit suspension in a chronic musculoskeletal condition population (Gross, Battié, & Asante, 2006, 2007).

Even though the FCE is predictive of work return (as found in past studies), the contribution of an FCE to increasing the prediction accuracy for work return and disability claim closure is modest (Gross & Battié, 2004; Gross, Battie, & Cassiday, 2004; Matheson et al., 2002). The modest contribution might be due to the multidimensionality of work return, including economic and psychosocial factors (He, Hu, Yu, & Liang, 2010; Krause, Dasinger, Deegan, Rudolph, & Brand, 2001; MacKenzie et al., 1998), but is most likely due to the poor ability of generic FCE evaluations to predict job performance, especially in jobs with complex and variable work tasks.

It is a common practice to extrapolate expected ability to perform frequent lifting on the job, based on the maximal ability while performing occasional lifting. However, this practice lacks a well-founded scientific basis (Jones & Kumar, 2003). Therefore, caution needs to be exercised because performing low-frequency, high-load lifts "taxes" the musculoskeletal system, whereas performing such lifts also brings the cardiopulmonary system into the equation. The cardiovascular system, in turn, may limit performance due to fatigue. Thus, the ability to perform frequent lifting, based on the extrapolation from the maximal ability, may not always give a true estimate of repetitive-lifting ability. It should also be noted that the role of psychosocial factors is especially important in evaluating the predictive ability of the FCE. Fishbain, Cutler, Rosomoff, and Steele-Rosomoff (1999) found that the completed number of FCE tasks was predictive for return to work only when combined with pain intensity level and other factors. This result was affirmed by a recent review in which pain intensity was established as an influential confound in FCE validity research (Cutler, Fishbain, Steele-Rosomoff, & Rosomoff, 2003; Kuijer et al., 2012).

Overall, the evidence supporting the FCE as a prediction tool for work return is, at best, mixed. Dusik, Menard, Cooke, Fairburn, and Beach (1993) evaluated the validity of the FCE by using return to work as a criterion outcome. The investigators compared FCE results using a standardized protocol versus a job simulation. They followed the return-to-work outcomes after participants were discharged from rehabilitation. Results indicated that the FCE was just as accurate as a job simulation (in predicting return to work) that involved a very simple repetitive job without any accommodation potential or flexibility. However, the FCE was much less accurate than the job simulation in predicting ability on a more complex job. In addition, Gross and Battié (2005) found that performance on the FCE was not predictive of sustained work return as indicated by opening a claim on old and new injuries, although it was somewhat predictive of recurrence soon after return to work (Gross & Battié, 2004). These findings cast more doubt on the validity of the generic FCE, partly because the issue related to characterization of job demands has not been satisfactorily resolved without actual job simulation. They also question the predictive value of any type of FCE over time.

However, recent research suggests that an FCE, combined with isoinertial and isokinetic testing, may improve the validity of the FCE. Fore et al. (in press) examined whether FCE scores were responsive to functional restoration treatment, predictive of 1-year socioeconomic outcomes, and predictive of physical demand levels (PDL) 1 year after treatment. Results indicated that 89 % of patients demonstrated improvements on their PDL from pre- to post-treatment and 78 % of patients had returned to work. In addition, posttreatment FCE results predicted return to work 1 year later.

Christian and colleagues (2002) examined whether persons judged to be employable after a formal work capacity assessment related to indemnity compensation benefits in New Zealand. Of those participants who were judged to be employable but not working at follow-up (57 % of the 141 participants in the study), some had repeated or reopened insurance claims. This suggested the possibility of a return to work at jobs that placed them at risk for further injury. Similar findings have also been observed from other studies. For example, it was found that limitations documented in the evaluation setting do not correlate with the ability to return to work. These discrepancies appear to be most problematic with static tasks, but less so with dynamic tasks or job simulation (Dempsey, Ayoub, & Westfall, 1998; Ferguson, Marras, & Gupta, 2000). Only the Physical Work Performance Evaluation (PWPE-FCE) had acceptable documentation of validity for a narrow range of jobs among the commercially available FCE protocols (Innes & Straker, 1999).

A generic FCE purports to assess functional job capacity by comparing performance on various structured, general tasks with categories of physical job demand. The categories of job requirements are determined through job analyses. Often, the job requirements are extrapolated from the job title and work classification provided by the *Dictionary of Occupational Titles* (DOT) or it successor, the US Department of Labor O*NET database (Pransky & Dempsey, 2004). These systems classify jobs through categorization of physical requirements for each generic occupational title and were not intended to serve as a basis for evaluation of work capabilities—discrepancies between actual job requirements and those listed in the DOT or O*Net are presumed to be the rule, not the exception. Furthermore, these systems do not provide specific measures of activity required (e.g., weights lifted, miles walked, etc.). The performance on an FCE is influenced by personal factors (i.e., motivation and beliefs) and by environmental factors (i.e., assessor and testing condition; Genovese & Galper, 2009). Thus, "direct" comparisons between performance on a generic FCE and the required physical demands based on occupational title are likely to result in an inaccurate representation of an individual's functional ability relative to a specific job. An accurate job simulation, though, has the potential to increase the predictive ability of test results.

For FCEs projected to measure working ability at a specific job, a formal job assessment is desirable. Several job assessment systems, designed to interface with FCE protocols, are available. However, accurate assessment of job demands can be challenging. There are several threats to FCE validity, including formal and informal job modifications, and a variety of alternatives to perform complex tasks (Chan, Tan, & Koh, 2000; Hoffman & Pransky, 1998). Related to job modifications, workers often alter how a job is executed. Furthermore, workers also utilize informal accommodations in order to perform a job despite physical limitations. Discussion with the examinee regarding job requirements may be helpful, but workers may not always be able to provide reliable data about physical job demands (Lindstrom, Ohlund, & Nachemson, 1994). Standard job descriptions from employers can be equally inaccurate. FCEs based on a job simulation examine only the physical components of the job; however, they fail to simulate the environmental (hot, cold, vibration) or psychosocial components (time pressure, working in isolation) (Mazanec, 1996). Thus, validation is difficult in some situations without some strong evidence for job performance linkage around physical tasks (Schonstein & Kenny, 2001). In instances when FCEs are successful in measuring physical job demands and properly simulating the job environment, return to work is also a function of many other factors, including physical demands and capacity, skill, motivation, workplace, and psychosocial attributes. Therefore, the validation of a particular FCE method is impossible without taking into account all the other factors that may affect a successful return to work (King, Tuckwell, & Barrett, 1998).

When an FCE is being performed to assess ability to perform a broad class of jobs, a high degree of job-specific validity may not be required. However, evaluators should note that results could easily be misleading. For example, the authors have observed multiple employees within a facility who have a job title such as "material handler" or a similarly vague title but who have very different job demands in terms of the loads handled and the frequency of lifting. Thus, the validity of an FCE across workers in the same job title could vary (Chan et al., 2000; Hoffman & Pransky, 1998; Lindstrom et al., 1994).

Reliability

Reliability is related to the consistency of a measure. In general, a test is considered reliable if it produces a relatively similar result over time. The reliability coefficient refers to the degree of consistency of results (Anastasi & Urbina, 1997), with a higher reliability coefficient indicating a higher consistency of a measure. There are several types of reliability including test-retest reliability (consistency over time), inter-rater reliability (consistency between different raters), intra-rater reliability (consistency by the same rater over time), and internal consistency (between equivalent parts in the same test) (Anastasi & Urbina, 1997; Nunnally & Bernstein, 1994). In the context of the FCE, the inter-rater reliability and the test-retest reliability are considered important. The test-retest reliability is important because it ensures that changes in the FCE results are due to the person, rather than a variation of the FCE itself. In the context of illness management, the inter-rater reliability is valuable because it ensures that the test produces consistent results despite the influence of a patient's and a rater's subjectivity.

To date, the evidence concerning the reliability of the FCE has demonstrated a large and undesirable degree of variability. A systematic review on the validity and reliability of the *Blankenship System* FCE (BS-FCE), *ERGOS Work Simulator* FCE (ES-FCE), *Ergo-Kit* FCE (EK-FCE), and *Isernhagen Work System* FCE (IWS-FCE) concluded that the inter-rater reliability of the IWS-FCE was good. However, these studies on inter-rater reliability were not rigorous enough to draw any firm conclusions (Gouttebarge, Wind, Kuijer, & Frings-Dresen, 2004). No definitive reliability studies were found for BS-FCE, ES-FCE, and EK-FCE. In sum, sufficient reliability studies of these standardized FCE approaches are lacking.

Functional Capacity Evaluation: Its Utility of FCE

The FCE consists of a wide range of activities designed to estimate a person's functional ability, whether it is specifically related to the job or if it depicts a general picture. The activities performed during a general, more extensive FCE range from simple to complex and attempt to fulfill these purposes. The FCE activities are typically categorized into nonmaterial handling and material handling activities. Nonmaterial handling activities include positional tolerance activities, such as sitting, standing, climbing, balancing, and walking (Coupland, Miller, & Galper, 2009). The material handling activities include carrying, floor-to-waist lifting, and waist-to-shoulder lifting (Innes, 2009). The material handling assessments involve a series of standardized tasks with weights and distances that are supervised by a trained professional (e.g., an occupational or physical therapist). The material handling assessments may involve the evaluation of velocity, peak force, and isokinetic lift, using computerized devices from Cybex (Cybex Inc, Medway, Ma) and Biodex (Biodex Medical Systems, Inc, Shirley, NY) or standardized weights. Some computerized devices also assess range-of-motion activities, including trunk flexion and extension. Overall, the choice of activities included in an FCE depends on the purposes and contexts of the evaluation. The following section will discuss the utility of FCE based on two main goals: illness management and injury prevention.

Illness Management

Illness management spans a wide range of conditions and situations, from simple to complex and from acute to chronic. The type and purpose of FCEs are slightly different in each condition and situation. Nevertheless, the main goal remains the same: to provide the patients, physicians, employers, benefit adjudicators, insurance companies, etc., with information on physical and functional abilities relative to job demands. For instance, people receiving treatment for acute illnesses are presumed to still be active employees. The purpose of administering an FCE for this group is to identify the job tasks that can be safely performed and also to identify whether adjustment to the workers' tasks is necessary (Genovese & Isernhagen, 2009). Hence, it is expected that the results of an FCE will facilitate an employee to keep working, or to assist an employee on sick leave to return to work early (resulting in a shortened length of disability). However, there is insubstantial evidence to conclude that an FCE is important in establishing safe alternative duty for return to work.

In the context of chronic illness management, FCEs have been utilized in work hardening/conditioning programs. Work hardening/conditioning programs are a form of tertiary prevention, aimed at preparing the individual to return to work. It is an interdisciplinary program which uses real or simulated work tasks and progressively graded conditioning exercises. The patients entering these programs usually have not reached maximal medical improvement (MMI), meaning that the patient has not reached the point at which a damaged body part or organ system is not likely to achieve further improvement (Civitello & Carter, 2010). Upon admission to these types of programs, the patient may undergo a series of assessments, one of which is the FCE. The purpose of the FCE in this situation is to provide the patient, employer, physicians, therapists, insurance agency, etc., with information on the patient's residual abilities (Genovese & Isernhagen, 2009). This purpose is achieved by assessing the patient's functional abilities related to the job and his/her general physical abilities. Thus, the FCE in this situation might be moderate in length, with a combination of generic and job-specific tasks. The FCE result will then be incorporated with the physician's report in order to set up a rehabilitation program and expected goal. It is important to note that many programs currently evaluate and rehabilitate injured workers without these sorts of structured FCE evaluations. Patients experience improvement during their time in rehabilitation. Even though patients improve, it is not practical to perform a reevaluation every time a change in function or work demands occurs, [see Fig. 13.2 (Armstrong et al., 2001)]. Changes on patients' physical capacity and pain tolerance may still happen, especially to those who are early in their recovery. Thus, obtaining repeated functional measurements during the course of physical rehabilitation may represent an unnecessary expense that is not required to achieve optimal outcomes (Rainville, Sobel, Hartigan, Monlux, & Bean, 1997). There is also little justification to conduct formal FCEs when the full range of available job accommodations has not been explored. Rather, the goal of rehabilitation is to increase the functional abilities and work tolerance so that they "match up" with the physical demands of the job. The FCE is often repeated at least once during the program in order to monitor improvement. At the conclusion of the program, another FCE may be administered to assess the patient's physical and functional abilities. The physician may incorporate FCE results with a medical evaluation in order to generate a recommendation. The recommendation includes a job-specific PDL and tasks that the patient is able to perform safely.

Structured FCEs, administered in conjunction with a rehabilitation program, usually incorporate a judgment of sincerity of effort. The purpose of incorporating sincerity of effort is to increase the accuracy in interpreting the FCE results. Sincerity of effort generally refers to an individual's conscious motivation to perform optimally during assessment (Lechner, Bradbury, & Bradley, 1998). There is an underlying assumption that sincere effort leads patients to demonstrate their maximal effort. The evaluation of a patient's sincerity of effort depends on an evaluator's perception. There are several methods commonly used to determine the sincerity of effort. Among the methods are the *Waddell Nonorganic Signs* and *Coefficient of Variation* (COV) (Matheson & Dakos, 2000; Waddell, McCulloch, Kummel, & Venner, 1980). Unfortunately, though, there is weak supporting evidence concerning the sincerity of effort evaluations. For example, there is more than one variable of performance influencing a painful condition, even when a subject is attempting to provide a maximal effort (Robinson & Dannecker, 2004). FCEs are often promoted as a method of "objectively" identifying conscious attempts to reduce effort. However, the scientific proof of its discrimination ability across a range of injured subjects is inconclusive (Hazard, Reid, Fenwick, & Reeves, 1988). One study reported high sensitivity and specificity of tests used to determine sincerity of effort, but only in subjects who were instructed to provide a very significant (50 %) reduction of maximal force (Jay et al., 2000). However, it did not specify the factors utilized to determine sincerity. Other studies have demonstrated that subjects can reproducibly perform at voluntarily reduced strength levels (Robinson, Geisser, Hanson, & O'Conner, 1993). Little evidence, though, exists for an unacceptable COV threshold; the suggested levels range from 5 to 29 % (Lechner et al., 1998).

The variability in performance observed in people with chronic low back pain may be determined by the variation in pain and function typically associated with that particular disorder. It also applies even to persons who are consistently providing a maximal tolerated effort. Reliability can be poor due to many factors, including variations in pain, position, self-limitation to avoid injury, equipment function, testing protocols, subject comprehension, or ability to follow specific directions (Innes, Tuckwell, Straker, & Barrett, 2002). Poor performance may also be influenced by failure to understand the degree of effort required, anxiety related to the test situation, depression, pain, fear avoidance, unconscious or conscious illness behavior or exaggeration, or malingering (Hirsch, Beach, Cooke, Menard, & Locke, 1991). Reliability can also be affected by training and acclimation. Significant reactivity (learning effect) has been demonstrated in low back pain patients with an isokinetic protocol, resulting in variations of 17–28 % (Grabiner, Jeziorowski, & Divekar, 1990). Patients may have reasonable fears about overexerting themselves that might lead to re-injury. Thus, insincere effort may not be the only factor behind the occurrence of the significant performance variability (Croft, Macfarlane, Papageorgiou, Thomas, & Silman, 1998; van den Hoogen, Koes, van Eijk, Bouter, & Deville, 1998).

Conversely, patients may demonstrate self-limitation that can be interpreted as valid given consistent occurrence; and overexertion (effort in a range that is unsafe for the individual) is also a possibility. FCE performance can be greatly hindered by pain. In this situation, testing may actually provide a measure of pain tolerance instead of peak functional capacity (Beimborn & Morrissey, 1988). Thus, changes over time may reflect changed psychosocial or behavioral factors affecting pain tolerance, and not muscle strength (Cooke, Menard, Beach, Locke, & Hirsch, 1992). In point of fact, Hazard et al. (1988) compared several indices of subject effort, including isokinetic force/distance curve patterns, peak force variations, blood pressure, and heart rates. They concluded that even the best physiologic measures and force curve analyses are not as reliable as an expert observer in detecting voluntary self-limitation. Thus, in essence, determining the underlying cause of limitation is a challenging task. The limitations demonstrated by patients may be due to their inability, or it may be due to their unwillingness to perform or put forth maximum effort. Unfortunately, the mislabeling of underperformance as insincere may lead to pervasive adverse consequences for workers, including misdiagnosis, improper treatment, increased litigation, and increased cost of care (Lechner et al., 1998). Therefore, it is important to clarify the distinction between validity as a scientific concept and attempts to measure sincerity of effort (the latter term is preferred). For practical purposes, FCEs appear to be effective in detecting submaximal efforts only when variation is high and the lack of full effort is obvious.

Injury Prevention

A pre-employment examination is widely practiced in the industrial World. In the USA alone, it is estimated that one-half of all workers undergo pre-employment examinations (Mohr, Gochfeld, & Pransky, 1999). A pre-employment examination is defined as the assessment of an applicant's capacity in performing required tasks as part of a job, without risk to self or others' health and safety (Mahmud et al., 2010; Serra et al., 2007). These examinations are also conducted as opportunities for preventive health screening. Based on the definition, the aim of the pre-employment examination is to match individuals to job demands in order to ensure that they possess the ability to perform the job (e.g., the functional ability to execute the required tasks in a safe manner). One potential way to assess functional ability is by administering an FCE during the recruitment process. The rationale of administering an FCE at this time is that the worker's performance during an FCE is predictive of his/her ability to safely perform the required job tasks (Schonstein et al., 2009). Assuming that the prediction is accurate, and the worker has the physical ability to perform the tasks, then the prediction of lower risk for injury would seem reasonable (Scott, 2002). The administration of an FCE during the recruitment process can be done in either the pre-offer or post-offer phase. The pre-offer phase refers to a phase when job offer has not yet been made, while the post-offer phase refers to a phase when the job offer has been made.

The difference between the pre-offer and post-offer FCEs is the extent of medical information that can be obtained by employers (Genovese & Isernhagen, 2009). The ADA (1990) prohibits employers from obtaining medical examinations of prospective workers when a job offer has not been made. Consequently, the pre-offer FCE must be administered and interpreted without the benefit of medical information. The ADA requires employers to clearly describe the physical requirements of the job and offer reasonable accommodations as needed. Furthermore, employers must ascertain that the functional and physical tests match up with the job requirements, with accommodations. Employers should be able to demonstrate that the selection method is necessary for safe performance of the job and no discrimination occurs as a result, as required by the US Equal Employment Opportunity Commission (2012). Similar to the requirement for the pre-offer FCE, the post-offer FCE should be job-related. However, a post-offer FCE is occasionally more informative than a pre-offer FCE because of the availability of medical information (Genovese & Isernhagen, 2009). In specific situations where physical demands are high and substantial accommodations are not possible, and where the FCE simulates actual job activities, FCEs as part of the preplacement process can be cost-effective. For example, a longitudinal study conducted by Harbin and Olson (2005), which examined post-offer FCEs, aimed to determine the effectiveness of functional assessment application on post-offer preplacement testing by implementing a job-specific FCE protocol. Results indicated a strong correlation between physical capacities to physical job requirement. Workers with a physical ability that matched the physical job requirements had a lower injury rate. The rates of low back, shoulder, and arm injuries for this group were 3 %, 2 %, and 1 %, respectively. These rates were very low compared to the rates of injuries of workers who did not demonstrate adequate physical ability to perform their job. The rates of low back, shoulder, and arm injuries in this group were 33 %, 28 %, and 76 %, respectively.

Several other studies also found a lower injury rate, less lost time, and less turnover and suggested that there were cost savings comparing a group of prior hires to subsequent workers hired through a preplacement FCE process (Faris, 2008; Gassoway & Flory, 2000; Toeppen-Sprigg & Isernhagen, 1999). However, these results have been questioned due to the likelihood of concurrent injury and disability prevention interventions, other simultaneous selection processes (such as drug screening), and program evaluation by those who also had a financial interest in the screening process.

Job Specific

Again, the purpose of a preplacement testing FCE is to assess whether workers have physical/functional abilities to safely perform the required tasks. A job-specific FCE is more accurate in providing an estimate of the worker's abilities, compared to the generic FCE. The rationale for this is that the closer the FCE mimics the real working situation, the better the generalization to the job. In order to achieve this, the essential tasks of the job need to be reproduced, along with the opportunities for individual accommodation (ADA, 1990; Genovese & Isernhagen, 2009; Harbin & Olson, 2005; Pransky & Dempsey, 2004).

Safety

Safety during an FCE administration is an important issue in injury prevention (Gibson & Strong, 2005; Schonstein et al., 2009), especially in the context of preplacement testing. Observations of changes in body mechanics, when lifting loads of increasing weight, have been proposed as a criterion for maximal acceptable load. This kinesiophysical approach mandates that lifting methods be judged within safe guidelines, and evaluators should extrapolate from safe body mechanics in test situations (Isernhagen, 1992), despite the absence of scientific support for its validity (Smith, 1994). Both overestimation and underestimation of actual ability can occur as a result (Ting, Wessel, Brintnell, Maikala, & Bhambhani, 2001).

FCE and Legal Considerations

In order to prevent discrimination against a class of job applicants, laws have been set in place that require FCE tests to represent a valid simulation of the job. *The Uniform Guidelines on Employee Selection Procedures* (1978) (29 Code of Federal Regulations, Chapter XIV, Part 1607) provide a "framework for assessing the proper use of tests and other selection procedures." These guidelines apply to all employee selection procedures. In addition, more recent legislation, specifically the *Americans with Disabilities* Act (ADA), pertains precisely to individuals with disabilities. In the situation of preplacement testing, both sets of laws need to be considered when selecting a particular FCE and assessing the results. In order to adhere to *The Uniform Guidelines on Employee Selection Procedures* guidelines during the selection of a test, one must meet specific validity requirements, including criterion-related validity, content validity, and construct validity. No matter which test is selected, it is required to have documented evidence for at least one of these types of validity. This evidence may come from experimental data demonstrating that a test is predictive of, or significantly correlated with, elements of job performance (criterion-related validity); data indicating that the content of the test is representative of important aspects of performance on the job (content validity); or findings demonstrating that the protocol measures the degree to which candidates have identifiable characteristics which have been determined important for successful job performance (construct validity) (Innes & Straker, 1999). As per the regulations, if such a test cannot be performed, the selection criteria should be "as job related as possible." Hence, the same concept is crucial for establishing a legal test, regardless of the scientific importance of properly assessing the job demands to worker capacity ratio.

The *Uniform Guidelines on Employee Selection* guidelines also contain technical standards for validity studies. Although it may seem obvious, a review of the job should be included in the validity study, when the goal is to assess the degree of match between job demands and worker capacity. However, not all FCE providers will perform a job analysis (Pransky & Dempsey, 2004). At a minimum, the job analysis is required to provide measures of work behavior on performance, relative to the job. The primary step should always be an accurate job description from the perspective of both legal requirements and technical appropriateness. When considering the ADA, the job description is, in fact, required. Indeed, Title 1 of the ADA explicitly addresses the nature, scope, timing, and use of FCEs, and, for those who are already employed, it significantly limits an employer's ability to require evaluations of capacity without reasonable cause. In addition, in the case of an individual with a disability, those without a disability, or those whom the employer has wrongly considered as disabled, the Act also protects them (42 US Code 12102(2)(C)). As far as agility tests are concerned, those that measure physical and functional capacity that might be part of an FCE may be allowed if they are consistently applied and job-related (i.e., have a valid relationship to ability to perform essential job functions). Therefore, an immediate "red flag" should arise when the concept of a "generic FCE" is applied.

Thus, employers who choose to use FCEs of debatable validity to select workers, or limit those who return to work after an injury, may be subject to litigation based upon anti-discrimination laws (Pransky & Dempsey, 2004). In addition, liability for injury occurring to patients as a result of FCE testing and liability of employers for inaccurate results are other legal issues that must be taken into consideration. While extensive job simulation is ideal from a legal and validity point of view, it may be prohibitively expensive in many cases (Pransky & Dempsey, 2004). Safety is also a chief concern. For example, exacerbation of low back pain has been reported during isometric exercise testing (Hansson, Bigos, Wortley, & Spengler, 1984). Despite suggestions that body mechanics during lifting should be used, there is no validated method to determine when FCE maneuvers are unsafe (Strege, Cooney, Wood, Johnson, & Metcalf, 1994). In the case where an organization has not previously used an FCE, the organization may become overly optimistic about the value of the results from such tests. Consequently, FCEs should be regarded, at best, as only one element of a larger program that systematically addresses injury prevention and return to work (Pransky & Dempsey, 2004). Also, depending upon the application of the FCE, the criteria for acceptability can substantially vary. If return to work is the primary goal of an FCE, an accurate prediction of safe return-to-work outcomes, including re-injury, may be most important (Pransky & Dempsey, 2004). If the primary goal is adjudication, then the primary criterion for acceptability of an FCE approach may be consistency within a legally defined set of parameters, because the function is more administrative than rehabilitative. Lastly, if the goal of the FCE is preplacement evaluation, then avoidance of discrimination, excessive cost relative to benefit, and predictive ability for future injury may be of greatest importance.

Clinical and mechanical methods of evaluation may often be comparable in terms of the information they can yield about a subject's performance in relation to their capacity (Menard, Cooke, Locke, Beach, & Butler, 1994; Reisine, McQuillan, & Fifield, 1995). In many instances, a thorough clinical evaluation that includes a review of functional activities of daily living may be sufficient to determine readiness to return to work. Some investigators have argued that, in the absence of an accurate work simulation test, questionnaires have greater validity and sensitivity to important changes in work capacity than "objective" evaluations of functional capacity (Loisel et al., 1998).

Conclusions

Many scientific and practical limitations are associated with FCEs. In some instances, these limitations may be overcome through a thorough job analysis and careful work simulation, combined with protocols that closely mimic work activities (and guided by expert evaluators) that result in findings with reasonable certainty (Frings-Dresen & Sluiter, 2003). Unfortunately, many FCEs do not achieve these standards of performance, and, in general, acceptable and accurate measures of voluntary self-limitations are not available. Further research is needed to develop valid, reliable, consistent, and efficient measures that correlate well with safe and sustained return to work. Until then, FCEs may not be the most helpful *sole* tool for practicing clinicians involved in return-to-work decisions. However, this is not to say that the FCE has no utility in and of itself. If the results from the FCE are combined with other information, they may be able to assist the resolution process for the issues of compensability, disability, and employability. Moreover, there are some instances where a standard FCE protocol can be used with state-of-the-art isoinertial and isokinetic measures, combined with physical job demands to predict return-to-work outcomes (Fore et al., in press).

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References

ADA. (1990). *Americans with Disabilities Act*. Retrieved June 9, 2012, from http://www.ada.gov/.

Anastasi, A., & Urbina, S. (1997). *Psychological testing*. Upper Saddle River, NJ: Prentice Hall.

Armstrong, T. J., Franzblau, A., Haig, A., Keyserling, W. M., Levine, S., Streilein, K., et al. (2001). Developing ergonomic solutions for prevention of musculoskeletal disorder disability. *Assistive Technology, 13*(2), 78–87.

Beimborn, D. S., & Morrissey, M. C. (1988). A review of the literature related to trunk muscle performance. *Spine, 13*(6), 655–660.

Bigos, S. J., Battié, M. C., Fisher, L. D., Hansson, T. H., Spengler, D. M., & Nachemson, A. L. (1992). A prospective evaluation of preemployment screening methods for acute industrial back pain. *Spine, 17*(8), 922–926. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/1387973.

Branton, E. N., Arnold, K. M., Appelt, S. R., Hodges, M. M., Battié, M. C., & Gross, D. P. (2010). A short-form functional capacity evaluation predicts time to recovery but not sustained return-to-work. *Journal of Occupational Rehabilitation, 20*(3), 387–393.

Chaffin, D. B., Herrin, G. D., & Keyserling, W. M. (1978). Preemployment strength testing: An updated position. *Journal of Occupational Medicine, 20*(6), 403–408. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/671117.

Chan, G., Tan, V., & Koh, D. (2000). Ageing and fitness to work. *Occupational Medicine (London), 50*(7), 483–491.

Christian, B. (2002). Return to work outcomes following accident compensation corporation work capacity assessment. *The New Zealand Medical Journal, 115*(1153), 209–211.

Civitello, D., & Carter, R. F. (2010). Maximum medical improvement in workers' compensation. *RSDSA Review, 23*(1), 10–11.

Cooke, C., Menard, M. R., Beach, G. N., Locke, S. R., & Hirsch, G. H. (1992). Serial lumbar dynamometry in low back pain. *Spine, 17*(6), 653–662.

Coupland, M., Miller, M., & Galper, J. S. (2009). Evaluating movement and positional tolerance. In E. G. Genovese & J. S. Galper (Eds.), *Guide to the evaluation of the functional ability: How to request, interpret and apply functional capacity evaluations* (pp. 145–167). Chicago, IL: American Medical Association.

Croft, P. R., Macfarlane, G. J., Papageorgiou, A. C., Thomas, E., & Silman, A. J. (1998). Outcome of low back pain in general practice: A prospective study. *British Medical Journal, 316*(7141), 1356–1359.

Cutler, R., Fishbain, D. A., Steele-Rosomoff, R., & Rosomoff, H. L. (2003). Relationships between functional capacity measures and baseline psychological measures in chronic pain patients. *Journal of Occupational Rehabilitation, 13*(4), 249–258.

Dempsey, P. G., Ayoub, M. M., & Westfall, P. H. (1998). Evaluation of the ability of power to predict low frequency lifting capacity. *Ergonomics, 41*(8), 1222–1241.

Dempsey, P. G., Ciriello, V. M., Clancy, E. A., McGorry, R., Pransky, G. S., & Webster, B. S. (2000). Quantitative assessment of upper extremity capacity and exposure. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 44*(31), 724–727. doi:10.1177/154193120004403128.

Dusik, L. A., Menard, M. R., Cooke, C., Fairburn, S. M., & Beach, G. (1993). Concurrent validity of the ERGOS work simulator versus conventional functional capacity evaluation techniques in a workers' compensation population. *Journal of Occupational Medicine, 35*(8), 759–767.

Faris, J. (2008). Lowering nursing injuries using post offer pre-employment testing. *Work, 31*(1), 39–45.

Ferguson, S. A., Marras, W. S., & Gupta, P. (2000). Longitudinal quantitative measures of the natural course of low back pain recovery. *Spine, 25*(15), 1950–1956.

Fishbain, D. A., Cutler, R., Rosomoff, H. L., & Steele-Rosomoff, R. (1999). Chronic pain disability exaggeration/malingering and submaximal effort research. *Clinical Journal of Pain, 15*(4), 244–274.

Fore, L., Asih, S., Perez, Y., Neblett, R., Mayer, T. G., & Gatchel, R. J. (in press). Predictive utility of functional capacity evaluations following a functional restoration program.

Frings-Dresen, M. H. W., & Sluiter, J. K. (2003). Development of a job-specific FCE protocol: the work demands of hospital nurses as an example. *Journal of Occupational Rehabilitation, 13*(4), 233–248.

Gassoway, J., & Flory, V. (2000). Prework screen: Is it helpful in reducing injuries and costs? *Work, 15*(2), 101–106.

Genovese, E., & Galper, J. (2009). Conclusion and agenda for the future. In E. G. Genovese & J. S. Galper (Eds.), *Guide to the evaluation of functional ability* (pp. 421–436). Chicago, IL: American Medical Association.

Genovese, E., & Isernhagen, S. J. (2009). Approach to requesting a functional capacity evaluations. In E. G. Genovese & J. S. Galper (Eds.), *Guide to the evalutions of functional ability: How to request, interpret and apply functional capacity evaluations* (pp. 19–40). Chicago, IL: American Medical Associations.

Gibson, L., & Strong, J. (2005). Safety issues in functional capacity evaluation: Findings from a trial of a new approach for evaluating clients with chronic back pain. *Journal of Occupational Rehabilitation, 15*(2), 237–251.

Gouttebarge, V., Wind, H., Kuijer, P. P. F. M., & Frings-Dresen, M. H. W. (2004). Reliability and validity of Functional Capacity Evaluation methods: A systematic review with reference to Blankenship system, Ergos work simulator, Ergo-Kit and Isernhagen work system. *International Archives of Occupational and Environmental Health, 77*, 527–537.

Grabiner, M., Jeziorowski, J., & Divekar, A. (1990). Isokinetic measurements of trunk extension and flexion performance collected with the Biodex Clinical Data Station. *The Journal of Orthopaedic and Sports Physical Therapy, 11*, 590–598.

Gross, D. P., & Battié, M. C. (2004). The prognostic value of functional capacity evaluation in patients with chronic pain part 2: Sustained recovery. *Spine, 29*(8), 920–924.

Gross, D. P., & Battié, M. C. (2005). Functional capacity evaluation performance does not predict sustained return to work in claimants with chronic back pain. *Journal of Occupational Rehabilitation, 15*(3), 285–294.

Gross, D. P., & Battié, M. C. (2006). Does functional capacity evaluation predict recovery in workers' compensation claimants with upper extremity disorders? *Occupational Environmental Medicine, 63*(6), 404–410.

Gross, D. P., Battié, M. C., & Asante, A. (2006). Development and validation of a short-form functional capacity evaluation for use in claimants with low back disorders. *Journal of Occupational Rehabilitation, 16*(1), 50–59.

Gross, D. P., Battié, M. C., & Asante, A. K. (2007). Evaluation of a short-form functional capacity evaluation: Less may be best. *Journal of Occupational Rehabilitation, 17*(3), 422–435.

Gross, D. P., Battie, M. C., & Cassiday, C. J. (2004). The prognostic value of functional capacity evaluation in patients with chronic low back pain: Part 1. Timely return to work. *Spine, 29*(8), 914–919.

Hansson, T. H., Bigos, S. J., Wortley, M. K., & Spengler, D. M. (1984). The load on the lumbar spine during isometric strength testing. *Spine, 9*(7), 720–724.

Harbin, G., & Olson, J. (2005). Post-offer, pre-placement testing in industry. *American Journal of Industrial Medicine, 47*(4), 296–307.

Harten, J. A. (1998). Functional capacity evaluation. *Occupational Medicine: State of the Art Reviews, 13*(1), 209–212.

Hazard, R. G., Reid, S., Fenwick, J., & Reeves, V. (1988). Isokinetic trunk and lifting strength measurements: Variability as an indicator of effort. *Spine, 13*(1), 54–57.

He, Y., Hu, J., Yu, I. T. S., & Liang, Y. (2010). Determinants of return to work after occupational injury. *Journal of Occupational Rehabilitation, 20*(3), 378–386.

Hirsch, G., Beach, G., Cooke, C., Menard, M., & Locke, S. (1991). Relationship between performance on lumbar dynamometry and Waddell score in a population with low-back pain. *Spine, 16*(9), 1039–1043.

Hoffman, S., & Pransky, G. (1998). Pre-employment examinations and the Americans with Disabilities Act: How best to avoid liabilities under federal law. *Journal of Occupational Rehabilitation, 8*(4), 255–263.

Innes, E. (2009). Dynamic material handling testing. In E. G. Genovese & J. S. Galper (Eds.), *Guide to the evaluation of functional ability: How to request, interpret and apply functional capacity evaluations* (pp. 91–115). Chicago, IL: American Medical Association.

Innes, E., & Straker, L. (1999). Validity of work-related assessments. *Work, 13*(2), 125–152.

Innes, E., Tuckwell, N., Straker, L., & Barrett, T. (2002). Test-retest reliability on nine tasks of the Physical Work Performance Evaluation. *Work, 19*(3), 243–253.

Isernhagen, S. (1992). Functional capacity evaluation: Rationale, procedure, utility of the kinesiophysical approach. *Journal of Occupational Rehabilitation, 2*(3), 157–168.

Jay, M. A., Lamb, J. M., Watson, R. L., Young, I. A., Fearon, F. J., Alday, J. M., et al. (2000). Sensitivity and specificity of the indicators of sincere effort of the EPIC lift capacity test on a previously injured population. *Spine, 25*(11), 1405–1412.

Jones, T., & Kumar, S. (2003). Functional capacity evaluation of manual materials handlers: A review. *Disability and Rehabilitation, 25*(4–5), 179–191.

King, P. M., Tuckwell, N., & Barrett, T. E. (1998). A critical review of functional capacity evaluations. *Physical Therapy, 78*(8), 852–866.

Krause, N., Dasinger, L. K., Deegan, L. J., Rudolph, L., & Brand, R. J. (2001). Psychosocial job factors and return-to-work after compensated low back injury: A disability phase-specific analysis. *American Journal of Industrial Medicine, 40*(4), 374–392.

Kuijer, P. P. F. M., Gouttebarge, V., Brouwer, S., Reneman, M. F., & Frings-Dresen, M. H. W. (2012). Are performance-based measures predictive of work participation in patients with musculoskeletal disorders? A systematic review. *International Archives of Occupational and Environmental Health, 85*(2), 109–123.

Lechner, D. E., Bradbury, S. F., & Bradley, L. A. (1998). Detecting sincerity of effort: A summary of methods and approaches. *Physical Therapy, 78*(8), 867–888.

Lindstrom, I., Ohlund, C., & Nachemson, A. (1994). Validity of patient reporting and predictive value of industrial physical work demands. *Spine, 19*(8), 888–893.

Loisel, P., Poitras, S., Lemaire, J., Durand, P., Southiere, A., & Abenhaim, L. (1998). Is work status of low back pain patients best described by an automated device or by a questionnaire? *Spine, 23*(14), 1588–1594; discussion 1595.

MacKenzie, E. J., Morris, J. A., Jurkovich, G. J., Yasui, Y., Cushing, B. M., Burgess, A. R., et al. (1998). Return to work following injury: The role of economic, social, and job-related factors. *American Journal of Public Health, 88*(11), 1630–1637.

Mahmud, N., Schonstein, E., Schaafsma, F., Lehtola, M. M., Fassier, J. B., Reneman, M. F., et al. (2010). Pre-employment examinations for preventing occupational injury and disease in workers. *Cochrane Database of Systematic Review,* (12), CD008881.

Matheson, L. N., & Dakos, M. (2000). *Re-visiting "How do you know he tried his best" …The coefficient of variation as a determinant of consistent effort.* Retrieved from http://www.epicrehab.com/free-resources/CV-and-Effort.pdf.

Matheson, L. N., Isernhagen, S. J., & Hart, D. L. (2002). Relationship among lifting ability, grip force, and return to work. *Physical Therapy, 82*(8), 249–256.

Mayer, T. G., Gatchel, R. J., Kishino, N., Keeley, J., Mayer, H., Capra, P., et al. (1986). A prospective short-term study of chronic low back pain patients utilizing novel objective functional measurement. *Pain, 25*(1), 53–68.

Mazanec, D. J. (1996). The injured worker: Assessing "return-to-work" status. *Cleveland Clinic Journal of Medicine, 63*(3), 166–171.

Menard, M. R., Cooke, C., Locke, S. R., Beach, G. N., & Butler, T. B. (1994). Pattern of performance in workers with low back pain during a comprehensive motor performance evaluation. *Spine, 19*(12), 1359–1366.

Mohr, S., Gochfeld, M., & Pransky, G. (1999). Genetically and medically susceptible workers. *Occupational Medicine, 14*(3), 595–611.

Nunnally, J., & Bernstein, I. (1994). *Psychometric theory*. New York: McGraw-Hill.

Oesch, P., Meyer, K., Jansen, B., Mowinckel, P., Bachmann, S., & Hagen, K. B. (2012). What is the role of "nonorganic somatic components" in functional capacity evaluations in patients with chronic nonspecific low back pain undergoing fitness for work evaluation? *Spine, 37*(4), E243–E250. doi:10.1097/BRS.0b013e31822e6088.

Pransky, G. S., & Dempsey, P. (2004). Practical aspects of functional capacity evaluations. *Journal of Occupational Rehabilitation, 14*(3), 217–229.

Rainville, J., Sobel, J., Hartigan, C., Monlux, G., & Bean, J. (1997). Decreasing disability in chronic back pain through aggressive spine rehabilitation. *Journal of Rehabilitation Research and Development, 34*(4), 383–393.

Reisine, S., McQuillan, J., & Fifield, J. (1995). Predictors of work disability in rheumatoid arthritis patients. A five-year followup. *Arthritis and Rheumatism, 38*(11), 1630–1637.

Reneman, M., Wittink, H., & Gross, D. P. (2009). The scientific status of functional capacity evaluation. In E. G. Genovese & J. S. Galper (Eds.), *Guide to the evaluation of functional ability: How to request, interpret, and apply functional capacity evaluation* (pp. 393–420). Chicago, IL: American Medical Association.

Robinson, M. E., & Dannecker, E. A. (2004). Critical issues in the use of muscle testing for determination of sincerity of effort. *Clinical Journal of Pain, 20*(6), 392–398.

Robinson, M., Geisser, M., Hanson, C., & O'Conner, P. (1993). Detecting submaximal efforts in grip strength testing with the coefficient of variation. *Journal of Occupational Rehabilitation, 3*, 45–50.

Schonstein, E., & Kenny, D. T. (2001). The value of functional and work place assessments in achieving a timely return to work for workers with back pain. *Work, 16*(1), 31–38.

Schonstein, E., Mahmud, N., & Kenny, D. T. (2009). Postoffer functional testing for injury prevention: Methodological and practical considerations. In E. G. Genovese & J. S. Galper (Eds.), *Guide to the evaluation of functional ability: How to request, interpret, and apply functional capacity evaluation* (pp. 259–272). Chicago, IL: American Medical Association.

Scott, L. R. (2002). Post offer screening. *AAOHN Journal, 50*(12), 559–563.

Serra, C., Rodriguez, M. C., Delcos, G. L., Plana, M., López, L. I. G., & Benavides, F. G. (2007). Criteria and methods used for the assessment of fitness for work: A systematic review. *Occupational and Environmental Medicine, 64*(5), 304–312.

Simpson, S. J., & Richlin, D. (2003). The role of functional capacity evaluations in occupational health settings. *AAOHN Journal, 51*(5), 202–203. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12769165.

Sinclair, M. A, & Drury, C. G. (1979). On mathematical modelling in ergonomics. *Applied Ergonomics, 10*(4), 225–234. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15676366.

Smith, R. L. (1994). Therapists' ability to identify safe maximum lifting in low back pain patients during functional capacity evaluation. *The Journal of Orthopaedic and Sports Physical Therapy, 19*(5), 277–281.

Strege, D. W., Cooney, W. P., Wood, M. B., Johnson, S. J., & Metcalf, B. J. (1994). Chronic peripheral nerve pain treated with direct electrical nerve stimulation. *The Journal of Hand Surgery, 19*(6), 931–939. doi:10.1016/0363-5023(94)90092-2.

Streibelt, M., Blume, C., Thren, K., Reneman, M. F., & Mueller-Fahrnow, W. (2009). Value of functional capacity evaluation information in a clinical setting for predicting return to work. *Archives of Physical Medicine and Rehabilitation, 90*(3), 429–434.

Ting, W., Wessel, J., Brintnell, S., Maikala, R., & Bhambhani, Y. (2001). Validity of the Baltimore therapeutic equipment work simulator in the measurement of lifting endurance in healthy men. *The American Journal of Occupational Therapy, 55*(2), 184–190.

Toeppen-Sprigg, B., & Isernhagen, S. J. (1999). *Fitness for duty assessment: Fitness for duty*. New Orleans, LA: American Occupational Health Conference.

US Equal Employment Opportunity Commission. (2012). *US equal employment opportunity commission*. Retrieved June 12, 2012, from http://www.eeoc.gov/laws/types/disability.cfm.

van den Hoogen, H. J., Koes, B. W., van Eijk, J. T., Bouter, L. M., & Deville, W. (1998). On the course of low back pain in general practice: A one year follow up study. *Annals of the Rheumatic Diseases, 57*(1), 13–19.

Vowles, K. E., Gross, R. T., & Sorrell, J. T. (2004). Predicting work status following interdisciplinary treatment for chronic pain. *European Journal of Pain, 8*(4), 351–358.

Waddell, G., McCulloch, J. A., Kummel, E., & Venner, R. M. (1980). Nonorganic physical signs in low-back pain. *Spine, 5*(2), 117–125.

Wind, H., Gouttebarge, V., Kuijer, P. P. F. M., Sluiter, J. K., & Frings-Dresen, M. H. W. (2009). Complementary value of functional capacity evaluation for physicians in assessing the physical ability of workers with musculoskeletal disorders. *International Archives of Occupational and Environmental Health, 82*(4), 435–443.

Disability and Impairment in Medicolegal Settings: Pain Disability Controversies

14

Izabela Z. Schultz and Catherine M. Chlebak

Introduction: Predicting Disability

Clearly, developing an effective model in disability prediction research forms a central bridging issue in the relationship between disability and impairmant. Significant barriers for the development of a disability prediction and determination model in medicolegal settings include ambiguity and multiplicity of definitions of pain, impairment, and disability, as well as methodological challenges in assessment and in work disability prevention and reduction (Schultz, 2008; Schultz & Chlebak, 2013; Schultz, Stowell, Feuerstein, & Gatchel, 2007). In the context of minimal availability of graduate and postgraduate training opportunities in the field of disability determination (Schultz, 2009), for clinicians, the demands of a stressed workers' compensation and other disability insurance systems (in particular, an increasing proportion of higher compensation costs arising from complex pain and mental health disability cases) might have exceeded research developments in the field (Gnam, 2005). This area forms a uniquely difficult area of research and practice in medicolegal settings.

Defining Disability and Impairment: Dissecting the Relationship Challenges

Theoretical Foundations

The concepts of disability and impairment are frequently intertwined in research literature, where often models and definitions of disability embed impairment definitions. The conceptual foundations emerge from a fragmented research history, creating three theoretical frameworks: biomedical, social construction, and biopsychosocial (Bickenbach, Chatterji, Badley, & Ustin, 1999; Lutz & Bowers, 2007; Schultz, Krupa, & Rogers, 2011; Schultz, Stowell et al., 2007; Schultz, Winter, & Wald, 2011; Schultz, Winter et al., 2007). These frameworks have themselves produced six models of occupational disability with parallel return-to-work models: biomedical, psychosocial, forensic, economic, ecological, and biopsychosocial. Differing research traditions, key tenets and values, constructs, emphasis on the individual, environment and disability determinants, and practice implications are represented in these models (Schultz, Stowell et al., 2007; Smart, 2001).

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Recent developments have collapsed these models into four groups of biomedical and forensic, psychosocial, ecologic/case management and economic, and biopsychosocial (Schultz, Stowell et al., 2007). Our *handbook* reviews and updates these models from current research perspective, highlighting their strengths and limitations (Knauf & Schultz, 2013).

Stepping back, within the biomedical framework, a medical condition produces a disability through an observable deviation from biomedical norms of structure or function (Bickenbach et al., 1999; Boorse, 1975, 1977; Schultz, Crook, Fraser, & Joy, 2000; Schultz, Stowell et al., 2007; Smart, 2001). Here, psychological injury is informed and governed by the psychiatric field, specifically the diagnostic manuals (i.e., the *Diagnostic and Statistical Manual of Mental Disorders-IV-TR* [*DSM-IV-TR*; American Psychiatric Association [APA], 2000] or the *Diagnostic and Statistical Manual of Mental Disorders-5* [*DSM-5*; APA, 2013]) and the practice of treating most mental diagnoses psychopharmacologically, with the associated dramatic growth in this form of treatment across all age groups (Comer, Olfson, & Mojtabai, 2010; Mojtabai & Olfson, 2008, 2011).

The social construction approach assumes that disability is a complex set of conditions, relationships, and activities, not just an attribute of an individual, that have been largely produced by the individual's social environment (Bickenbach et al., 1999; DePoy & Gilson, 2004; Olkin & Pledger, 2003; Tate & Pledger, 2003). *Disability* is conceptualized in terms of how a specific environment creates social and physical barriers to hinder functioning and full participation (Linton, 2001). Thus, disability is viewed as dependent on societal response; with an appropriate response, disability would be nonexistent (Smart, 2001; Smart & Smart, 2007). With impairment and disability, a distinction is made. Disability is based on demands and supports within a specific environment where the specific impairment occurs (Schultz, 2008).

The biopsychosocial theory integrates clinical and social approaches. Classic work by Engel proposed a micro- (interactional), meso- (organizational or community), and macro- (structural) ecological and structural levels to predict social and clinical outcomes (1977; Tate & Pledger, 2003). This approach has evolved to highlight disability as multifactorial, including environmental, personal (Fine & Asch, 1988; Meyerson, 1988), psychosocial elements (Schultz et al., 2000; Tate & Pledger, 2003). An interactive disability model has also been postulated—disability is viewed as situational and functional limitations that can be altered by social and environmental factors (Verbrugge & Jette, 1994). Other evolvements include the Institute of Medicine (Pope & Tarlov, 1991) and World Health Organization's (WHO) International Classification of Impairments, Disabilities, and Handicaps (ICIDH) model (1980).

The most recent iteration of the biopsychosocial model is the WHO's International Classification of Functioning, Disability, and Health model (ICF). The disablement concept, previously focused on handicap, impairment, and disability, has been replaced by a more inclusive concept of enablement. Participations, impairments, and activities now form the new focus. More specifically, *disablement* is viewed as difficulty encountered with any or all of the interconnected functional areas: activity limitations, participation restrictions, and impairments (problems with body structure or structure) (WHO, 2001).

The dimensions of disablement have implications on systemic and clinical interventions (Bickenbach et al., 1999). At the *impairment* level, rehabilitative or medical responses are the most appropriate; here, the medical model is an accurate disablement representation. Evaluating an individual's performance against a set or standardized environment identifies activity limitations. Appropriate responses are to strive to extend or correct a range of an individual's own capabilities through rehabilitation or to provide assistive devices to compensate for activity limitations. Participation, where an individual's actual social and physical environment is included and the primary interventions either add environmental facilitators or remove environmental barriers to full participation.

This ICF model is intended as worldwide reference tool for assessing individual functioning and disability. Complex and dynamic interactions among disability, impairment, and other personal and contextual factors are shown here; specifically, impairment is viewed as reflecting a reciprocal relationship with activity. Activity, in turn, is a conceptualized as a reciprocal interaction with participation. Contextual factors, including environmental and personal, mediate the relationship between disability and impairment (WHO, 2001).

Within the psychological injury, pain, and law field, this paradigm is considered the most promising development theoretically. Here, the strengths are in recognizing the dynamic relationship between the individual and the environment, a functional focus, and the absence of stigmatizing, diagnostic labels. Its approach is relational, dynamic, and multifocal, integrating medical and social perspectives, and supports operationalization in health and social sciences (Peterson & Paul, 2009). The ICF model has also demonstrated utility as a "standard for defining concepts, building constructs, hypothesizing relationships, and proposing new theories that will further research and psychology" (Peterson, 2011, p. 4). The alignment of these strengths with key disability determination objectives supports utilization of the ICF model within the psychological injury and pain field. For this field, it is important to move beyond the assessment of the individual (as complicated it might already be) to assessing environmental supports and demands including the community, workplace, and the family and their relationships with health and personal factors. These systems interactively produce activity limitations and participation restrictions that are disabling (Schultz, 2009).

Applied Perspectives

Adding to the complexity, from the three major theoretical frameworks of biomedical, social construction, and biopsychosocial, three applied perspectives of disability emerge to impact research and practice, including in forensic applications and in varying interactions: legal and administrative, scholarly research, and clinical (Altman, 2001; Schultz, 2005, 2008).

Legal/Administrative Applications

Private and public administrative bodies have developed their own legal disability definitions due to the legal ramifications such as benefits, rights, and responsibilities. However, Altman (2001) has noted that disability is often defined as "situations associated with injury, health, or physical conditions that create specific limitations that have lasted (or are expected to last) for a named period of time" (p. 98). For disability compensation systems, such as workers' compensation and long-term disability insurance companies, a historical preference for administrative disability definitions is shown. These narrow and functionally specific definitions usually highlight the need for "objective proof" of impairment to justify work disability (Schultz, 2005, 2008). Such standards of proof vary widely across jurisdictions and systems.

Within the public area, disability is defined more broadly, moving away from more narrow, function-specific definitions (Schultz, 2008). One example is within the American with Disabilities Act (ADA, 1990) (Schultz, 2008; Smart, 2001). Disability is defined here as (1) a physical or mental impairment that substantially limits one or more of the major life activities of such individuals, (2) a record of such impairment, or (3) being regarded as having such an impairment (Sec. 3 [2] 42 U.S.C. 12102 1990). Impairment is classified as "any emotional or psychological disorder, such as mental retardation, organic brain syndrome, emotional or mental illness, or specific learning disabilities" (29CFR Part 1630.1[h2]). Classification as an "individual with disability" involves evidence showing (1) a physical, cognitive, or intellectual, and psychiatric condition or multiple mental impairment conditions; (2) discrimination and/or stigma; and (3) a significant limitation in at least one major life activity (Schultz, 2008; Smart, 2001).

Federal and state agencies use definitions specific to the service provided. For example, with social security disability benefits, individuals are required to have a severe disability that is (1) predicted to last minimally 1 year or result in death and (2) prevents work at a "substantially gainful activity level." Currently, this organization does not recognize the American Medical Association (AMA) Guides' rating impairments. Veterans Affairs is another agency utilizing their own criteria for disability rating (Feinburg & Brigham, 2013).

Within this arena, the definitions of disability draw heavily on both biomedical and social construction traditions (Smart, 2001). Schultz (2008) observed that, because the relationship is undefined between these two theories, ongoing legal difficulties and risks are fueled. For individuals with minimal limitations, such as stuttering, obesity, facial disfigurement, and mental health disabilities, the ADA definition for disability may be met because of the experience of stigma and or discrimination (Schultz, 2008; Smart, 2001; WHO, 2001). Across systems and programs, impairment is defined as more consistent and measurable; however, disability is viewed as a social construct and thus different weights and benefits are assigned. In one system, an individual can be "disabled" and in another not, based on the same impairment (Feinburg & Brigham, 2013).

Comparing these fields, a divergence in conceptualizing disability is seen: one is narrow in its scope to create financially viable and objectively verifiable compensable solutions for the institutions granting disability status, and the other shows a broader perspective to ensure equal rights for individuals with disability. This trend persists today (Schultz, 2005, 2008).

Scholarly Research

The definitions of work disability in rehabilitation outcome literature are primarily economically or clinically derived and are even more varied than in legal or clinical definitions. Schultz and colleagues (Schultz, 2005; Schultz, Stowell et al., 2007) named six substantive categories for classifying much of the literature:

- Self-report of disability by an individual with disability, e.g., sickness impact profile (Bergner et al., 1981; Gilson et al., 1975) or the Work Limitations Questionnaire (Amick, Rogers, Malspies, Bungay, & Cynn, 2001; Lerner et al., 2001) or various other disability indices.
- Report of disability by a clinician and/or significant other.
- Health-care utilization.
- Duration of disability.
- Return to work and/or employability, including cycling between disability and RTW and repeating patterns of return to work.
- Health-care- and wage-loss-based costs of disability.

Examining the definitions, a number of themes emerge. Most definitions are cross-diagnostic and cross-categorical, and a common factor is a function focus. This is despite the multiplicity of disability classifications, such as severe versus mild, absent versus present, acquired versus congenital, and stigmatizing versus non-stigmatizing, and the conceptualization of disability in an "all or nothing" dichotomy or in a continuum (Schultz, 2008, 2009; Smart, 2001).

Fair application for individuals with disabilities, and having a significant body of systematic, evidence-based research, is critical for reliability, validity, and relevance for legal and clinical definitions and related disability determination methodologies. A number of barriers exist, hampering progress. This includes:

- Diversity of approaches and inconsistency among research, clinical, and administrative applications have hampered disability prediction, early identification of high-risk individuals, and disability prevention (Schultz, 2005).
- Definition multiplicity and related methodological approaches create difficulties in integrating research on the relationship between disability and impairment (Linton et al., 2005; Pransky, Gatchel, Linton, & Loisel, 2005).
- Stakeholders (e.g., employers, the government, compensation systems, health care, and societal institutions) are vested in their own desired disability outcomes included in related research (Young et al., 2005).
- Measurement properties, especially validity evidence, have not been considered in the largely market-driven disability determination industry (Schultz, 2005).
- Conceptualization of the biopsychosocial model as a theory and the resulting acceptable

level of specificity for systematic, empirical validation has not yet been reached; this is despite an accumulation of quantitative and qualitative research evidence (Imrie, 2004).

Impairment Determination Practice: The AMA Guides' Approach

Within the clinical realm, health-care providers use disability definitions to predict (provide prognosis of) future function, focusing on the pathology's identification, qualification, and quantification. Prognosis is based on individual characteristics and condition type. The AMA has governed evaluation guidelines that both standardize and create best practices around determining impairment since 1958. Termed the *AMA Guides to the Evaluation of Permanent Impairment* (AMA Guides), they are primarily used as a reference tool to assess compensation losses from illness or injury in compensation and legal settings. This methodology is "intended to assist adjudicators and others involved in the adjudicative process" (Rondinelli, 2009; Rondinelli & Eskay-Auerbach, 2009, p. 27). Significantly, the most recent *AMA Guides, Sixth Edition* (Rondinelli, 2009) has adopted the ICF model of disability, signaling a theoretical departure from the traditional biomedical approaches and associated antiquated language of about 30 years old into a more integrated biopsychosocial paradigm (WHO, 2001). As a result, definitions of disability and impairment have shifted.

For the AMA, disability is defined as an activity or participation limitation in domains including work, society, and home within an impairment context. Disability is conceptualized as a "relational outcome," reflecting an individual's capacity to perform a specific task or activity within a unique environment (Brandt & Pope, 1997). This definition is similar to both the previous iteration of the AMA Guides (Cocchiarella & Andersson, 2000) and the current ICF model (WHO, 2001). The latter defines disability as "an outcome or result of the complex relationship between an individual's health condition and personal factors, and of the external factors that represent the circumstances in which an individual lives" (p. 17). As discussed earlier in this chapter, disability is seen through "activity limitations" (p. 213); activity is understood as a task execution such as driving or writing, and "participation restrictions" are defined as interactions that impact life experiences (WHO, 2001).

For the *AMA Guides, Sixth Edition*, the definition of impairment has had more significant changes since its previous iteration in 2000, broadening its scope. Currently, impairment is defined as "a significant deviation, loss, or loss of use of any body structure or body function in an individual with a health condition, disorder, or disease" (p. 5). The term "function" includes physiological and psychological elements, while the term "structure" continues to maintain an exclusively medical focus (Rondinelli, 2009). This shift has created some controversy in the medical community, producing an "ambiguous position where impairment seems to require framing in the context of its functional consequences" (Bellamy & Campbell, 2009, p. 47).

In an attempt to address long-standing validity and reliability issues, in part due to a historical dependency on expert opinion, intuition, and consensus versus systematic, evidence-based research to build the Guides (Rondinelli, 2010), the *AMA Guides Sixth Edition* (Rondinelli, 2009) developed five axioms to define priorities, articulate the shift in paradigm, and provide clarity around use of evidence-based practices, methodological congruity, and diagnosis. The assessment approach has a greater function focus, emphasizes evidence-based research to support decision making, has a reduction in unreliable measures including those for range of motion, and expands their multimodal assessment approach (Rondinelli & Eskay-Auerbach, 2009).

The Guides caution against using impairment ratings as a proxy or a "surrogate" for disability determination (Rondinelli & Eskay-Auerbach, 2009, p. 27). This important assertion contrasts with much of clinical literature, research, and practices where disability and impairment concepts are frequently used interchangeably. Clinicians, instead of focusing on determining impairment and its impacts on work performance, quite regularly provide opinions of disability. Individuals are assessed as "not disabled" or "totally disabled" despite the lack of evidence on the impact of impairment on work ability, general performance, and workplace characteristic factors. This problem occurs in current clinical and medicolegal contexts and within the measurement field (Schultz, 2005), frequently in cases of chronic musculoskeletal pain disability.

Within medicolegal contexts, an important issue is expectation differences among disability stakeholders. For example, referring sources requesting independent medical examinations with information on work performance impact from clinicians may instead receive opinions on employability (Schultz and Brady, 2003; Schultz, 2005). Professionally, only vocational experts are uniquely prepared to render these opinions—they are qualified to evaluate the impairment context, such as job availability, labor market, and accommodations and thus contribute to determining disability directly based on *both* contextual findings and clinical impairment. However, disability entitlement decisions are often ultimately reserved to judges, disability status adjudicators, and other related triers of fact in the legal system (Schultz, 2005).

The clinical definitions of disability and impairment, unlike legal and administrative definitions, must adhere to methodological evaluation standards of measurability, validity, reliability, and fairness. Within forensic psychology specifically, high-stakes assessments demand adherence to existing best practices and continual improvements based on research advances. Yet, clinicians are pressured to address disability-related issues where evidentiary support or clarity is lacking, moving beyond scientific boundaries. Although the legal field traditionally operates in "black and white contexts," legal decision-making advancements will most likely occur with recognition of the complexity, of person-environment interaction, and multidimensionality of disability determination (Schultz, 2009).

Disability Determination in Complex Disabilities: Musculoskeletal Pain

Disability determination becomes increasingly challenging with the growing demands involving medicolegal assessments and claims decisions regarding complex disabilities. Knowledge in defined areas, such as pain or somatic disorders, as well as conditions frequently comorbid with pain in medicolegal assessments, including depression, post-traumatic stress disorder (PTSD), or traumatic brain injury, has been expanding more rapidly than practitioners and researchers can assimilate and integrate the data, improve practices, and develop trans-diagnostic or cross-diagnostic knowledge (Schultz, 2009; Wald & Taylor, 2009). Another factor is the early developmental stages of the measurement properties of the AMA Guides' procedures (Schultz, 2005). Low back pain, the most common work disability, is an example of a complex disability with determination difficulties. Serious concerns have been documented on reliability issues, including Zuberbier et al. (2001) regarding the range-of-motion physical assessment protocol with the AMA Guides Fourth Edition (1993) and Forst, Friedman, & Chukwu, (2010) on minimal improvements in reliability in assessing impairment ratings from the *AMA Guides Fifth Edition* (Cocchiarella & Andersson, 2000) to the Sixth Edition (Rondinelli, 2009). Interestingly, in the transition to the newest edition, the contentious range-of-motion assessment protocol was removed and replaced by a diagnosis-focused procedure (Rondinelli & Eskay-Auerbach, 2009). For psychiatric disabilities, Bellamy and Campbell (2009) asserted that for the *AMA Guides Sixth Edition*, although permanent impairment determination is more structured and results in an impairment rating (versus earlier guides), validity, reliability, and acceptability are not discussed or described.

Occupational therapists and vocational rehabilitation evaluators tend to determine the majority of work disability cases. However, health professionals not trained specifically in assessing interaction between individual characteristics and environmental demands and supports, namely, forensic psychologists, neuropsychologists, physiatrists, and psychiatrists, are also called upon. Moreover, multiple concerns have been raised by researchers, practitioners, and stakeholders with respect to current and historic disability determination practices, including the absence of appropriate taxonomies and functional impairment conceptualizations, a historical precedent for psychologists and physicians to focus on individual pathology and diagnosis versus function, confusion and difficulty around relationship between impairment and disability, lack of an environmental/contextual lens in forensic practice to complement the individual focus, and limited psychometrically and biometrically appropriate tools used to evaluate functional impairment in assessments of an ecological nature (except for behavioral scales used with children and individuals with severe disability-related barriers) (Halpern & Fuhrer, 1984; Shriver, Anderson, & Proctor, 2001; Yoman & Edelstein, 1994). In addition, although de-biasing approaches have been advanced in the literature for high-stakes assessments, they have not been consistently implemented in forensic practice and controversies in this area abound, adversely affecting credibility of medicolegal determinations.

Disability Prediction in Complex Pain Disabilities: Searching for an Algorithm

Knowledge mobilization of researched quantifiable predictors of disability to the practice of disability determination in medicolegal contexts is in an early stage. Notably, it is most advanced in musculoskeletal pain disorders. Advancement in the field is hampered by the absence of integrative, empirically supported models of disability prediction for both medicolegal and clinical (prevention, case management, and rehabilitation) applications and the prevalence of outdated biomedical and forensic models of disability determination in compensation and legal settings. Before any compensation-related analyses are completed, decisions on the severity of occupational disability must be made. Yet such decisions, whether made by a vocational expert, a judge, jury, or a compensation specialist, are extremely complex and require bridging impairment and disability via contextual, individual, and work-related factors (Schultz, 2005).

A qualitative exploration of the implicit criteria used in determining occupational disability in psychological injury, and occupational chronic pain cases within the workers' compensation system, resulted in the formulation of a preliminary decision-making tree informed by Gladwin's ethnographic decision-making model (Beck & Schultz, 2000; Gladwin, 1989). Box 14.1 outlines a number of questions implicated in the subsequent steps of decision making regarding the severity of occupational disability. These questions exemplify a qualitatively determined algorithm used in decision making for occupational disability in a compensation setting to be used for future validation research. Notably, existing pre-

Box 14.1: Decision-Making Steps to Determine Occupational Disability Due to Psychological and Pain Disability (Adapted from Schultz and Brady 2003)

1. Are the symptoms of diagnosable psychological/pain impairment present?
2. Is there a preexisting psychological/pain impairment?
3. Is there a portion of the psychological/pain impairment, which arises from injury at claim?
4. Does the psychological/pain impairment affect current work capacity?
5. Is the person able to return to his/her pre-injury employment?
6. If so, is there a significant risk for deterioration and/or of residual symptoms after return to work?
7. Can a job change attenuate or eliminate the psychological/pain impairment?
8. Does the person have work capacity in a competitive environment?
9. Is the person capable, or expected, to adapt adequately, with or without job accommodation, despite the psychological/pain impairment?
10. Is the person able to perform most activities of daily living despite the psychological/pain impairment?
11. Is there significant executive dysfunction and/or significant lack of adaptability to change and stress?

dictive actuarial formulae and research-supported models of occupational disability are group based. Decision making in an individual medicolegal cases is not permitted due to problems including validity such as sensitivity and specificity (Schultz et al., 2004) and insufficient validation of the model for such applications. At the current state of development and validation, these models are better used to serve in identifying individuals at elevated risk for disability and to apply early intervention and secondary prevention than to aid in disability determination in medicolegal settings.

This study improves our understanding of decision-making processes of evaluators making disability determination judgments in clinical and medicolegal settings. Research on the effectiveness of training judges/evaluators in such improved understanding of their implicit decision-making criteria, by making these implicit criteria explicit, would contribute to future training and standardization of approaches in pain and disability policy applications in medicolegal and compensation settings.

Pain Disability Epidemic?

A primary focus of this chapter is on the complex disability, pain. Within the USA, pain is one of the most common symptoms for patients to consult a physician for (Hing, Cherry, & Woodswell, 2006), accounting for about 2.3 % of all visits (Cherry, Burt, & Woodwell, 2001). Pain is considered the most common cause of disability (Feinburg & Brigham, 2013); of this, the majority of costs are attributed to 5–10 % of individuals who also develop chronic pain and disability (Waddell, Aylward, & Sawney, 2002). For medicolegal claims, it has become a "major issue." Thus, with a diagnosis of chronic pain, an "overwhelming probability" exists that the individual will file a medicolegal claim (Barth, 2009b, p. 1).

Musculoskeletal injuries of the lower back form the largest subgroup of pain disabilities, forming the "leading cause of work disability" for the 45–65-year-old group (Costa-Black, Loisel, Anema, & Pransky, 2010, p. 227; Picavet & Schouten, 2003). Disappointingly, although no significant change in back pain injury rates have occurred over time, disability related to back pain has increased (Feinburg & Brigham, 2013). This group now forms the largest burden socioeconomically when factoring costs such as health-care payments, productivity losses, work disability burden, and complications, such as a minimum 20 % risk to mortality, permanent disability, and increased probability of mental health problems in the range of 2–3 times (Costa-Black et al., 2010). In the USA, these costs can exceed $214.9 billion yearly (Praemer, Furner, & Rice, 1999). Indirect costs include social and quality of life losses and personal suffering (WHO, 2003).

Challenges in Pain Assessment

Despite this significant burden and rapid research advances in the field in the last two decades, most forms of chronic pain are still poorly understood; when understood, pain severity is poorly managed (Turk & Melzack, 2011). The most significant challenge lies in its subjectivity, a problem documented as early as the 1960s. Specifically, the pain assessment continues to rely on self-report, yet the pain rater's ability to retrieve information from memory, including subjective memory, is notoriously prone to error (Broderick et al., 2008). Within the pain disability context, for example, Stone, Broderick, Shiffman, and Schwartz (2004) documented that patients both significantly overestimate and underestimate pain in self-reports of severity. Barth (2009a) summarized existing research in both claims and nonclaims settings and asserted unreliability of self-reporting. For example, one study showed that individuals who had a medicolegal claim reported significantly higher pre-claim functioning than individuals who had not made a claim; this finding was replicated. Another replicated study found that individuals denied preexisting conditions that were particularly relevant for persistent back or neck pain, including histories of back or neck pain complaints and a history of psychological distress. This issue was named as a direct barrier to an objective assessment with the *AMA Guides Sixth Edition* (Rondinelli & Eskay-Auerbach, 2009). Other complications include confounding psychological, behavioral, personal, and categorical issues (Schultz, 2009).

Another significant challenge to disability determination is the link between pathology and pain. Only a small percentage of individuals with chronic low back pain have a specific injury or diagnosis, with less than 5 % of cases showing potentially serious pathology (Costa-Black et al., 2010); the presented disability is often disproportionate to the evident disease (Dersh, Polatin, Leeman, & Gatchel, 2005). The functional loss experienced by an individual can clearly be linked with pathology or can far exceed expectations; the pain has poor correlation with objective indicators of dysfunction in the body. These hallmarks prove controversial for determining pain impairment using the AMA Guides, which are highly focused on objective findings (Rondinelli & Eskay-Auerbach, 2009). Malingering, symptom exaggeration, and a variety of gains and losses associated with the pain can occur. This topic will be discussed in another section of the present chapter (Choi, Asih, & Polatin, 2013; Feinburg & Brigham, 2013). Within the litigation context, symptom magnification and/or over-endorsement are more common than in general clinical practice, and with purposeful misrepresentation or when the individual presents with diminished credibility, this issue further muddies disability definitions (Feinburg & Brigham, 2013).

Navigating the administrative maze of different benefit systems and definitions of pain, disability, and impairment is another significant issue (Feinburg & Brigham, 2013). Pain, disability, and impairment may be independent or coexist (Robinson, Turk, & Loeser, 2004). The *International Association for the Study of Pain* (IASP) defined pain as a subjective experience that is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage." Due to its subjective and relativistic nature, this definition is exceedingly difficult to operationalize in medicolegal settings, especially those focusing on "objective proof" of impairment. Further, the Association distinguishes between neuropathic and nociceptive pain. The latter is usually related to impairment, while the former exists regularly with dysfunction (Feinburg & Brigham, 2013; IASP, 2011). Moreover, within disability research, pain is viewed as a symptom—not a diagnosis, disease, or a clinical sign (Waddell, 2004)—and "managing the pain does not guarantee that the disability will resolve" (Feinburg & Brigham, 2013, p. 1032).

The *AMA Guides Sixth Edition* (Rondinelli, 2009) adheres to the IASP pain definition; the AMA's chronic pain definition follows established norms of persistent pain of about 3 months for tissue injury. Not surprisingly, difficulty arises with determining impairment and disability related to pain. For the AMA, impairment typically is determined through objective findings, and disability is viewed as an activity limitation and/or a participation restriction resulting from a disease, disorder, or health condition.

In the medicolegal context, impairment related to pain has been a controversial issue. Historically, protocol on impairment determination started in the *AMA Guides Fourth Edition* (1993); the *AMA Guides Fifth Edition* (Cocchiarella & Andersson, 2000) had recommendations that were "at odds with the editorial principles, based on evidence-based medicine, validation, and inter-rater physician reliability" (Atkinson, 2009, p. 79). The ambiguities and inconsistencies of this edition are also documented elsewhere (e.g., Robinson et al., 2004). The *AMA Guides Sixth Edition* (Rondinelli, 2009) is viewed as more simplified in comparison. For example, in the absence of an anatomical and objective impairment, the subjective pain complaint is allotted an arbitrary impairment of up to 3 % (Atkinson, 2009). However, this allotment can only be applied in unusual circumstances, including having no other basis for impairment rating (Rondinelli, 2009).

Watson (2011) argued that "pain itself cannot be incorporated into an assessment of impairment" (p. 298) because of reliance on subjectivity and self-report versus independent validation. The systemic nature of chronic pain lends itself to assessing the whole person, not one organ or the affected part, adding further difficulty to the assessment process. Ultimately, many pain specialist physicians acknowledge that this procedure does not adequately attend to functional loss and disability related to chronic pain (Feinburg & Brigham, 2013). Indeed, the *AMA Guides Sixth Edition* (Rondinelli, 2009) acknowledged the significant challenges in rating pain impairment: “to date, there is no consensus among experts about the usefulness and validity of the rating systems for PRI [pain related impairment]…controversies relate to the absence of an objective way to quantify pain or its effect on an individual and are fueled by the…dearth of peer-reviewed literature on the pros and cons of rating PRI” (Rondinelli & Eskay-Auerbach, 2009, p. 44).

In order to mitigate reliability issues and promote consistency, the *AMA Guides Sixth Edition* limited the usage of stand-alone PRI ratings, reserving this system for a “painful condition” that is both not captured elsewhere in the Guides and is a “generally acknowledged medical syndrome” (Rondinelli & Eskay-Auerbach, 2009, pp. 50–52). Here, the rating primarily focuses on observed behaviors, including verbal reports and nonverbal pain behaviors. No reliability or validity research has been conducted on PRI assessments; assessment decisions are made solely using clinical judgment (Rondinelli, 2009). Clearly, a heavy reliance on subjective self-reporting plays a significant role in reliability reduction as well. These divisive issues hamper progress within chronic pain assessment. Bellamy and Campbell (2009) offered that appropriate physician training, requiring candidates to exceed the minimum reliability and validity requirements, is one interim solution. Impairment assessment is completed when the patient has reached “the point at which a condition has stabilized and is unlikely to change (improve or worsen) substantially in the next year, with or without treatment” (Rondinelli, 2009, p. 26) or maximal medical improvement. Difficulties exist in reviewing health stability, determining probability of function restoration, and managing pain flare-ups as part of the initial screening (Feinburg & Brigham, 2013).

An estimated rating then is derived from the *Pain Disability Questionnaire* (PDQ), a self-report assessment tool that measures how pain affects function and daily living activities. This measure was designed to address chronic pain associated with musculoskeletal disorders and has excellent psychometric properties including strong reliably, validity, and responsiveness (Gatchel, Mayer, & Theodore, 2006). The results are then categorized into five degrees of disability ranging from none to severe, following the ICF model of disability. A whole-person impairment percentage between 0 and 3 % is awarded, which can be adjusted by the physician based on a clinical assessment of the patient’s reliability and credibility. Here, the AMA attempts to include a biopsychosocial approach, moving away from an assessment exclusively based on alteration or loss of organ parts or function. They capped the percentage awarded based on long-standing controversy on the ratings themselves, which carries forward from the *AMA Guides Fifth Edition*. However, since the last edition, the rating scheme was simplified, again based on criticism from the medical community (Rondinelli, 2009; Rondinelli & Eskay-Auerbach, 2009; WHO, 2001).

The independent medical evaluator (IME) may hold a different opinion than the treating physician. The physician is noted to take a patient advocate role, may have little experience or desire to comment on disability, and have challenges in defining disability. Regularly, conflict and distrust occur among the IME, claimants, and claim examiners based on doubt and skepticism around the claimant’s pain complaints and reported functional capacity (Barth & Brigham, 2005; Feinburg & Brigham, 2013).

Clinical assessment, which informs forensic psychology, demands a biopsychosocial approach to address the dynamic and complex interaction of social, psychological, and biological factors (Costa-Black et al., 2010; Schultz, 2005; Soucy, Truchon, & Côté, 2006; Waddell & Aylward, 2009). Individuals who have similar injuries and pathologies may thus present distinctly differently, adding degrees of difficulty in assessing (Feinburg & Brigham, 2013). Overall, the *AMA Guides Sixth Edition* (Rondinelli, 2009) offers a modest step towards a biopsychosocial approach, but does not fully resolve ongoing impairment determination issues from current measurement science perspective.

DSM-Based Diagnostic Perspectives on Pain

According to the *DSM-IV-TR* (APA, 2000), three types of chronic diagnosable pain conditions were postulated, two of them diagnosed as mental health disorders: *pain disorder associated with psychological factors*, where psychological factors were judged to have a major role in the onset, severity, exacerbation, or maintenance of pain, and *pain disorder associated with both psychological factors and a general medical condition*, where both psychological factors and a general medical condition are judged to have important roles in the onset, severity, and exacerbation of pain. The third type of pain disorder, associated with a general medical condition, was considered to be a medical and not a mental disorder and thus not included in the *DSM-IV-TR*. These definitions and classification of pain disorder, although acknowledging an importance of both medical and psychological factors, were more consistent with the anachronistic mind-body Cartesian model of pain than with current advances in pain science and the inclusive IASP definition of pain. Clinicians in medicolegal settings struggled to diagnose chronic pain conditions using *DSM-IV-TR* classification because pain is best understood in a biopsychosocial framework and it is difficult, if at all possible, to diagnose a purely psychogenic or purely medically produced chronic pain condition. By default, pain disorder associated with both psychological factors and a general medical condition was therefore often selected as a diagnosis.

The newly published *DSM-5* (APA, 2013) subsumed chronic pain and pain disorders under a broad diagnostic umbrella called *somatic symptom disorder*. Individuals can be diagnosed with this disorder regardless of having a medical diagnosis (e.g., cancer, fibromyalgia, or spinal cord injury). The diagnostic criteria include (A) one or more somatic symptoms that are distressing or result in significant disruption of daily life; (B) excessive thoughts, feelings, and behaviors related to the somatic symptoms or associated health concerns as manifested by one of the following: (1) disproportionate and persistent thoughts about the seriousness of one's symptoms, (2) persistently high level of anxiety about health or symptoms, and (3) excessive time and energy devoted to these symptoms or health concerns; and (C) the state of being symptomatic is persistent (typically more than 6 months). The diagnostic specifier, called "with predominant pain," is applied to individuals with a preponderance of pain symptoms. In addition, there are three levels of severity of this disorder, mild, moderate and severe, depending on which diagnostic criteria are fulfilled.

Although the new diagnostic category does recognize the significance of psychosocial factors in pain, it places diagnosis of chronic pain primarily in the realm of mind and psychiatry, still not fully embracing the biopsychosocial model. The inclusion of pain (and other somatic) symptoms, regardless of diagnosis and medical etiology, in the context of psychopathology is controversial. Many patients with cancer, spinal cord injury, or complex acute and post-acute orthopedic injuries will meet the broad diagnostic criterion of "disproportionate and persistent thoughts about the seriousness of one's symptoms" (APA, 2013, p. 311). While it is unclear what "disproportionate" means, and against which norms this descriptor should be measured, the persistence of thinking of severe and potentially life-threatening pain (such as in cancer or neuropathic pain) is common among individuals with serious illness or disability. In this context, over-pathologizing the typical and expected pain experience and conceptualizing it as a mental disorder is an example of diagnostic threshold and construct validity issues with which *DSM-5* proponents have been struggling. Negative social and treatment implications of having been labeled as having "a diagnosable mental disorder," in addition to suffering due to severe and persistent pain arising from a diagnosable and known pain-producing condition (which often warrants persistent thinking about it due to its pervasive, preoccupying, and disruptive nature), abound. As Young aptly put it, placing pain disorder among somatic disorders "leads to the types of problems that the *DSM-5* draft is trying to rectify in this regard. Clinicians still might gravitate away from it if they feel it is pejorative to the client.

Or, they might unjustly gravitate to it if they wish to emphasize that the patient's medically unexplained symptoms are emotional in their etiologies" (2010, p. 292).

Future research and clinical applications will demonstrate the scope of the impact of the over-inclusive nature of *somatic symptom disorder* diagnosis on future practice, policy, and empirical investigations, not only in the area of pain disability but in health sciences in general. In the meantime, clinicians are expected to exercise caution and thoroughly validate, qualify, and justify their diagnostic statements regarding *somatic symptom disorder* while actively de-biasing their opinions. Inter-rater reliability research for this diagnosis is highly recommended.

Prediction of Musculoskeletal Pain Disability: Searching for an Actuarial Formulae

For musculoskeletal pain, particularly back conditions, empirical, multivariate formulae that predict disability from early clinical signs have reached an impressive 80 % accuracy rate for return-to-work outcomes (Burton, Waddell, & Main, 2003; Linton et al., 2005; Schultz, Crook, Berkowitz, Milner, & Meloche, 2005; Schultz & Gatchel, 2005). Research barriers to advancement include cohort-sample makeup, outcome measure articulation, methodological issues, system-based barriers, heterogeneous follow-up measures, generalization problems to other settings, jurisdictions, and populations, and guideline flaws (Heymans et al., 2006; Linton et al., 2005; Soucy et al., 2006). For employment, rendering evidence-based expert opinions requires an understanding of age of injury onset, chronological age, longitudinal disability course, and psychosocial factors (Schultz, 2009). Hirsh, Molton, Johnson, Bombardier, and Jensen (2009) emphasized for another complex disability, spinal cord issues, the importance of the individual—no "one-size-fits-all" formula exists—and the inclusion of other elements such as cultural background, minority status, gender, and age in psychological injury, pain, and the field of law.

Future work in disability determination will require inclusion of "nontraditional" psychological literature, such as counseling, community, health, and organizational psychology and related health disciplines such as nursing, vocational rehabilitation, occupational and rehabilitation medicine, and occupational therapy. Modifiable and non-modifiable predictors of occupational disability are *both* individual and workplace oriented. A systematic review of these factors was provided in a study by White et al. (2013). Despite empirical support for their significance and modifiability, most of the system-based factors predictive of disability are not covered in medicolegal disability determinations. Approaching psychological injury/pain cases with a transdisciplinary or interdisciplinary approach is recommended (Schultz, 2009).

Subjectivity, Malingering, and Motivational Issues in Pain Disability

As described, significant pain assessment challenges exist. Within a medicolegal setting, this includes the subjective presentation of pain as defined by the IASP and the *AMA Guides Sixth Edition* (2011; Rondinelli, 2009), which contrasts to the demand for objective evidence by the court system, and the fact that most pain is unattributed to a medical cause (Dersh et al., 2005). Other issues include pain defying the biomedical model prevalent in law, the inability to classify pain as either a diagnosis or an injury, questions around if pain itself is a mental disorder, and challenges in interpreting and applying the pain disorder diagnosis using the psychiatrically based *DSM-IV-TR (*APA, 2000) and its over-inclusive successor, *DSM-5* (APA, 2013).

These issues make many researchers, clinicians, and disability stakeholders suspicious of secondary gain and malingering. Researchers postulate that coping and motivational factors mediate disability and impairment (Roessler, 1989; Schultz & Brady, 2003). Coping processes, outcomes, and factors like avoidant coping and catastrophizing have significance as disability predictors (Dunn & Dougherty, 2005; Elliott, Kurylo, & Rivera, 2005; Heinemann, 1995;

Johnson, Zautra, & Davis, 2006; Schultz & Stewart, 2008; Wegener & Shertzer, 2006). More recent research demonstrated the importance of understanding the roles of *perception of injustice* (Sullivan, Feuerstein, Gatchel, Linton, & Pransky, 2005; Sullivan et al., 2008; Sullivan, Adams, & Ellis, 2013), *expectations of return to work* (Schultz et al., 2004, 2005), and the *perception of uncertainty* (Stewart, Polak, Young, & Schultz, 2012) in the development and maintenance of occupational disability and in disability prevention interventions. Unfortunately, these significant psychosocial predictors of disability, despite availability of research-based measurement tools, are not identified routinely within determination of disability (Schultz, 2009). On a positive note, in forensic neuropsychological assessments, determination of assessment validity and testing effort is considered a practice standard (Rohling & Boone, 2007), although methodology in this field continues to require further research and refinement.

Gain as a term implies benefit and, within the medicolegal arena, carries negative connotations, particularly the term secondary gain, often equated with financial gain (Choi et al., 2013). This oversimplification in conjunction with limited understanding of motivational concepts (Schultz, 2009), misinterpretation of constructs (Kennedy, 1946; Mendelson, 1994; Schultz et al., 2000), and the practice of interchangeably applying ill-defined, unsavory “code words” such as malingering, faking, subjective complaints, psychological overlay, exaggeration, illness behavior, lying, deception, and symptom magnification have produced significant challenges for the medicolegal field. The misinterpretation of secondary gain has been itself detrimental to developing important and accurate losses and gains motivational constructs associated with disability (Dersh et al., 2005; Fishbain, Cutler, Rosomoff, & Rosomoff, 1994; Kwan, Ferrari, & Friel, 2001; Leeman, Polatin, Gatchel, & Kishino, 2000).

Psychological literature paints a more complex picture, identifying multiple types and layers of losses and gains experienced by an individual. As a start, however, losses are simply defined as a reduction of an individual’s invested resources (Harvey, 2000). Choi et al. (2013) conducted a literature review and summarized the losses into three levels: primary or initial losses (e.g., job loss, personal injury, loss of autonomy and independence, discrimination, and loss of roles), secondary losses or losses that develop from and can initiate primary losses (e.g., financial loss, loss of roles, self-esteem, autonomy, and capacity, community approval, work social relationships, meaningful relating to society through work, recreational activities, respect from those in helping professions and social network, anger and guilt from disability, social stigma, and new role being undefined and uncomfortable) (Dersh et al., 2005), and tertiary losses. These final losses are linked with an individuals’ illness and is experienced by those other than the individual (e.g., financial hardship, increased responsibility and decreased autonomy, guilt, and stigmatization) (Choi et al., 2013).

Gains are also subdivided into three categories: primary, secondary, and tertiary gains. Primary gains are achieved when a physical symptom reduces inner conflict, stress, or anxiety (e.g., chronic pain can mediate primary gains [Dersh et al., 2005]); secondary gains are created by others and received by an individual; and tertiary gains occur when others, such as significant others and health-care providers, carry on individual’s symptoms (e.g., financial gain, decreased conflict, sympathy from others, increased dependency, gratification of altruistic needs, admiration from others, being viewed as “compassionate”) (Choi et al., 2013; Ferrari & Kwan, 2001; Kwan et al., 2001).

Secondary gains are often associated with financial gain with the medicolegal field and have both external and internal presentation. For the former, this includes aforesaid financial gain such as wage replacement; subsidies; and settlement; avoiding sex; holding a spouse in a marriage or relationship; protection from legal and other obligations such as probationary demands and child-support payments; vocational retraining; skills upgrade; and job manipulation such as promotion; prevention of termination of layoff; and handling of work adjustment or human resources department difficulties. Internal secondary gains include dependence; anger towards stakeholders such as the compensation or legal system, employer, or family; being taken care of; getting sympathy and concern from family and friends; getting "off the hook" from undesirable obligations; differing communication patterns compared to when healthy; drug use; and avoidance of social roles (Dersh et al., 2005).

With chronic pain, secondary losses often outweigh secondary gains. In fact, although the gains may extend disability, the losses are often more powerful psychological factors (Worzer, Kishino, & Gatchel, 2009). Leeman et al. (2000) explained how losses can infiltrate all life areas, impacting social relationships, self-esteem, general world view, employment, financial stability, autonomy, and familial roles. The losses can trigger secondary emotional difficulties, such as anxiety and depression. No evidence suggests that secondary gains can be equated with malingering; resolving litigation or compensation issues does not reduce disability (Bellamy, 1997; Fishbain et al., 1994; Guest & Drummond, 1992; Mendelson, 1994; Norris & Watt, 1983). Poor prognosis in disability claims does not equate with secondary gains. Instead, research has linked it with sick-role reinforcement (Turk, 1997), reduced treatment responsiveness (Hadjistavropoulos, 2004), fear of disability, denial and guarding against getting well due to adversarial challenges (Bellamy, 1997), presence of psychiatric conditions, and patient-clinician relationship difficulties (Allaz et al., 1998).

Researchers have named other impactful losses. Robinson, Gardner, and Luft (1993) documented contextual factors related to the losses, including compensation laws, socioeconomic and workplace factors, and mixed messages from physicians, IMEs, claims adjustors, attorneys, and employers. "Social iatrogenesis" was a term coined by Bellamy (1997) regarding disease production by well-intentioned social programs, symptom rationalization and somatization, and patient-physician relationships. Not surprisingly, research within the medicolegal context has extended to examining perceived justice and fairness within the legal system. Themes include linking disability determination with current understanding of the relationship between perceived injustice and disability; acknowledging further the impact of perceived justice on the compensation process; and encouraging legal professionals to observe for intangible psychosocial issues, particularly regarding breach of contract, and to ask psychologists to evaluate the same. A brief summary of current research is presented below.

Franche et al. (2009) developed and validated an assessment tool examining perceived injustice in relation to heightened disability and pain behavior. Four theoretical domains of justice, namely, procedural, informational, distributive, and interpersonal, underpin this measure. With further validation research using other populations and jurisdictions, this measure could be used in determining disability (Schultz, 2009). Sullivan et al. (2008), Sullivan, Davidson, Garfinkel, Siriapaipant, and Scott (2009) developed another measure of perceived justice. They reported that an increased perception of injustice is linked with more protective pain behaviors compared to a decreased injustice perception. This is regardless of physical task demands. Both authors postulated the significance of evaluating perceived injustice as a key predictor of disability and as a potential intervention target. Relatedly, Hayman (2009) argued that psychological injury and law have more to learn from third parties acting in bad faith and attorneys in regard to complicating the complainant's psychological outcomes after claim events. They discussed the evolution of law in acknowledging intangible losses, in particular mental distress from a contract breach between a disability insurer and claimant where the claimant has been wrongly denied benefits.

Within the medicolegal context, malingering is often linked with secondary gain. In fact, malingering is associated with a small subset of individuals (i.e., 1.25–10.4 % [Fishbain, Cutler, Rosomoff, & Rosomoff, 1999]) engaged in exploitive behaviors for reward gain. This includes having a history of manipulative behaviors, presentation of life outside of the claim as orderly and "normal," and exhibiting noncompliance with treatment (but will attend all disability evaluations for the goal of claim validation) (Leeman et al., 2000; Robinson, Rondinelli, Scheer, & Weinstein, 1997). The *DSM-IV-TR* defined malingering as "the *intentional* production of false or grossly exaggerated physical or psychological symptoms, *motivated* by external incentives" (p. 739) (emphasis added). The *DSM-5* included malingering under V-codes associated with the same category as before, now called nonadherence to medical treatment, and provides the same problematic and poorly validated diagnostic criteria as *DSM-IV-TR*: medicolegal context, discrepancy between the person's claimed stress or disability and the objective findings, lack of cooperation, and the presence of an *antisocial personality disorder* (APA, 2000, 2013). A related but broader issue is deception, understood as an attempt to induce in a perceiver a false judgment or belief by deliberately providing false information (Craig & Badali, 2004).

Issues in Assessing Secondary Gain and Malingering in Pain

Assessing for secondary gain and malingering pain is a complex and challenging clinical and medicolegal task with difficulties including:

- Secondary gain issues such as measurement difficulties due to its psychoanalytic origin, conflicting psychological theories, and abuse of term in forensic practice.
- Oversimplification of complex motivational processes, including isolating the gains from the losses, "partial" malingering, exaggeration, proving intentionality of behavior, and malingering being associated with self-deception.
- Usage of dichotomous, moralistic, and anachronistic thinking (i.e., malingerer versus "honest") occurs regularly in clinical and forensic settings. In fact, most individuals have secondary gains.
- Highly variable and often exaggerated base rates of malingering behavior (Fishbain et al., 1999).
- Research design difficulties such as a paid simulation design versus using actual individuals that malinger, claim status used as a proxy for malingering, equating unreliable effort in testing with malingering, and lack of control for non-malingering factors that impact effort (e.g., fatigue, pain, ADHD, dissociation, and seizures).
- Lack of empirical evidence for most methods of malingering detection (with the possible exclusion of isokinetic testing as demonstrated by Fishbain et al. (1999)); methods lacking evidentiary support include facial expressions, grip strength, isometric techniques, clinical examination methods, and forced choice methods.
- No evidence for the association between Waddell signs and secondary gain and malingering (Fishbain Cutler, Rosomoff, & Rosomoff, 2003, 2004). In fact, the signs were developed to determine good outcome from surgery, not to detect malingering (Feinburg & Brigham, 2013).

In addition, practice in this area, due to its construct validity and empirical support issues, in the context of polarization and politicization of opinions, continues to be prone to clinicians' bias in assessment. This problem is often associated with an assessor's confirmatory bias (a tendency to support an initial hypothesis) and a fundamental attribution error (a tendency to attribute observed individual behavior to a person rather than situation or the interaction between a person and situation), and a host of other cognitive and potentially also cultural biases. It is important to use systematic measures to de-bias high-stakes pain disability assessments, by the generation and exploration of alternative hypotheses, delayed judgment, maintaining detailed case notes and observations, the use of multimethod approaches, and the application of complex clinical conceptualizations to avoid case simplification and premature termination of assessment (APA Task Force on Guidelines for Assessment and Treatment of Persons with Disabilities 2012; Sandoval, 1998).

Knowledge Mobilization in Pain Malingering: Examples of Challenges of Translating Research into Practice

Bianchini, Greve, and Glynn (2005) proposed five potentially promising criteria for diagnosing malingering-related pain disability.

They recommended examining evidence for (A) significant external incentives; (B) physical evaluation; (C) cognitive/perceptual examination (neuropsychological testing); (D) self-report; and (E) behavior meeting criteria B, C, and D, not fully accounted for by other psychiatric, neurologic, or developmental factors. Strengths of this approach include attempts to operationalize malingering, standardize assessment, and stimulate research and use of qualifiers such as "probable," "definite," and "possible." This approach shows superiority to the *AMA Guides Sixth Edition* assessment protocol, which nearly exclusively relies on subjective reporting methods using nonempirically validated methods. This extends to the five assessment factors offered for physicians to consider in assessment of malingering and effort issues, namely, (1) congruency with established conditions, (2) consistency over time and situation, (3) consistency with anatomy and physiology (recommending Waddell's signs, known to be an unreliable source for assessing secondary gain issues, as a tool, and suggestions towards inclusion of other factors such as cultural considerations in the assessment), (4) interobserver agreement from relatives and other professionals, and (5) "inappropriate" illness behavior (Rondinelli, 2009, pp. 38–39). Despite promise with Bianchini et al.'s (2005) approach, though, weaknesses hamper this method. They include criterion C (neuropsychological testing), not having proven relevancy for pain evaluation, no empirical basis or psychometric data to support the criterion, bias and judgment error possibilities in the "discrepancies" assessment, and the extreme complexity in clinical administration of the assessment, which impacts reliability (i.e., the more complex clinical judgment required, the lower the reliability of measurement). Surveillance sample problems (i.e., no norms, context recognition, or randomization [samples of convenience used]), difficulties with representativeness of observations, outdoor activities, and ignoring of pain and distress variability pose another issue. Other weaknesses include no built-in bias removal methodology, use of a simplified concept of malingering (i.e., yes or no), controversies around the Fake Bad Scale (FBS) on the *Minnesota Multiphasic Personality Inventory* (MMPI-II) (Butcher, Gass, Cumella, Kally, & Williams, 2008), and unresolved issues of intentionality measurement.

Caution concerning judgments of deception or malingering in pain is warranted, as explained by Craig and Badali (2004), following evidence-informed considerations:

- No specific markers are identified; the task requires judgment of the pattern of evidence.
- People can be successful in both exaggerating and suppressing evidence of pain.
- Judgments of deception require a judgment of conscious intent.
- Specific signs associated with deception often are observed in honest people.
- Absence of physical pathology consistent with self-report is only suggestive.
- Lack of treatment adherence is commonplace among honest people.
- Self-report is vulnerable to bias.
- Nonverbal behavior can be dissimulated, but self-monitoring is less rigorous.
- Distinction between evidence-based and speculative observations needs to be recognized.
- Financial compensation is not invariably linked to pain-related disability.
- Neither demographic nor personality characteristics predict pain deception.
- Unclear symptom presentation typifies some painful conditions and some honest people.
- Psychometric scales addressing credibility are not specific to lying about pain.
- Inconsistencies during assessment are not unique to those engaged in deception.
- Medically incongruent pain behavior is not specific to deception.
- Confidence in complex judgments is usually unrelated to detection accuracy.

Understanding these important considerations in clinical forensic assessment of musculoskeletal pain and in disability determination is bound to improve their methodological standards and make them more science based, objective, and bias-free. Inclusion of this body of knowledge in training of future and current pain impairment and disability assessors is paramount.

Best Practices on Assessment of Malingering and Effort Issues in Pain Disability

Research evidence supports a number of best practices to help mitigate the significant challenges in assessing malingering and effort issues in pain disability, as delineated below:

- Assess all motivational factors. This includes primary, secondary, and tertiary gains and losses involved in disability claims and the relationships among them. Include an economy of gains and losses. Perceived secondary and tertiary losses, for example, might enable disability particularly when the losses increase feelings of helpless and hopelessness. An individuals' motivation to return to work is assumed to increase as secondary losses outweigh secondary gains (with the converse applicable as well) (Choi et al., 2013).
- Use a multimethod approach. That is to say: observe verbal and nonverbal cues over time; review a full range of records; analyze test results; use tests of symptom validity and validity scales on known emotional status measures (ensure that tests have good psychometric properties and are fair with respect to disability type, gender, age, ethnicity, and cultural factors); as well as review qualitative patterns and collateral data.
- Never rely on single source of evidence or salient data.
- Apply bias removal techniques before rendering an opinion (Sandoval, 1998). Use complex case formulation, delay judgment, and generate alternative hypotheses.
- Do not diagnose malingering unless proof of intentional falsification of symptoms is present.
- Do not use "code words" to imply possible exaggeration or malingering without actually saying so directly and presenting evidence to support it.

These recommended evidence-informed practices, which are quite universal across health professions involved in these determinations, would benefit from inclusion in newly developed training and licensing programs for medicolegal evaluators of musculoskeletal pain and disability. Furthermore, the actual assessment of motivational factors in pain, often casually performed in current clinical practice, deserves words of caution. This assessment area constitutes the most challenging and error-prone part of any pain disability or impairment assessment, and it requires a thorough knowledge of current construct validity issues, psychosocial research base (with its limitations), and psychometrically sound instruments. Clinicians without specialized training in this field, who provide direct or oblique opinions on these matters, are vulnerable to assessment validity problems and violation of professional and ethical standards of practice.

Conclusions: Towards the Future

Medicolegal controversies in diagnosis, assessment, and determination of musculoskeletal pain-related impairment and disability continue despite recent research advances and proliferation of new science-based methodological approaches within the context of ongoing validation and the refinement of the biopsychosocial model of pain disability. These ongoing issues are best addressed with the advancement of knowledge and research in the field, together with prompt knowledge mobilization to reach clinicians-users in forensic practice contexts. Existing clinical and evidentiary gap areas include:

- Standardization of musculoskeletal pain assessment, validity, reliability, and fairness of utilized diagnostic and predictive methodologies (including AMA Guides, *DSM-5*, and various pain assessment and test protocols) in musculoskeletal pain.
- Balancing idiosyncratic clinical and empirically based procedures; effectiveness of de-biasing approaches.
- Risk for disability determination formulae for different contexts, populations, and types of musculoskeletal pain.
- Balancing sensitivity and specificity in empirical predictive models of disability.
- Complexity of the relationship between pain-related impairment and disability.

- Inclusion of contextual factors, such as occupational demands and supports and other environmental/system factors, together with implementation of construct- and evidence-supported methodology in the assessment of effort, malingering, and economy of primary, secondary, and tertiary gains and losses.

Forensic psychologists particularly are challenged with translating conceptual, research, and methodological advances regarding psychosocial factors associated with musculoskeletal pain disability to the medicolegal practice. Difficulties include the inclusion of an appropriate balance between: (1) individual psychosocial predictors of pain disability, such as beliefs, expectations, coping, catastrophizing, perception of uncertainty and perception of injustice, fear and avoidance of movement, and pain behavior, such as guarding, and (2) quantitative and qualitative assessment data and job, workplace, and other system- related factors (e.g., Schultz & Stewart, 2008; White et al., 2013).

Since the introduction of the then revolutionary IASP definition of pain 15 years ago, knowledge in the field of pain and pain disability has accumulated rapidly. Now, both pain scientists and clinicians may be ready for an empirically and conceptually informed update of the definition of pain that would facilitate its operationalization. Forensic practice, theory, and research in the musculoskeletal pain field does require a consistent and updated definition of pain in order to eliminate disconnection areas among them and to advance valid, reliable, and fair diagnostic and prognostic approaches.

Pain disability stakeholders, including individuals with pain, justice and compensation systems, health-care and rehabilitation systems, policymakers, and employers and unions ultimately have a vested interest in improved translation of science to practice in the field. This is despite differing definitions of disability and social and economic agendas. As physicians, psychologists, occupational therapists, and vocational rehabilitation professionals share similar conceptual and methodological challenges in the medicolegal context, multidisciplinary approaches to knowledge-translation efforts and development of evidence-informed practice guidelines will be beneficial.

References

Allaz, A., Vannotti, M., Desmeules, J., Piguet, V., Celik, Y., Pyroth, O., et al. (1998). Use of the label 'litigation neurosis' in patients with somatoform pain disorder. *General Hospital Psychiatry, 20*, 91–97.

Altman, B. (2001). Disability definitions, models, classification schemes, and applications. In G. L. Albrecht, K. D. Seelman, & M. Bury (Eds.), *Handbook of disability studies*. Thousand Oaks, CA: Sage Publications.

American Medical Association. (1993). *Guides to the evaluation of permanent impairment* (4th ed.). Chicago: AMA Press.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

American Psychological Association Task Force on Guidelines for Assessment and Treatment of Persons with Disabilities. (2012). Guidelines for assessment of and intervention with persons with disabilities. *American Psychologist, 67*(1), 43–62.

Americans with Disabilities Act of 1990, 42 U.S.C.A. § 12101 *et seq*. (West 1993).

Amick, B. C., III, Rogers, W. H., Malspies, S., Bungay, K., & Cynn, D. (2001). The Work Limitations Questionnaire. *Medical Care, 39*(1), 72–85.

Atkinson, R. L. (2009). Assessment of pain in the AMA6 Guides. *ANZ Journal of Surgery, 79*(Suppl. 1), A53.

Barth, R. J. (2009a). Examinee-reported history is not a credible basis for clinical or administrative decision making. *AMA Guides Newsletter*, Sept–Oct.

Barth, R. J. (2009b). A historical review of complex regional pain syndrome in the "Guides Library". *AMA Guides Newsletter*, Nov–Dec.

Barth, R. J., & Brigham, C. R. (2005). Who is in the better position to evaluate, the treating physician or an independent examiner? *AMA Guides Newsletter*, Sept–Oct.

Beck, K. A., & Schultz, I. Z. (2000). *Translating psychological impairment into occupational disability ratings: A decision making model* (Research Report). Vancouver, Canada: Workers' Compensation Board of British Columbia.

Bellamy, R. (1997). Compensation neurosis: Financial reward for illness as nocebo. *Clinical Orthopaedics, 336*, 94–106.

Bellamy, N., & Campbell, J. (2009). A selective critical but constructive desktop appraisal of the American Medical Association Guides to the Evaluation of Permanent Impairment (AMA 6). *International Journal of Disability Management Research, 4*(2), 27–51.

Bergner, M., Bobbitt, R. A., Carter, W. B., & Gilson, B. S. (1981). The sickness impact profile: development and final revision of a health status measure. *Medical Care, 19*, 787–805.

Bianchini, K. J., Greve, K. W., & Glynn, G. (2005). On the diagnosis of malingered pain-related disability: Lessons from cognitive malingering research. *The Spine Journal, 5*, 404–417.

Bickenbach, J. E., Chatterji, S., Badley, E. M., & Ustin, T. B. (1999). Models of disablement, universalism and the international classification of impairments, disabilities and handicaps. *Social Science and Medicine, 48*, 1173–1187.

Boorse, C. (1975). On the distinction between disease and illness. *Philosophy and Public Affairs, 5*, 49.

Boorse, C. (1977). Health as a theoretical concept. *Philosophy and Science, 44*, 542.

Brandt, E. N., & Pope, A. M. (Eds.). (1997). *Enabling America: Assessing the role of rehabilitation science and engineering*. Washington, DC: National Academy Press.

Broderick, J. E., Schwartz, J. E., Vikingstad, G., Pribbernow, M., Grossman, S. S., & Stone, A. A. (2008). The accuracy of pain and fatigue items across different reporting periods. *Pain, 139*, 146–157.

Burton, G., Waddell, A. K., & Main, C. (2003). *Screening to identify people at risk of long-term incapacity for work: A conceptual and scientific review*. London: Royal Society of Medicine Press.

Butcher, J. N., Gass, C. S., Cumella, E., Kally, Z., & Williams, C. L. (2008). Potential for bias in MMPI-2 assessments using the Fake Bad Scale (FBS). *Psychological Injury and Law, 1*(13), 191–209.

Cherry, D., Burt, C., & Woodwell, D. (2001). *National ambulatory medical care survey: 1999 summary* (advanced data from vital and health statistics, no. 322). Hyattsville, MD: National Center on Health Statistics.

Choi, Y., Asih, S. R., & Polatin, P. B. (2013). Understanding motivation to return to work: The economy of gains and losses. (Manuscript submitted for publication).

Cocchiarella, L., & Andersson, G. B. J. (Eds.). (2000). *Guides to the evaluation of permanent impairment* (5th ed.). Chicago: American Medical Association Press.

Comer, J. S., Olfson, M., & Mojtabai, R. (2010). National trends in children and adolescent psychotropic polypharmacy in office-based practice, 1996–2007. *Journal of the American Academy of Child and Adolescent Psychiatry, 49*(10), 1001–1010.

Costa-Black, K. M., Loisel, P., Anema, J. A., & Pransky, G. (2010). Back pain and work. *Best Practice & Research. Clinical Rheumatology, 24*, 227–240.

Craig, K. D., & Badali, M. A. (2004). Introduction to the special series on the detection of pain deception and malingering. *Clinical Journal of Pain, 20*, 377–382.

DePoy, E., & Gilson, S. F. (2004). *Rethinking disability: Principles for professional and social change*. Belmont, CA: Thomson/Brooks/Cole.

Dersh, J., Polatin, P., Leeman, G., & Gatchel, R. (2005). Secondary gains and losses in the medicolegal setting. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims* (pp. 421–443). New York: Springer.

Dunn, D. S., & Dougherty, S. B. (2005). Prospects for a positive psychology of rehabilitation. *Rehabilitation Psychology, 50*(3), 305–311.

Elliott, T. R., Kurylo, M., & Rivera, P. (2005). Positive growth following acquired physical disability. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 687–699). New York: Oxford University Press.

Engel, G. (1977). The need for a new medical model: A challenge in biomedicine. *Science, 196*, 129–136.

Feinburg, S. D., & Brigham, C. R. (2013). Assessing disability in the pain patient. In T. R. Deer, M. S. Leong, A. Buvanendran, V. Gordin, P. S. Kim, S. J. Panchal, & A. L. Ray (Eds.), *Comprehensive treatment of chronic pain by medical, interventional, and integrative approaches* (pp. 1031–1043). New York: Springer.

Ferrari, R., & Kwan, O. (2001). The no-fault flavor of disability syndromes. *Medical Hypotheses, 56*(1), 77–84.

Fine, M., & Asch, A. (1988). Disability beyond stigma: Social interaction, discrimination, and activism. *Journal of Social Issues, 44*, 3–21.

Fishbain, D. A., Cutler, R. B., Rosomoff, R. S., & Rosomoff, H. L. (1994). The problem-oriented psychiatric examination of the chronic pain patient and its application to the litigation consultation. *Clinical Journal of Pain, 10*(1), 28–51.

Fishbain, D. A., Cutler, R., Rosomoff, H. L., & Rosomoff, R. S. (1999). Chronic pain disability exaggeration/malingering and submaximal effort research. *Clinical Journal of Pain, 15*(4), 244–274.

Fishbain, D. A., Cutler, R., Rosomoff, H. L., & Rosomoff, R. S. (2003). Chronic pain disability exaggeration/malingering and submaximal effort research. In I. Z. Schultz & D. O. Brady (Eds.), *Psychological injuries at trial*. Chicago: American Bar Association.

Fishbain, D. A., Cutler, R., Rosomoff, H. L., & Rosomoff, R. S. (2004). Is there a relationship between nonorganic physical findings (Waddell signs) and secondary gain/malingering? *Clinical Journal of Pain, 20*(6), 399–408.

Forst, L., Friedman, L., & Chukwu. A. (2010). Reliability of the AMA Guides to the Evaluation of Permanent Impairment. *Journal of Environmental Medicine, 52*(12), 1201–1203.

Franche, R.-L., Severin, C. N., Lee, H., Hogg-Johnson, S. H., Hepburn, C. G., Vidmar, M., et al. (2009). Perceived justice of compensation process for return-to-work: Development and validation of a scale. *Psychological Injury and Law, 2*(3–4), 225–237.

Gatchel, R. J., Mayer, T. C., & Theodore, B. R. (2006). The Pain Disability Questionnaire: Relationship to one-year functional and psychosocial rehabilitation outcomes. *Journal of Occupational Rehabilitation, 16*(1), 75–94.

Gilson, B. S., Gilson, J. S., Bergner, M., Bobbitt, R. A., Kressel, S., Pollard, W. E., et al. (1975). The sickness impact profile: Development of an outcome measure of health care. *American Journal of Public Health, 65*, 1304–1310.

Gladwin, C. H. (1989). *Ethnographic decision tree modeling.* Newbury Park, CA: Sage Publications.

Gnam, W. H. (2005). The prediction of occupational disability related to depressive and anxiety disorders. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention, and prevention* (pp. 371–384). New York: Springer.

Guest, G., & Drummond, P. (1992). Effect of compensation on emotional state and disability in chronic back pain. *Pain, 48*(2), 125–130.

Hadjistavropoulos, T. (2004). Ethics for psychologists who treat, assess and/or study pain. In T. Hadjistavropoulos & K. D. Craig (Eds.), *Pain: Psychological perspectives* (pp. 327–344). Mahwah, NJ: Lawrence Erlbaum Associates.

Halpern, A. S., & Fuhrer, M. J. (1984). *Functional assessment in rehabilitation*. Baltimore: Paul H. Brooks.

Harvey, J. (2000). *Give sorrow words: Perspectives on loss and trauma*. Philadelphia: Brunner/Mazel.

Hayman, F. E. (2009). Damages for mental distress and bad faith in disability claims. *Psychological Injury and Law, 2*(3–4), 248–253.

Heinemann, A. W. (1995). Measures of coping and reaction to disability. In L. A. Cushman & M. Scherer (Eds.), *Psychological assessment in medical rehabilitation* (pp. 39–90). Washington, DC: American Psychological Association.

Heymans, M. W., de Vet, H. C. W., Knol, D. L., Bongers, P. M., Koes, B. W., & van Mechelen, W. (2006). Workers' beliefs and expectations affect return to work over 12 months. *Journal of Occupational Rehabilitation, 16*, 685–695.

Hing, E., Cherry, D. K., & Woodswell, D. A. (2006). *National ambulatory medical care survey: 2004 summary* (advanced data from vital and health statistics, no. 374). Hyattsville, MD: National Center on Health Statistics.

Hirsh, A. T., Molton, I. R., Johnson, K. L., Bombardier, C. H., & Jensen, M. P. (2009). The relationship of chronological age, age at injury, and duration of injury to employment status in individuals with spinal cord injury. *Psychological Injury and Law, 2*(3–4), 199–204.

Imrie, R. (2004). Demystifying disability: A review of the International Classification of Functioning, Disability and Health. *Sociology of Health & Illness, 26*, 287–305.

International Association for the Study of Pain, Subcommittee on Taxonomy (IASP) (2011). *Classification of chronic pain: Descriptions of chronic pain syndromes and definitions of pain terms* (2nd ed., revised). Retrieved from http://www.iasp-pain.org/Content/NavigationMenu/Publications/FreeBooks/Classification_of_Chronic_Pain/default.htm.

Johnson, L. M., Zautra, A. J., & Davis, M. C. (2006). The role of illness uncertainty on coping with fibromyalgia symptoms. *Health Psychology, 25*(6), 696–703.

Kennedy, F. (1946). The mind of the injured worker: Its effect on disability. *Compensation Medicine, 1*, 19–24.

Knauf, M. T., Schultz, I. Z., (2013). Models of return to work for musculoskeletal disorders: An update. In R. J. Gatchel & I. Z. Schultz (Eds.), *Handbook of musculoskeletal disorders in the workplace.* New York: Springer.

Kwan, O., Ferrari, R., & Friel, J. (2001). Tertiary gain and disability syndromes. *Medical Hypotheses, 57*(4), 459–464.

Leeman, G., Polatin, P. B., Gatchel, R. J., & Kishino, N. (2000). Managing secondary gain in patients with pain-associated disability: A clinical perspective. *Journal of Workers Compensation, 9*(4), 25–44.

Lerner, D., Amick, B., Rogers, W. H., Malspeis, S., Bungay, K., & Cynn, D. (2001). The Work Limitations Questionnaire. *Medical Care, 39*, 72–85.

Linton, S. J. (2001). Occupational psychological factors increase the risk for back pain: A systematic review. *Journal of Occupational Rehabilitation, 11*, 53–66.

Linton, S. J., Gross, D., Schultz, I. Z., Main, C. J., Côté, P., Pransky, G., et al. (2005). Prognosis and the identification of workers risking disability: Research issues and directions for future research. *Journal of Occupational Rehabilitation, 15*, 459–474.

Lutz, B. J., & Bowers, B. J. (2007). Understanding how disability is defined and conceptualized in the literature. In A. E. Dell Orto & P. W. Power (Eds.), *The psychological and social impact of illness and disability* (5th ed., pp. 11–21). New York: Springer.

Mendelson, G. (1994). Chronic pain and compensation issues. In P. D. Wall & R. Melzack (Eds.), *Textbook of pain* (3rd ed., pp. 1387–1400). New York: Churchill Livingstone.

Meyerson, L. (1988). The social psychology of disability: 1948 and 1988. *Journal of Social Issues, 44*, 173.

Mojtabai, R., & Olfson, M. (2008). National trends in psychotherapy by office-based psychiatrists. *Archives of General Psychiatry, 65*(8), 962–970.

Mojtabai, R., & Olfson, M. (2011). Proportion of antidepressants prescribed without a psychiatric diagnosis is growing. *Health Affairs, 30*(8), 1434–1442.

Norris, S., & Watt, I. (1983). The prognosis of neck injuries resulting from rear-end vehicle collisions. *Journal of Bone Joint Surgery, 65*(B), 608–611.

Olkin, R., & Pledger, C. (2003). Can disability studies and psychology join hands? *American Psychologist, 58*(4), 296–304.

Peterson, D. B. (2011). *Psychological aspects of functioning, disability, and health.* New York: Springer Publishing Company.

Peterson, D., & Paul, H. (2009). Using the international classification of functioning, disability & health (ICF) to conceptualize disability and functioning in psychological injury and law. *Psychological Injury and Law, 2*(3–4), 205–214.

Picavet, H. S., & Schouten, J. S. (2003). Musculoskeletal pain in the Netherlands: Prevalences, consequences and risk groups, the DMC(3)-study. *Pain, 102*(1–2), 167–178.

Pope, A. M., & Tarlov, A. R. (1991). *Disability in America: Toward a national agenda for prevention*. Washington, DC: National Academy Press.

Praemer, A., Furner, S., & Rice, D. (1999). *Musculoskeletal conditions in the United States*. Rosemont, IL: American Academy of Orthopaedic Surgeons.

Pransky, G., Gatchel, R. J., Linton, S. J., & Loisel, P. (2005). Improving return to work research. *Journal of Occupational Rehabilitation, 15*, 453–457.

Robinson, J. C., Gardner, L. B., & Luft, H. S. (1993). Health plan switching and anticipated increased medical care utilization. *Medical Care, 31*(1), 42–51.

Robinson, J. P., Rondinelli, R. D., Scheer, S. J., & Weinstein, S. M. (1997). Industrial rehabilitation medicine. 1. Why is industrial rehabilitation medicine unique? *Archives of Physical & Medical Rehabilitation, 78*(3 Suppl.), S3–S9.

Robinson, J. P., Turk, D. C., & Loeser, J. D. (2004). Pain, impairment, and disability in the AMA Guides. *Journal of Law, Medicine, and Ethics, 32*, 315–326.

Roessler, R. T. (1989). Motivational factors influencing return to work. *Journal of Applied Rehabilitation Counseling, 20*, 14–17.

Rohling, M. L., & Boone, K. B. (2007). Future directions in effort assessment. In K. B. Boone (Ed.), *Assessment of feigned cognitive impairment: A neuropsychological perspective* (pp. 453–469). New York: Guilford.

Rondinelli, R. D. (Ed.). (2009). *Guides to the evaluation of permanent impairment* (6th ed., revised). Chicago: American Medical Association Press.

Rondinelli, R. D. (2010). Commentary on reliability of AMA Guides to the Evaluation of Permanent Impairment. *Journal of Environmental Medicine, 52*(12),1204–1205.

Rondinelli, R. D., & Eskay-Auerbach, M. (2009). *Transition to the AMA Guides Sixth: Guides to the evaluation of permanent impairment* (6th ed.). Chicago: AMA Press.

Sandoval, J. (1998). Critical thinking in test interpretation. In J. Sandoval, C. L. Frisby, K. F. Geisinger, J. D. Scheuneman, & J. R. Grenier (Eds.), *Test interpretation and diversity: Achieving equity in assessment* (pp. 31–50). Washington, DC: American Psychological Association.

Schultz, I. Z. (2005). Impairment and occupational disability in research and practice. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention* (pp. 25–41). New York: Springer.

Schultz, I. Z. (2008). Disentangling the disability quagmire in psychological injury: Part 1—Disability and return to work: Theories, methods, and applications. *Psychological Injury and Law, 1*, 94–102.

Schultz, I. Z. (2009). Determining disability: New advances in conceptualization and research. *Psychological Injury and Law, 2*(3–4), 199–204.

Schultz, I. Z., & Brady, D. O. (2003). *Psychological injuries at trial*. Chicago: American Bar Association.

Schultz, I. Z., & Chlebak, C. M. (2013). Bridging the gap: Evidence-informed best practices for injured workers in critical musculoskeletal and mental health disabilities. (Manuscript submitted for publication).

Schultz, I. Z., Crook, J., Berkowitz, J., Milner, R., & Meloche, G. R. (2005). Predicting return to work after low back pain injury using the psychosocial risk for occupational disability instrument: A validation study. *Journal of Occupational Rehabilitation, 15*(3), 365–376.

Schultz, I. Z., Crook, J., Fraser, K., & Joy, P. W. (2000). Models of diagnosis and rehabilitation in musculoskeletal pain-related occupational disability. *Journal of Occupational Rehabilitation, 10*, 271–293.

Schultz, I. Z., Crook, J., Meloche, G. R., Berkowitz, J., Milner, G. R., & Zuberbier, O. A. (2004). Psychosocial factors predictive of occupational low back disability: Towards development of return to work model. *Pain, 107*, 77–85.

Schultz, I. Z., & Gatchel, R. J. (2005). Research and practice directions in risk for disability prediction and early intervention. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention, and prevention* (pp. 523–540). New York: Springer.

Schultz, I. Z., Krupa, T., & Rogers, S. E. (2011). Best practices in accommodating and retaining persons with mental health disabilities: Answered and unanswered questions. In I. Z. Schultz & E. S. Rogers (Eds.), *Work accommodation and retention in mental health* (pp. 445–466). New York: Springer.

Schultz, I. Z., & Stewart, A. M. (2008). Disentangling the disability quagmire in psychological injury: Part 1—Evolution of disability models: Conceptual, methodological and forensic practice issues. *Psychological Injury and Law, 1*, 103–121.

Schultz, I. Z., Stowell, A. W., Feuerstein, M., & Gatchel, R. J. (2007). Models of return to work for musculoskeletal disorders. *Journal of Occupational Rehabilitation, 17*, 327–352.

Schultz, I. Z., Winter, A., Milner, R., Zuberbier, O., Krupa, T., et al. (2007). *Towards best evidence-informed workplace practices for job accommodations for persons with mental health disabilities: Integration of evidence*. Unpublished manuscript.

Schultz, I. Z., Winter, A., & Wald, J. (2011). Evidentiary support for best practices in job accommodation in mental health: Employer-level interventions. In I. Z. Schultz & E. S. Rogers (Eds.), *Work accommodation and retention in mental health* (pp. 409–424). New York: Springer.

Shriver, M. D., Anderson, C. M., & Proctor, B. (2001). Evaluating the validity of functional behavior assessment. *School Psychology Review, 30*(2), 180–192.

Smart, J. F. (2001). *Disability, society, and the individual*. Austin, TX: Pro-Ed.

Smart, J. F., & Smart, D. W. (2007). Models of disability: Implications for the counseling profession. In A. E. Dell Orto & P. W. Power (Eds.), *The psychological and social impact of illness and disability* (5th ed., pp. 75–100). New York: Springer.

Soucy, I., Truchon, M., & Côté, D. (2006). Work-related factors contributing to chronic disability in low back pain. *Work, 26*, 313–326.

Stewart, A. M., Polak, E., Young, R., & Schultz, I. Z. (2012). Injured workers' construction of expectations of return to work with sub-acute back pain: The role of perceived uncertainty. *Journal of Occupational Rehabilitation, 1*, 1–14.

Stone, A. A., Broderick, J. E., Shiffman, S. S., & Schwartz, J. E. (2004). Understanding recall of weekly pain from a momentary assessment perspective: Absolute agreement, between- and within-person consistency, and judged change in weekly pain. *Pain, 107*, 61–69.

Sullivan, M. J. L., Adams, H., & Ellis, T. (2013). A psychosocial risk-targeted intervention to reduce work disability: Development, evolution, and implementation changes. *Psychological Injury and Law, 6*, 250–257.

Sullivan, M. J. L., Adams, H., Horan, S., Mahar, D., Boland, D., & Gross, R. (2008). The role of perceived injustice in the experience of chronic pain and disability: Scale validation and development. *Journal of Occupational Disability, 18*(3), 249–261.

Sullivan, M. J. L., Davidson, N., Garfinkel, B., Siriapaipant, N., & Scott, W. (2009). Perceived injustice is associated with heightened pain behavior and disability in individuals with whiplash injuries. *Psychological Injury and Law, 2*(3–4), 238–247.

Sullivan, M. J. L., Feuerstein, M., Gatchel, R. J., Linton, S. J., & Pransky, G. (2005). Integrating psychosocial and behavioral interventions to achieve optimal rehabilitation outcomes. *Journal of Occupational Rehabilitation, 15*(4), 475–489.

Tate, D. G., & Pledger, C. (2003). An integrative conceptual framework of disability: New directions for research. *American Psychologist, 58*(4), 289–295.

Turk, D. C. (1997). The role of demographic and psychosocial factors in transition from acute to chronic pain. In T. S. Jensen, J. A. Turner, & Z. Wisenfeld-Hallin (Eds.), *Proceedings of the 8th World Congress on pain: Progress in pain research and management* (Vol. 8, pp. 185–213). Seattle, WA: IASP Press.

Turk, D. C., & Melzack, R. (2011). The measurement of pain and the assessment of people experiencing pain. In D. C. Turk & R. Melzack (Eds.), *Handbook of pain assessment* (pp. 3–18). New York: The Guildford Press.

Verbrugge, L. M., & Jette, A. M. (1994). The disablement process. *Social Science and Medicine, 38*, 1–14.

Waddell, G. (2004). *The back pain revolution* (2nd ed.). Edinburgh: Churchill Livingstone.

Waddell, G., & Aylward, M. (2009). *Models of sickness and disability applied to common health problems*. London: Royal Society of Medicine Press.

Waddell, G., Aylward, M., & Sawney, P. (2002). *Back pain, incapacity for work and social security benefits*. London: Royal Society of Medicine Press.

Wald, J., & Taylor, S. (2009). Work impairment and disability in posttraumatic stress disorder: A review and recommendations for psychological injury research and practice. *Psychological Injury and Law, 2*(3–4), 254–262.

Watson, P. J. (2011). Clinical assessment of low back pain. In D. C. Turk & R. Melzack (Eds.), *Handbook of pain assessment* (pp. 294–308). New York: The Guildford Press.

Wegener, S. T., & Shertzer, E. L. (2006, August). Foundations of rehabilitation psychology: Adaptation and emotion. In *American Psychological Symposium #3134*. Symposium conducted at the annual convention of the American Psychological Association of the Department of Physical Medicine and Rehabilitation, Johns Hopkins University School of Medicine, New Orleans, LA.

White, M., Wagner, S., Schultz, I. Z., Murray, E., Bradley, S. M., Hsu, V., et al. (2013). Modifiable workplace risk factors contributing to workplace absence across health conditions: A stakeholder-centred best-evidence synthesis of systematic reviews. *Work, 45*(4), 475–492. Advance online publication.

World Health Organization (WHO). (1980). *International classification of impairments, disabilities, and handicaps: A manual of classification relating to the consequences of disease*. Geneva, Switzerland: Author.

World Health Organization (WHO). (2001). *ICF: The International Classification of Functioning, Disability, and Health*. Geneva, Switzerland: Author.

World Health Organization (WHO). (2003). *The burden of musculoskeletal conditions at the start of the new millennium* (WHO Technical Report Series No. 919). Retrieved from http://whqlibdoc.who.int/trs/WHO_TRS_919.pdf/.

Worzer, W. E., Kishino, N. D., & Gatchel, R. J. (2009). Primary, secondary, and tertiary losses in chronic pain patients. *Psychological Injury and Law, 2*(3–4), 215–224.

Yoman, J., & Edelstein, B. A. (1994). Functional assessment in psychiatric disability. In J. R. Bedell (Ed.), *Psychological assessment and treatment of persons with severe mental disorders* (pp. 31–56). Washington, DC: Taylor & Francis.

Young, A. E. (2010). Chronic pain in the DSM-IV and the DSM-5 draft: The pain of it all. *Psychological Injury and Law, 3*, 289–294.

Young, A. E., Wasiak, R., Roessler, R. T., McPherson, K. M., Anema, J. R., & van Poppel, N. M. (2005). Return-to-work outcomes following work disability: Stakeholder motivations, interests and concerns. *Journal of Occupational Rehabilitation, 15*, 543–556.

Zuberbier, O. A., Hunt, D. G., Kozlowski, A., Berkowitz, J., Schultz, I. Z., Crook, J. M., et al. (2001). Commentary on the AMA guides lumbar impairment validity checks. *Spine, 26*(24), 2735–2737.

Workers' Compensation and Other Disability Insurance Systems Involved in Occupational Musculoskeletal Disorders

15

Richard C. Robinson and John P. Garofalo

Overview

Over the last century, rights for injured workers and protections for employers have developed and evolved considerably. Furthermore, "social safety net" programs, such as Social Security Disability Insurance that developed as part of Franklin Roosevelt's "New Deal," continue to play a significant role for individuals with occupational musculoskeletal disorders. In 2010, approximately 57 million Americans between the ages of 21 and 64 were classified as disabled (U. S. Census Bureau, 2012). In addition, according to the Social Security Administration, an individual who is 20 years of age only has a 70 % chance of reaching full retirement without becoming disabled. Developing an understanding of the impact of these programs on patients with musculoskeletal disorders can improve the effectiveness of clinicians and systems involved in providing care to this growing population of patients. Moreover, along with federal programs, State workers' compensation programs serve as a crucial social contract for Americans. Workers' compensation insurance represents an agreement between employers and employees in which employees who are injured during the course of their work receive wages and health care for their job-related injury. In exchange for these benefits, employers are protected from certain lawsuits involving the work-related injury. This agreement is commonly referred to as "the compensation bargain (Reville & Escarce, 1999)."

The major aim of this chapter is to review the disability insurance programs available to patients with occupational musculoskeletal disorders—an issue that is particularly topical as musculoskeletal injuries represent one of the most common medical events that result in a patient receiving workers' compensation (De Boer, Bruinvels, Rijkenberg, Donceel, & Anema, 2009).

Concepts Related to Disability Insurance

As referenced in the first chapter of this handbook, important distinctions can be made among the concepts of *pain*, *impairment*, and *disability*, as well as a further distinction between *pain* and *nociception*. Briefly, it comes as a surprise to most injured workers that there are no true "pain"

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receptors in the human body. Rather, there are temperature, mechanical, and chemical receptors that transmit signals through the dorsal horn of the spinal column to the brain. It is only when the brain decodes those signals as "danger" that we experience the sensation of pain. Even more relevant is that we can experience *nociception*, the firing of sensory receptors, without experiencing pain, or experience pain without *nociception* (Butler & Moseley, 2003). For instance, if people enjoy working on their car or in their garden, they might have cut or scratched their hand numerous times over the years. For this person, they may cut their hand while working in the garden (*nociception*), but as the brain has registered these types of signals before in this context, the person may not realize they have cut themselves until they later look down and see their blood. However, if individuals put their hand on a chair arm rest and cuts themselves, doing the same amount or less of tissue damage, they might immediately notice and verbally respond (e.g., saying "ouch").

In addition to *nociception* without pain, pain can occur without *nociception*. For example, phantom limb pain is a commonly cited instance of when the brain is experiencing pain without any sensory input from the missing limb. For many individuals with chronic pain from a musculoskeletal disorder, continued pain persists despite the lack of *nociception* from the periphery (Butler & Moseley, 2003). As can be seen, a complex relationship exists among *nociception*, *pain*, and *disability*. This complex interaction makes it quite difficult to develop sensible, reasonable rules that guide the determination of disability. As an aside, as neuroimaging technology becomes less expensive and neural pathway discovery and "brain mapping" proceed, there may come a time when neuroimaging is used to differentiate individuals who are experiencing *nociception* and *pain* from those individuals who are experiencing *pain* without *nociception* (*NEJM citation*) (Wager et al., 2013). This obviously will continue to challenge our assumptions and understanding regarding what we refer to as pain.

As discussed, *pain* refers to a complex perceptual phenomenon that is influenced by biological, psychological, and social factors. In the modern area, Beecher (1946) was one of the first physicians to document the importance of psychosocial factors in the pain experience. He reported that injured combat soldiers reported less pain and required less medication than postoperative patients at the Massachusetts General Hospital. He hypothesized that a combat injury represented safety and removal from danger, while a surgery represented increased danger to a civilian. One can easily imagine how the brain of an injured worker processes the continued pain from a potentially career-ending injury that threatens the worker's finances and sense of self-worth. For example, *nociception* from a bulging disc will be processed differently by the brain of a stone mason who prides himself on his ability to physically keep up with coworkers 20 years his junior, compared to the brain of a college professor whose brain may interpret the nociception as simply the inevitable effects of aging.

Injuries and other biological factors play a significant role in the initiation of *pain*, but psychosocial factors play an increasingly large role the longer the *pain* persists. The biopsychosocial model has replaced the traditional biomedical model conceptualization of pain that assumes the severity of pain should correspond with the amount of tissue damage (Andrasik, Flor, & Turk, 2005; Gatchel, Peng, Peters, Fuchs, & Turk, 2007; Gatchel & Turk, 2008; Nederhand, Hermens, Ijzerman, Turk, & Zilvold, 2002; Turk & Okifuji, 2002). In fact, in recent years, our growing understanding of the neuroscience of pain has only served to bolster the evidence for the biopsychosocial approach to pain (Butler & Moseley, 2003; Chapin, Bagarinao, & Mackey, 2012; Lawrence, Hoeft, Sheau, & Mackey, 2011). Unfortunately, all too often, some physicians and healthcare providers still conceptualize *pain* from the traditional medical model (Astin, Goddard, & Forys, 2005), which contributes to confusion and poor consensus regarding *impairment* and *disability* of injured workers.

Impairment can be viewed as a medical construct that attempts to identify the biological components stemming from an occupational injury. *Impairment* evaluations may not adequately capture the actual difficulties of injured workers and can be used as a gross oversimplification of the pain experience. *Disability* is a legal/administrative construct influenced by impairment assessments (Gatchel, 2005), but it is typically determined by the legal system at some point during the workers' compensation, private disability, or social security disability process (more will be discussed regarding determination of disability later in this chapter).

It is useful to consider other psychosocial constructs to fully understand the disabled or injured worker as unintended reinforcers and motivators are frequently present in systems as complex as workers' compensation or disability insurance. Psychodynamic theories are not viewed as appropriate when understanding musculoskeletal injuries, but one concept from the psychodynamic literature remains relevant. Namely, concepts related to secondary gain play a large role in how we understand patients receiving disability, and it deserves some attention regarding our explication of this challenging area. For example, a distinction can be made among *primary*, *secondary*, and *tertiary* gain, as well as among these types of gain and *malingering*. Close to 100 years ago, Freud hypothesized that unexplained physical symptoms represented a compromise between unacceptable wishes and internalized moral wishes (Breuer & Freud, 1937). From this perspective, an individual who lost the use of his or her dominant hand without a clear medical explanation may have been hypothesized to have been conflicted between a wish to strike a co-worker or supervisor and internal prohibitions against such behavior. This compromise (i.e., the loss of use of the dominant hand) would have been considered *primary gain*. Although the concept of *primary gain* is no longer considered useful, *secondary gain* has strong support in the empirical literature. *Secondary gain* refers to the behavioral reinforcers that play a role in aggravating or maintain impaired functioning, such as the benefit received from not working in the form of payment or solicitous behaviors from loved ones or the removal of aversive stimuli, such as no longer having to attend a job that is disliked or even hated. Finally, *tertiary gain* refers to the behavioral reinforcers that impact the family and other important individuals in a disabled person's life. For instance, the monetary reinforcement or additional help from that is provided with an injured partner at home would be considered *tertiary gain* (Kwan, Ferrari, & Friel, 2001).

Secondary and *tertiary gain* remain important, empirically grounded concepts in the musculoskeletal disorder literature. Based on the aforementioned examples, these concepts can be viewed as behavioral in nature (i.e., increasing a behavior with benefits or the removal of unwanted negative stimuli) (Gatzounis, Schrooten, Crombez, & Vlaeyen, 2012). However, this view does not imply that disability somehow becomes a conscious choice or decision. The associations formed by the individual are not volitional; analogous to Pavlov's studies on classical conditioning, if a bell is rung enough times before food is presented, simply hearing that bell will elicit a salivation response from a canine. As can be seen, the salivary response is not volitional. Unfortunately, there are those individuals who do choose to avoid work or receive disability payments intentionally and deliberately despite knowing that they are capable of work. These individuals who deliberately present themselves as more impaired than they are in order to receive disability are considered *malingering*. As defined by the American Psychiatric Association (APA), "The essential feature of *Malingering* is the intentional production of false or grossly exaggerated physical or psychological symptoms, motivated by external incentives such as avoiding military duty, avoiding work, obtaining financial compensation, evading criminal prosecution or obtaining drugs" (American Psychiatric Association, 2000; p. 739). The element to take note of relates to the intentional production of symptoms that is not found when referring to *secondary* or *tertiary gain*. Determining when unexplained symptoms are feigned or influenced by behavioral factors, such as *secondary gain*, is difficult to accomplish. Furthermore, *malingering* and *secondary gain* are not mutually exclusive. However, the APA provides some guidance when clinicians attempt to determine the presence of malingering. Specifically, *malingering* should be considered if patients present with a combination of these elements:

1. Medicolegal context of presentation (e.g., the person is referred by an attorney to the clinician for examination)
2. Marked discrepancy between the person's claimed stress or disability and the objective findings

3. Lack of cooperation during the diagnostic evaluation and in complying with the prescribed treatment regimen
4. The presence of antisocial personality disorder (American Psychiatric Association, 2000, p. 739)

Indeed, all individuals who receive or apply for disability will meet criteria for the first factor, and many who experience behavioral reinforcement of symptoms from secondary gain will demonstrate the second element. Although the distinction between the biomedical model and biopsychosocial model has been discussed, the introduction of two other models is needed to further understand the context in which workers' compensation and other forms of disability exist. The *insurance model*, which has also been termed the forensic or compensation model, posits that individuals who may receive some benefit as a result of their disability are at increased risk of feigning or exaggerating their symptoms (Schultz, Joy, Crook, & Fraser, 2005).

The *insurance model* also assumes that workers' compensation and other disability insurance systems are, in fact, largely responsible for the disability or continued symptoms. The origins of the *insurance model* can be traced back to the work of Foster Kennedy who, in 1946, published results comparing compensation systems between Germany and Denmark. He noted that 5 % of Danes had ongoing symptoms after an accident, compared to 95 % of Germans who reported continued symptoms after an accident (Kennedy, 1946). He attributed this discrepancy to the reports that Germans received financial compensation during disability compared to a one-time settlement for injured Danish workers (Mendelson, 1995). In addition, Miller (1961) who vigorously promoted the "cured by verdict" belief stated that 98 % of patients he had followed no longer suffered from pain or other symptoms and were working 2 years after their claim had been settled. As one can imagine, the *insurance model* puts the injured or disabled individual in a situation in which they have to prove they are impaired and unable to work. When one remembers behavioral principles, it is not surprising that this model could lead to further impairment and disability. Furthermore, one would expect that individuals who wish to hold down costs or deny benefits would rely on the early and preliminary findings of Kennedy and Miller to promote the controversial claim that the insurance systems are in fact responsible for disability (Mendelson 1995).

A brief review of the impact of compensation systems on the functioning of injured workers' is relevant at this juncture, but a more thorough review can be found in Schatman (2012). Although some studies have revealed poorer outcomes for patients with occupational disorders who are involved in the workers' compensation system, the results have been far from unitary. Much of the research has involved comparing individuals in an interdisciplinary pain program receiving workers' compensation benefits to those who are not (Dworkin, Handlin, Richlin, Brand, & Vannucci, 1985). Moreover, these data have historically not included underserved and underrepresented minority populations (Tait & Chibnall, 2011). Again, overall, the literature has yielded mixed reports (Dworkin et al., 1985). Dworkin et al. (1985) began to make sense of the seemingly discrepant data, noting that individuals who worked typically fared better from an interdisciplinary treatment program. When they examined 454 individuals with chronic pain, long-term outcomes were better predicted by employment and compensation status (Dworkin et al. 1985). Mendelson (1995) approached the question in a different manner by examining 760 individuals involved in litigation. He reported that 75 % were not working after 2 years, approximately from the time of the court settlement; a finding he interpreted as calling into question the idea of "cure by verdict" (Mendelson, 1995). Despite the decades of conflicting research and high quality studies such as Dworkin et al. (1985), the belief persists that compensation leads to poorer health outcomes. In fact, as recently as 2011, Spearing and Connelly, 2011 conducted a systematic meta-review and concluded that there was no strong evidence between litigation and quality of health outcomes.

The *labor relations model* posits that disability must be understood and addressed from a systems model that takes into account the work context, as well as the potential loss experienced by the employee by no longer working (Schultz et al., 2005). In this model, the view is that a mutual beneficial solution is the preferred method to resolve work-related injuries. Employers invest time and money recruiting, training, and retaining skilled workers, and it would appear intuitive that, if they are able to return an employee to full time work, both the employer and employee will benefit. Although workers' compensation is predicated upon the premise that it is intended to protect the employer from litigation while providing treatment for injured workers, adversarial situations can develop between employers and employees that cost time and energy to manage. Furthermore, as has been discussed previously, an adversarial model can often lead an injured individual to attempt to "prove" they are disabled, thus reinforcing illness behavior. Another aspect of the labor relations model is the importance of work to the injured worker, as work provides a sense of identity, interpersonal relationships, and other factors important for health emotional functioning (Schultz, Joy, Crook, & Fraser, 2005). It is this loss of these work factors that has been termed *secondary loss* (Gatchel, 2004). Lastly, the labor relations model emphasizes the role of the employer in returning an injured worker to employment and retaining that worker (Schultz et al., 2005). Recognizing the interactions among the complex concepts of impairment, disability, and pain and the myriad of psychosocial influences on the behavior, physical, and emotional functioning of disabled or injured workers provides a context when reviewing workers' compensation and disability insurance systems.

Workers' Compensation

Workers' compensation systems had their origins in Europe, specifically in Germany and the United Kingdom. In the United States, the States of Georgia and Alabama legislated that employees could sue employers for negligence beginning in 1855 (Ford, 2011). However, it was not until 1902 that reform occurred in the United States that allowed for laws resembling the "compensation bargain," where workers who are injured during the course of their work receive wages and health care for their job-related injury and employers are protected from certain lawsuits. The federal government passed legislation to protect injured workers in 1906, and most States enacted similar laws over the next 50 years. Today, workers' compensation is one of the largest social safety net programs available to employees. Specifically, this program spent $57.6 billion in wages and medical care in 2008, with $28.6 billion in wages or other benefits and $29.1 billion in medical expenses (Sengupta, Reno, & Burton, 2010). Typically, income support is 66 % of the employees' standard wages. According to the most recent data available from the US Census Bureau, 20,213,000 Americans were classified as having a work disability, which includes individuals under 65 unable to work for a variety of health-related concerns. Of those 20 million Americans, 35.5 % are receiving social security income (U.S. Census Bureau, Statistical Abstract of the United States, 2012).

In most States, once workers have been injured, they are placed on temporary total disability that continues until they are able to return to employment. However, most States have time constraints for temporary disability, and, when the allotted time has expired and the employees cannot return to work, they undergo an examination, and a medical determination regarding the level of disability and functionality is then made (McInerney & Simon, 2012). Lastly, an injured worker's treating or "attending" physician may decide prior to the end of the allotted time for total temporary disability that a worker has achieved "maximal medical improvement," followed by an assessment of the individual's disability level (McInerney & Simon, 2012). With regard to the evaluation of disability, once *maximal medical improvement* or expiration of total temporary disability has been determined, a decision regarding the level of disability falls into one of two broad categories: *permanent partial disability* (PPD) or *permanent total disability*. For individuals with *PPD*, most State programs calculate benefits based on earnings prior to the work-related injury (McInerney &

Simon, 2012). Albeit with some degree of variation, these State programs have scheduled injuries that essentially delineate the amount of compensation that will be received, such as a loss of a leg is equivalent to a certain dollar amount or unscheduled injuries based on the amount of the body that is damaged. Furthermore, some state programs provide injured employees lump sums rather than regular payments over a fixed duration. In contrast to PPD, permanent total disability accounts for less than 1 % of all workers' compensation cases (McInerney & Simon, 2012).

Currently, approximately 96 % of individuals who receive a wage or salary are protected by workers' compensation laws (Burton, 2007). A notable exception to this trend is Texas, where approximately 33 % of employers in Texas were classified as "nonsubscribers." These employers are not protected by the compensation bargain and, in turn, may face legal action from their injured employees (Texas Department of Insurance, 2012). In other States, exceptions are made for companies with few employers, State or local governments, and certain occupations (Burton, 2007). Although most employees are covered by workers' compensation laws, several tests are required to be met for an individual to qualify for workers' compensation in most States. Specifically, Burton (2007) stated succinctly, "… (1) there must be a personal injury (2) resulting from an accident that (3) arose out of employment (4) and in the course of employment" (p. 4). Most States require that all four aspects be present for the individual to be deemed as having an injury that is compensable under the workers' compensation system of that State.

The first test is commonly referred to as the *personal injury test*, and it addresses the causal relationship of a work-related injury. The cause-result dyad can involve both physical and mental effects, including physical–physical and/or physical–mental effects. For instance, an individual who loses a hand in a machine press would have a physical cause and a physical injury. However, if this same worker develops posttraumatic stress disorder as a result of his/her physical injury, he/she will have also suffered a mental injury. When the cause of an injury is mental and results in a mental injury, the *personal injury test* can become quite complicated, such as a worker developing major depressive disorder after being verbally abused by a superior during a staff meeting (Burton, 2007). The second test is commonly referred to as the *accident test*. According to Burton (2007), there are four elements regarding the *accident test* "… (1) unexpectedness of cause; (2) unexpectedness of result; (3) definite time of cause; and (4) definite time of result" (p. 4). Of interest, some States will not accept a claim if the injury occurred through the normal course of work. Intuitively, occupational diseases with a gradual onset may have difficulty meeting the requirements of the *accident test* (Burton, 2007).

The third element considered when deciding if an injury presents as compensable under workers' compensation involves the *arising out of employment test*. This element distinguishes among occupational, personal, and neutral risks. Occupational risks are compensable, but personal risks are not. For instance, breathing in toxic fumes at a fertilizer plan is an occupational risk for lung disease, but smoking cigarettes is a personal risk for lung disease. Neutral risk, which falls into neither of the above categories, is decided based on different legal doctrines depending on the jurisdiction. The three doctrines used to determine the compensability of neutral risks include the following: *increased risk doctrine*, *actual risk doctrine*, and *positional risk doctrine*. With regard to the *increased risk doctrine*, this doctrine necessitates that the occupation increases the risk when compared to other individuals who might be present. *Actual risk doctrine* refers to positions in which there are actual risks inherent in the position. Finally, the *positional risk doctrine* refers to the risk when an occupation puts an individual in a position where an injury occurs and would not have occurred if their job had not placed them in that position (Burton, 2007). Lastly, in all jurisdictions, the *course of employment test* is considered when determining the compensability of an injury. Essentially, for the injury to be judged compensable, the injury had to occur during the course of employment. Typically, traveling to and from work does not meet the *course of employment test*, but traveling to a business lunch or calling on a client most likely would qualify (Burton, 2007).

Occupational diseases, such as black lung or chronic obstructive pulmonary disease, may not meet all four tests described above. However, a large number of States cover these diseases using a format similar to scheduled benefits for particular diseases, as well as a category for diseases that may not be found on their schedule (Burton, 2007). As mentioned repeatedly, States manage workers' compensation benefits in different ways. However, employers in different States work within one of three systems. Depending on the State, employers can:

(a) Purchase workers' compensation from a commercial insurance agency
(b) Purchase insurance from the State
(c) Self-insure

When a State offers all three means of providing workers' compensation to employees, it is termed a *three-way system* (Burton, 2007; Table 15.1).

In 1972, the National Commission on State Workers' Compensation Laws identified goals to address troubled State workers' compensation systems:

1. "Compulsory rather than elective coverage, with no exceptions for small firms or government employment.
2. Employee's choice of jurisdiction for filing interstate claims to be broadened.
3. Full coverage of work-related diseases, similar to that now provided for work-related accidents and injuries
4. Adequate weekly cash benefits for temporary total disability, permanent total disability and death cases.
5. No arbitrary limits on the amount or duration of benefits for permanent total disability or for death.
6. Full medical and physical rehabilitation services without statutory limits on dollar amount or length of time" (p. 31).

Table 15.1 Workers' compensation insurance financial arrangements

State funds
North Dakota
Ohio
Washington
Wyoming
State funds and private insurance
Arizona
California
Colorado
Hawaii
Idaho
Kentucky
Louisiana
Maine
Maryland
Minnesota
Montana
New Mexico
New York
Oklahoma
Oregon
Pennsylvania
Rhode Island
Texas
Utah
West Virginia
Private insurance
Alabama
Alaska
Arkansas
Connecticut
Delaware
District of Columbia
Florida
Georgia
Illinois
Indiana
Iowa
Kansas
Massachusetts
Michigan
Mississippi
Missouri
Nebraska
Nevada
New Hampshire
New Jersey
North Carolina
South Carolina
South Dakota
Tennessee
Vermont
Virginia
Wisconsin

An area that remains controversial for the workers' compensation system is the methods for determining PPD. As one can imagine, temporary total or temporary partial disability does not produce the amount of confusion or controversy due to their temporary status. As alluded to earlier, the majority of States have *scheduled benefits* or *specific benefits* that are established by rule or law and provide a certain amount of cash benefits based on a scheduled that typically includes a cost associated with the body part. For example, in Alabama, if a worker losses a hand, they are eligible for 170 weeks of benefits. Typically, it is not until after a period of temporary disability that a determination is made regarding the determination of the scheduled benefit (Barth, 2000).

As mentioned, temporary disability ends when a worker is either (a) able to return to work, (b) reached *maximal medical improvement* (i.e., their injury is determined by a physician to be permanent and stable), or (c) a fixed period of time has elapsed in which temporary disability automatically ceases. Although there is a wide discrepancy among State workers' compensation systems, most reimburse two-thirds of the worker's weekly wages. However, as there are "caps" on the amount that can be paid, many higher wage workers are not receiving anything close to two-thirds their pre-injury wage (Barth (2000)). As can be seen, although every worker is treated equally when scheduled benefits are used, the loss of a hand for a master carpenter is far more impactful from a potential earnings standpoint than the loss of a hand for a teacher. Most States utilize *scheduled benefits*, or plans that essentially resemble *scheduled benefits*, such as Texas that assigns points based on the American Medical Association's Guides to the Evaluation of Permanent Impairment, which is now in its sixth edition. However, even with *scheduled benefits*, or a system of de facto *scheduled benefits*, difference among jurisdictions exists when handling partial losses. Jurisdictions may simply quantify the loss and provide a worker with a percentage of the number of week benefits. However, in other jurisdictions, disability is taken into account and the worker may receive up to the full amount for the loss of the entire limb (Barth, 2000).

In addition to *scheduled benefits*, most States also cover injuries that are not listed on their schedule. Once again, there is a wide array of differences among States regarding *unscheduled benefits*, but the four following approaches are described by Barth (2000):

1. Impairment basis
2. Loss of wage-earning capacity basis
3. Wage-loss basis
4. Bifurcated basis

The *impairment basis* for determining unscheduled benefits involves physicians determining the level of impairment rating. This determination is typically based on the American Medical Association's Guides to the Evaluation of Permanent Impairment (Barth, 2000). However, as discussed elsewhere in this handbook, this method is beset by controversy. Oftentimes, supposed Independent Medical Examiners, who are hired by the insurance company or State, provide their expert opinion regarding the impairment rating of the worker. Unfortunately, it is hard to conclude that these physicians are "independent," as often their livelihood is connected implicitly to providing insurance companies with conclusions that save money for the company that is paying the "independent" medical examiner's fees. Conversely, treating physicians who have often established a working relationship with their patient may not view their patient from an objective standpoint and may be at risk for advocating for them rather than presenting an objective opinion. Furthermore, there may be less noble motivations for treating physicians or physicians' hired by a patient's attorney to rate the patient as more impaired than they actually are at the time of the evaluation.

The *loss of wage-earning capacity* is another approach to determining unscheduled benefits. In this approach, the cash benefits are determined by the presumed impact on future earnings Barth (2000). Again, States approach this matter differently, with some States looking at the impact of the injury on the workers' competitiveness, while other States focus upon the loss of future earnings. As one can imagine, the amount of uncertainty that must be assumed and approximated presents challenges to this approach. Several factors are typically used to estimate the impact of the injury on future earnings or competiveness, including experience, language, economic conditions, impairment rating, age, and education (Barth, 2000).

The third method is considered the *wage-loss basis*, and it is similar to the *loss of wage-earning capacity*, but bases benefit determination on the actual earnings lost. In the States that take this approach, individuals are only provided PPD *benefits* if they are unable to return to work close to their earning capacity prior to their injury (Barth, 2000). In addition to the question of equitable benefits that a wage-loss system may violate, in practice, these systems are difficult to manage and can provide unintended perverse incentives. For instance, those workers with strong work ethics and who may not be ready to return to work may financially be disincentivized (Barth, 2000).

The fourth method is the *bifurcated basis*, which is essentially a combination of approaches with the hope that benefits of different approaches can be retained without the negative aspects. Typically, the approach that is used varies according to the injured worker's work status when *partial permanent disability* is determined Barth (2000). An injured worker who is working may receive a benefit based on their impairment rating if they are at, or close, to their wage prior to their injury. However, if they are not working or close to the wage they were earning prior to their injury, a loss of wage-earning approach may be applied. As will be seen, the relationship between workers' compensation insurance and disability insurance is closely intertwined. Furthermore, although the process of disability determination is complicated and varies by State, the initiation of workers' compensation benefits is relatively straightforward than the multistep process involved in Social Security Disability Insurance Barth (2000).

Social Security Disability Insurance

Disability insurance protects an individual's earned income from a disability that impacts a workers' ability to perform the core functions of his/her job. Disability insurance is broadly categorized into short- and long-term benefits, as well as private and federal programs. However, most private disability plans require that beneficiaries who receive disability under their commercial plan to apply for Social Security Disability benefits. The Social Security Administration is responsible for covering the largest number of disabled citizens. Combined, the Social Security Disability Insurance program and the Supplement Security Income program paid approximately $90 billion in benefits to 11.2 million Americans. According to the Social Security Administration, disability is defined as, "…the inability to engage in substantial gainful activity based on a medically determinable impairment that is expected to last at least 12 months or result in death" (p. 3: Trends in the Social Security and Supplemental Security Income Disability Programs, 2006). Social Security Disability Insurance is a federal government program that provides income supplements through payroll tax funding on a temporary or permanent basis for individuals who are disabled. The program went into effect in 1956 and, originally, only covered workers who were aged 50 and above, as well as individuals who were disabled prior to age 18. The addition of dependent's benefits occurred in 1958, and the age requirement (i.e., 50 and above) was dropped in 1960. In 1967, benefits were also provided to disabled widows or widowers (Trends in the Social Security and Supplemental Security Income Disability Programs, 2006).

The Social Security Disability program derives its funds from a 15.6 % payroll tax split evenly between employees and employers (self-employed individuals are responsible for the full amount) and is only applied to the first $110,100 of income (CEPR, 2012) (Census, 2012). The benefits workers receive are based on the individual's earnings. According to the Social Security Administration, benefits are based on pre-disability earnings or average indexed monthly earnings (AIME) (Census, 2012). Once a worker becomes eligible for disability benefits, a 5-month waiting period begins before the individual receives monetary benefits. Furthermore, a disabled individual becomes eligible for

Medicare 24 months after having been determined to be eligible for Social Security Disability Insurance. The average monthly benefit for workers classified as disabled was $1,130 according to Social Security Administration statistics for February, 2013. As mentioned, disabled individuals, as well as dependents, are eligible for this program. The Supplemental Security Income is a program started in 1974 that provides income to the elderly, blind, and individuals determined to be disabled. However, unlike Social Security Disability Insurance, the Supplemental Security Income program is a means tested, and a prior work history is not required. Supplemental Security Income is primarily a program that attempts to ameliorate poverty (Trends in the Social Security and Supplemental Security Income Disability Programs, 2006).

Similar to concerns regarding compensation, neurosis is the concern that Social Security programs provide a disincentive to work and promote disability. In fact, Marini and Stebnicki (1999) reviewed the common reasons that Social Security Disability and Supplemental Security beneficiaries provide for not working. For instance, many beneficiaries stated that they were afraid of losing their medical benefits, or their doctor told them that they should not work. In addition, they cited fear of losing their benefits for attempting to work at a job where they quickly discover that they are too disabled to maintain or that the job they could maintain pays less than their benefits Marini and Stebnicki (1999). Of even more concern is that, in one study by the General Accounting Office of the United Stated, less than 1 % (i.e., .25 %) of individuals who were receiving Social Security Disability Insurance or Supplemental Security Income returned to work through the vocational rehabilitation programs that are managed through the States (*Marini article*).

It may be useful to develop a clear understanding of the process for applying for Social Security Disability benefits, as the process for applying for the benefits makes receiving workers' compensation benefits quite easy (Shrey & Lacerte, 1995). For instance, it is not uncommon for individuals to wait 6–12 months before they are informed if they are eligible for benefits, and, of those individuals who apply, only one-third receive benefits when they first apply.

State agencies engage in the work of determining who is disabled for the federal government. However, the Social Security Administration will preliminary review the application for basic requirements, including current work activities and length of employment (Social Security Administration, 2012). Essentially, two tests are required: *recent work* and *duration of work*. The *recent work* test takes into consideration age as well as recent work. An example of the *recent work* test that would apply to most individuals claiming a musculoskeletal disorder would involve a person who was disabled in the quarter in which they turned 31 or later and would have had to "work during 5 years out of the 10-year period ending with the quarter your disability began" (p. 5) (social security). Furthermore, the person would have had to work for a certain period of time depending on age. For instance, in 2012, an individual 27 years old or younger required 1.5 years of gainful employment to meet the *duration of work* test; a 44-year-old required 5.5 years; and a 60-year-old required 9.5 years (Social Security Administration, 2012).

Typically, when disability is being determined, a potentially disabled person, family member, or attorney provides contact information for healthcare providers, medication and dosage, laboratory and other test results, and medical records from physicians, therapists, hospitals, and case managers. In addition, the State agency responsible for determining disability will require a description of the type of work, as well as tax information and other administrative forms. The Social Security Administration utilizes a five-step process that involves five questions for individuals who are seeking disability:

1. Are you working?
2. Is your medical condition "severe"?
3. Is your medical condition on the List of Impairments?
4. Can you do the work you did before?
5. Can you do any other type of work?

First, the Social Security Administration determines if you are working and how much you are making each month. For instance, in 2012, you could not engage in "substantial gainful activity" and earn more than $1,010 a month and still receive Social Security Disability benefits. However, individuals who have been determined to be disabled and wish to return to work can earn as much as they wish and still retain disability benefits for 9 months. However, the 9 months need not be consecutive. Second, the State agency that manages disability benefits next determines if the medical condition is "severe." As one can imagine, the term "severe" is somewhat subjective, but essentially requires that a medical condition "significantly" impairs an individual from engaging in basic work activities for at least 12 months (Social Security Administration, 2012).

After the federal branch of disability determination decides that a person has met the basic requirements of current work, duration of work, and recent work and the State agency determines if the claimed medical condition is severe, the State agency next determines if the medical condition is on the list of impairments. If an individual's condition is not listed, then the agency assesses whether the individual's condition is similar to one of the impairments on the list. However, when one reviews the list of impairments, significant subjectivity remains for musculoskeletal and mental disorders. If an individual meets criteria for the third step, then an individual is determined to be disabled. However, if the criteria for step three have not been met, then the State agency moves to step four. In this fourth step, the State agency asks whether the person can engage in the work they had done previously. For example, a construction worker with a severe musculoskeletal disorder would meet criteria for this fourth step. If you cannot do the work that you did before, the State agency will move onto the last and final step. Step five determines whether you can engage in any other kind of work (Social Security Administration, 2012). The State agency will take into account your medical condition, age, education, past employment history, and skill set.

For those individuals who are denied their first attempt at receiving benefits, approximately one-half will attempt again. If an individual does decide to file a second appeal, additional medical records are required. At this stage, approximately 15 % are determined to be disabled. However, of the remaining individuals who have thus far not received disability, 68 % appeal for the third and final time. Instead of Independent Medical Examiners, these individuals are able to present their case to an Administrative Law Judge, and an expert in vocational skills is often employed to assist in the disability determination. The vocational expert will take into account the individual's medical status, age, education, and skills. In this third group, approximately 58 % are determined to be eligible for disability benefits. At this level, approximately 42 % of individuals appeal the Social Security Administration Appeals Board; however, only 4 % are determined to be eligible for benefits at this level. Finally, 30 % of the remaining individuals who have not been determined to be eligible for benefits appeal to their United States District Court. As can been seen, approximately 33 % of individuals can be easily classified as disabled. Of interest, it is understandable why individuals who have spent considerable time and energy to justify their disability would have difficulty returning to work.

Traditionally, individuals with mental health conditions comprise one of the largest group of individuals who are classified as disabled (Marini, 2003). In 2012, approximately 20% of workers who received disability had been diagnosed with a thought disorder (such as Schizophrenia) or Mood Disorder, with an additional 3.9% meeting criteria for another mental disorder excluding developmental disorders and intellectual disabilities (Administration, 2012).

Of note for this text, in 2012, 29.8% of individual workers who receive disability are classified as having a musculoskeletal disorder, with low back injuries accounting for the majority (Administration, 2012). However, the number of individuals who began to receive disability as a result of Carpal Tunnel Injury grew quickly at the end of the 20th century as a result of increased use of computers (Marini, 2003). Of note, chronic pain in and of itself is not considered sufficient for a determination of disability and, in the eyes of the Social Security Administration, chronic pain must be tied to a clear physical impairment.

Of those claimants with musculoskeletal disorder, close to one-third are individuals ages 60 to 64 (Marini, 2003). According to Social Security Administrations estimates, approximately 10% of their claimants do not have physical evidence to support their complaint of pain. However, as discussed earlier in this Chapter, that is a very specious argument to make given the complex nature of pain. Marini (2003) described the individual who is disabled by a musculoskeletal disorder succinctly: “Beneficiaries with musculoskeletal disorders will statistically be older than those with mental disorders, likely ranging in age from late forties to late fifties…many beneficiaries with this type of disorder will present with low back injury, repetitive motion injuries (e.g., carpel tunnel syndrome, and pain secondary to the disability.” Pg. 41.

In 1999, the Ticket to Work and Work Incentive Improvement Act attempted to address barriers to disabled employees regarding work. Specifically, under this Act, disabled individuals who received Medicare would continue to do so for 8 years after returning to employment. Also, if individuals attempted to return to work and demonstrated they were unable to work, they could regain their medical benefits faster than those who are applying for the first time. Another provision of the Ticket to Work Act provides individuals receiving disability more flexibility regarding vocational rehabilitation. Of those individuals who are receiving disability and wish to return to work, a functional capacity evaluation can be performed to aid in determining transferrable skills. Essentially, the evaluation helps to determine if an individual can engage in certain physical activities (e.g., climbing, kneeling, etc.) either (a) constantly, (b) frequently, (c) occasionally, or (d) never. As is often the case, a significant degree of subjectivity is involved in functional capacity evaluations. According to Marini (2003) “…many beneficiaries are limited to mostly sedentary, light and some medium lifting work (maximum lift of 50 lbs occasionally), often due to injury, education and age factors” (p. 25). Furthermore, individuals with musculoskeletal disorders report difficulty sitting, standing, or walking for periods longer than 15–30 min.

The Relationship Between Workers’ Compensation and Social Security Benefits

An interesting trend has been noted over the last three decades, workers’ compensation and welfare programs are being cut while disability roles increase. Currently, an estimated 14 million individuals received payment from the government for a disability. Of interest, data support the notion that many individuals who have a work-related injury do not receive workers’ compensation benefits (Spieler & Burton, 2012). As can be seen, the workers’ compensation system can be difficult for injured workers, as well as well-intentioned clinicians with limited work in the workers’ compensation realm. Although, in some ways, coverage expanded in the 1970s after *the Report of the National Commission on State Workers’ Compensation Laws* (1972), the general trend since the 1990s has been to reduce and limit coverage (Spieler and Burton, 1998). Typically, patients with clear traumatic injury, such as a loss of a limb, have an easier time with workers’ compensation systems. However, injured workers with chronic pain or an occupational disease, such as cancer from repeated exposure to carcinogens at work, will have a more difficult time with their workers’ compensation claims (Spieler & Burton, 2012).

In order to assess the discrepancy between injured workers and receipt of workers’ compensation benefits, Spieler and Burton (2012) examined reasons for not receiving workers’ compensation benefits and recommendations. Although this sounds like a rather straightforward epidemiological study, the complexity and differing definitions of work-related injury and disability posed particularly challenging. However, they concluded that stricter rules in State workers’ compensation systems accounted for less receipt of benefits among individuals with work-related injuries. Evidence of this trend is also reflected by the 12 % decrease in the amount of money spent on workers’ compensation benefits during the 1990s (McInerney & Simon, 2012).

Although no one factor can explain the increase in disability, one factor frequently cited for the increase in disability claims is the transformation of welfare under President Bill Clinton. One aspect of welfare reform incentivized States to help return individuals to employment by requiring the states to pay a larger share of welfare costs. An unintended consequence may have resulted from the welfare to work program. Specifically, a State does not have to pay for a worker on Social Security Disability Insurance.

McInerney and Simon (2012) examined the statistics from the 1990s and reported that Social Security Disability Insurance outlays rose by approximately 70 % and, at the same time, workers' compensation benefits decreased by 12 %. However, when they examined the relationships among disability and workers' compensation within States, they concluded that the restrictions in State workers' compensation systems did not appear to account for the increase found in individuals seeking and receiving disability. However, Guo and Burton (2012) reached different conclusions than McInerney and Simon (2012) and argue that workers' compensation benefits and compensability rules have a modest effect on individuals seeking Social Security Disability Insurance. As can be seen, the evidence is not clear about the relationship between these social programs, but the existence of the relationship is clear.

Conclusion

Workers' compensation and Social Security Disability Insurance programs provide an important "safety net" for tens of millions of Americans. Societal and governmental factors, as well as developing and ever more complex understandings of musculoskeletal disorders, impairment, and pain, shape the debate about these programs. While increased knowledge can lead to *complex* and more sophisticated conceptualizations of disorders and diseases, societal and governmental factors can lead to more *complicated* but less effective solutions. As we develop greater understanding of the human brain, our paradigms will no doubt shift, and the subjectivity present throughout these systems may resolve as we forego attempts naively to simplify the *complex* nature of health and physical impairment.

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th Ed., Text Revision). Washington, DC: American Psychiatric Association.

Andrasik, F., Flor, H., & Turk, D. C. (2005). An expanded view of psychological aspects in head pain: The biopsychosocial model. [Review]. *Neurological Sciences, 26*(Suppl 2), s87–s91.

Astin, J. A., Goddard, T. G., & Forys, K. (2005). Barriers to the integration of mind-body medicine: Perceptions of physicians, residents, and medical students. [Research Support, N.I.H., Extramural]. *Explore, 1*(4), 278–283.

Barth, P. S. (2000). Workers' compensation systems and benefits for permanent partial disabilities. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders*. Philadelphia: Lippincott, Williams & Wilkins.

Beecher, H. K. (1946). Pain in men wounded in battle. *Annals of Surgery, 123*, 96–105.

Breuer, J., & Freud, S. (1937). *Studies in hysteria.* Authorized translation with an introduction by A. A. Brill. (Nervous and Mental Disease Monograph Series No. 61.) New York: Nervous and Mental Disease Publishing.

Burton, J. (2007). An overview of workers' compensation. *Workers' Compensation Policy Review, 7*(3), 3–27.

Butler, D., & Moseley, L. (2003). *Explain pain*. Adelaide City West, Australia: Noigroup Publications.

Census, U. S. (2012). *Anniversary of Americans with disabilities act*. Washington, DC: U.S. Census Bureau News.

Chapin, H., Bagarinao, E., & Mackey, S. (2012). Real-time fMRI applied to pain management. [Review]. *Neuroscience Letters, 520*(2), 174–181.

De Boer, W., Bruinvels, D. J., Rijkenberg, A. M., Donceel, P., & Anema, J. R. (2009). Evidence-based guidelines in the evaluation of work disability: An international survey and a comparison of quality of development. *BMC Public Health, 9*, 349.

Dworkin, R. H., Handlin, D. S., Richlin, D. M., Brand, L., & Vannucci, C. (1985). Unraveling the effects of compensation, litigation, and employment on treatment response in chronic pain. *Pain, 23*(1), 49–59.

Ford, R. O. (2011). *Labor matters: The African American labor crisis*. Bloomington, IN: Xlibris.

Gatchel, R. J. (2004). Psychosocial factors that can influence the self-assessment of function. *Journal of Occupational Rehabilitation, 14*(3), 197–206.

Gatchel, R. J. (2005). *Clinical essentials of pain management*. Washington, DC: American Psychological Association.

Gatchel, R. J., Peng, Y. B., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. [Research Support, N.I.H., Extramural Research Support, U.S. Gov't, Non-P.H.S. Review]. *Psychological Bulletin, 133*(4), 581–624.

Gatchel, R. J., & Turk, D. C. (2008). Criticisms of the biopsychosocial model in spine care: Creating and then attacking a straw person. [Letter]. *Spine, 33*(25), 2831–2836.

Gatzounis, R., Schrooten, M. G., Crombez, G., & Vlaeyen, J. W. (2012). Operant learning theory in pain and chronic pain rehabilitation. *Current Pain & Headache Reports, 16*, 117–126.

Guo, X. S., & Burton, J. F. (2012). The growth in applications for social security disability insurance: A spillover effect from workers' compensation. *Social Security Bulletin, 72*(3), 69–88.

Kennedy, F. (1946). The mind of the injured worker: Its effect on disability. *Compensation Medicine, 1*, 19–24.

Kwan, O., Ferrari, R., & Friel, J. (2001). Tertiary gain and disability syndromes. *Medical Hypotheses, 57*(4), 459–464.

Lawrence, J. M., Hoeft, F., Sheau, K. E., & Mackey, S. C. (2011). Strategy-dependent dissociation of the neural correlates involved in pain modulation. [Research Support, N.I.H., Extramural Research Support, Non--U.S. Gov't]. *Anesthesiology, 115*(4), 844–851.

Marini, I. (2003). What rehabilitation counselors should know to assist social security beneficiaries in becoming employed. *Work, 21*(1), 37–43.

Marini, I., & Stebnicki, M. A. (1999). Social security administration's alternative provider program: What can rehabilitation administrators expect? *Journal of Rehabilitation Administration., 23*(1), 31–41.

McInerney, M., & Simon, K. (2012). The effect of state workers' compensation program changes on the use of federal social security disability insurance. *Industrial Relations, 51*(1), 57–88.

Mendelson, G. (1995). Chronic pain, compensation and clinical knowledge. *Theoretical Medicine, 12*(3), 227–246.

Miller, H. (1961). Accident neurosis. *British Medical Journal, 1*, 919–925; 992–998.

Nederhand, M. J., Hermens, H. J., Ijzerman, M. J., Turk, D. C., & Zilvold, G. (2002). Cervical muscle dysfunction in chronic whiplash-associated disorder grade 2: The relevance of the trauma. [Research Support, Non--U.S. Gov't]. *Spine, 27*(10), 1056–1061.

Reville, R. T., & Escarce, J. J. (1999). Managed care and the workers' compensation bargain. *Medical Care, 37*(10), 969–971.

Roderick O. Ford, J. D. (2011). *Labor matters: The African American labor crisis, 1861-2010*. Bloomington, IN: Xlibris Corporation.

Schatman, M. E. (2012). Workers' compensation and its potential for perpetuations of disability. In R. J. Gatchel & I. S. Schultz (Eds.), *Handbook of occupational health and wellness*. New York: Springer.

Schultz, I. Z., Joy, P. W., Crook, J., & Fraser, K. (2005). Models of diagnosis and rehabilitation in musculoskeletal pain-related occupational disability. In I. S. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention, and prevention*. New York, NY: Springer.

Sengupta, I., Reno, V., & Burton, J. F. (2010). *Workers' compensation: benefits, coverage and costs, 2008*. Washington, DC: National Academy of Social Insurance.

Shrey, D. E., & Lacerte, M. (1995). *Principles and practices of disability management industry*. Winter Park, FL: GR Press.

Social Security Administration. SSA Publication No. 05-10029 ICN 456000 Unit of Issue—HD (one hundred) June 2012 (July 2011 edition may be used).

Social Security Administration. (2012). *Annual Statistical Report on the Social Security Disability Insurance Program*. Washington, DC.

Spearing, N. M., & Connelly, L. B. (2011). Is compensation "bad for health"? A systematic meta review. *Injury, 42*, 15–24.

Spieler, E., & Burton, J. F. (1998). Compensation for disabled workers: Workers' compensation. In T. Thomason, J. F. Burton & D. Hyatt (Eds.), *New approaches to disability in the workplace*. Industrial Relations Research Association.

Spieler, E. A., & Burton, J. F., Jr. (2012). The lack of correspondence between work-related disability and receipt of workers' compensation benefits. [Review]. *American Journal of Industrial Medicine, 55*(6), 487–505.

Tait, R. C., & Chibnall, J. T. (2011). Legal sequelae of occupational back injuries: A longitudinal analysis of Missouri judicial records. *Spine, 36*(17), 1402–1409.

Texas Department of Insurance. (2012). *Employer participation in the Texas workers' compensation system*. Austin: Texas Department of Insurance.

The Report of the National Commission on State Workmen's Compensation Laws. (1972). Washington, DC.

Trends in the Social Security and Supplemental Security Income Disability Programs. (2006). Washington, DC: Social Security Administration.

Turk, D. C., & Okifuji, A. (2002). Psychological factors in chronic pain: Evolution and revolution. [Research Support, U.S. Gov't, P.H.S. Review]. *Journal of Consulting & Clinical Psychology, 70*(3), 678–690.

U.S. Census Bureau, (2012) Statistical Abstract of the United States: (131st Edition) Washington, DC, 2011. http://www.census.gov/compendia/statab/.

Wager, T. D., Atlas, L. Y., Lindquist, M. A., Roy, M., Woo, C. W., & Kross, E. (2013). An fMRI-based neurologic signature of physical pain. *The New England Journal of Medicine, 368*, 1388–1397.

16

Approaches to the Quantitative Physical and Functional Capacity Assessment of Occupational Musculoskeletal Disorders

Samuel M. Bierner

Overview

In this chapter, we consider the objective characteristics that would be needed for an ideal assessment of worker physical and functional capacities. We review the pertinent clinical literature relating to quantitative assessment of physical capacity and function in the injured worker setting, from 1999 to 2012, and draw conclusions about the usefulness, if any, of these tests in the current environment. We also examine some recent findings from the physiology literature that may shed light on future improvements.

In an ideal situation, how would the physician or therapist evaluate the physical and functional capacities of an injured worker? What would be the characteristics of objective assessment that would have excellent inter-rater reliability? The ideal instrument does not exist for measurement of human physical capacity or functional capacity. We are left with what we can measure versus what measure(s) seem to have shown importance in the area of functional performance. Table 16.1 lists important characteristics of the physiological and statistical characteristics of an *objective measurement instrument*. By *objective*, most would agree that we want an instrument that when used by two appropriately trained examiners (whether therapist, physician, psychologist, or other professional) can give statistically identical results. If the examiner could affect the outcome of the test, then the instrument could not be considered objective; it must be "intersubjectively verifiable" (Gove, 1986).

The psychological state of the examinee (normal or injured worker) may determine the psychophysical effort that is exerted during testing, which we will call "motivation." Many factors can influence such motivation, and those factors may influence the outcome of the test so much that a true maximal "physiological response" cannot be reliably measured (e.g., lifting strength) Kagan (2012). This disjunction between psychophysical effort and maximal physiological capacity (i.e., strength) may preclude accurate discrimination between the worker with deconditioning due to injury or prolonged convalescence (a lack of rehabilitation) from the worker with intact physiological capability but diminished motivation to perform in the test situation. The former would benefit from further physical rehabilitation, while the latter will not improve with such treatment and may be harmed by prolonging a period of temporary disability.

By *quantitative*, we mean that we want "hard nonsubjective results" (as opposed to qualitative impressions) that use some scale that is measurable across different populations and is subject to statistical analysis. By way of a contrary example,

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Table 16.1 Ideal characteristics of quantitative assessment method

Statistical characteristics
Validity shown for the target population (injured worker)
Excellent inter-rater reliability (stable results from different examiners)
High inter-test reliability (stable results over time)
Adequacy of content sampling (relevant to the job physical demands)
Stability of the characteristic being measured
Physiological characteristics
Biological variability in strength (isometric, isokinetic), stamina (fatigue), and flexibility (range of motion) is accounted for
Need for psychophysical effort (motivation) is minimized
Diurnal variability is known

the physician during her performance of the neurological examination will assess the gait of a patient. Such analysis of gait is *qualitative* in nature and highly dependent upon the skill, experience, and observational prowess of the examiner (medical students and beginning residents often find such qualitative observation of gait quite difficult to learn). The trained neurological examiner will observe subtle abnormalities of gait that point to a particular disorder (e.g., early Parkinson's disease, spasticity, etc.). We accept this qualitative interpretation of gait in most instances of patient care because the use of the more quantitative and objective gait analysis laboratory is restricted to specialized centers and often to research applications due to the time and labor costs involved.

Physiological Observations

Recent discoveries in neurophysiology have shed some light on the above limitations. These findings raise issues about the voluntary nature of movements, psychogenic movement disorders (PMDs), and the relationship between the brain and changes that occur in the brain of persons suffering from chronic pain. The most frequent clinical presentation of a worker who presents with inconsistent performance on a motor task (such as lifting) is that of pain as the "cause" of the limitation in performance. The qualitative impression of the examiner (usually a therapist) is that the effort being given is submaximal. Some basic physiological measurements, such as changes in blood pressure, heart rate, and respiratory rate, could be (and are) used to determine whether the worker being examined has given sufficient effort to change his baseline cardiovascular physical state. However, these changes in vital signs are most often a reflection of the deconditioned state: poor exercise tolerance causing elevated heart rate response to improve cardiac output. Such elevation in HR can be affected by medications being used by the subject for blood pressure or other conditions and could give a false negative result. A worker with better physical conditioning may show minimal elevations in HR and can still improve cardiac output because of better stroke volume. If all we wanted to show was that the worker is deconditioned, we could utilize a standard exercise treadmill test to document this state.

These cardiovascular changes are not under voluntary ("conscious") control, which is why they are so useful as measures of physical effort. What we would like to find is a measure of motor output (strength or movement) which would identify the upper limit of physical performance of which the worker is capable. We might then compare the quantitative output to normalized values based on height, age, and gender. The grip strength test (e.g., Jamar dynamometer) is an example of such a standardized motor output. There are published values for populations based on heavy versus sedentary physical labor and gender (Rondinelli, Genovese, Katz et al., 2008). The measurement of the three position grip strength test gives a curve which approximates a bell-shaped curve in normal persons. This measurement (three position grip, as well as alternating handgrip test) is also widely considered to be fairly accurate in identifying conscious poor effort (which we will call *malingering* in the context of workers' compensation). One often finds the grip dynamometer used in the functional capacity evaluation (FCE). However, there are problems with this method as discussed below.

Unfortunately, these physiological measures are the ones which are best defined in the context of work-related injury assessment, but leave much to be desired in terms of assessing motor capacity (performance). The remainder of the standard FCE relies on these two tests to detect potential malingering. We then must infer that the remainder of the performance on the FCE is probably submaximal or a result of poor effort if these two tests show inconsistent results.

Recent functional magnetic resonance imaging (fMRI) done by neurophysiologists has shown that persons suffering with chronic pain have detectable changes in their brain morphology, consistent with atrophy of gray matter (cortex) (Apkarian, Sosa, Sonty et al., 2004). These changes are clearly beyond the realm of conscious control of the subject and are tied into important areas of cortex involved in motor planning and execution of movement as well as emotional context. While these studies and their interpretation continue, they clearly imply that persistent states of pain may lead to alterations in the brain that can affect other aspects of the afferent (sensory input) and efferent (motor output) of the human being. Afferent input into the central nervous system occurs through the somatosensory neural input from the periphery, mediated by the dorsal horn of the spinal cord. The physiological phenomenon of *central sensitization* implies that various nociceptive inputs can change the balance between inhibition and excitation of the dorsal horn, with amplification of pain signals and dispersion of such disinhibitory signals to adjacent areas of the spinal cord. Pain is only one of the many types of somatosensory input into the nervous system. Recent physiological reports in patients with fibromyalgia syndrome (a disorder of "central sensitization") have shown ipsilateral activation of cortex in persons with allodynia tested by stroking the skin. Such patients had abnormal tender point scale examinations consistent with FMS, whereas controls did not show such ipsilateral activation (Fallon, Chiu, Li et al., 2013). The authors concluded that these findings reflected abnormal physiological changes as a result of somatosensory information manifesting as chronic pain. These findings may represent a manifestation of central sensitization and may contribute to clinical symptom severity (Bandak et al., 2012; Fallon et al., 2013). This provides yet another example of how brain physiology may be altered by chronic pain states.

So, persons with chronic pain may show abnormal activation of cortex by physiological measures, as well as brain morphological changes by imaging. How would these findings change our interpretation of a worker's performance on a test of functional capacity? The results of these recent neurophysiological investigations have not yet been incorporated into practical tests that can be performed in a clinical, as opposed to a research, setting. However, I think these new findings are critically important as we refine and develop new methods to assess the injured worker. These new findings may help to explain some of the deficiencies of the current state of FCE testing.

Central fatigue is a term coined to describe "decline in voluntary activation of muscle" likely due to a combination of "inadequate descending activation of motoneurones and net reduction in motoneuronal activation caused by disfacilitation (involving muscle spindle and tendon organ afferents) and inhibition (involving small diameter group III and IV muscle afferents) acting on spinal and supraspinal sites" (Gandevia, 1999). Central fatigue may manifest as perceived weakness during a test of exertion, such as a FCE. Recent physiological studies reviewed by Gruet et al. highlighted that motor cortex is influenced by other upstream mechanisms (probably arising in the prefrontal cortex and somatosensory cortex) which likely contribute to central fatigue. They postulated that future work using a combination of imaging and corticomuscular coherence methods will be necessary to identify CNS sites associated with supraspinal failure during exercise (Gruet, Temesi, Rupp et al., 2013; Ranieri & Di Lazzaro, 2012).

Some workers may manifest a disorder of movement that has been termed "psychogenic movement disorder" (PMD). These clinical phenotypes may range from complete paralysis of one or more limbs (conversion disorder) to more limited abnormalities such as tremors, unusual adventitious movements (voluntary myoclonus), or dystonia (e.g., writer's cramp). Neuropsychiatry distinguishes somatoform disorders, including conversion and somatization (not under conscious control), from factitious disorder (done to fulfill a psychological need) and malingering (behavior to achieve a goal) (Kranick, Gorrindo, & Hallett, 2011). None of the currently used physical performance or functional capacity tests can give definite answers in the recognition of these psychogenic disorders (PMD). At the present time, such disorders require neurological examination and neurophysiological assessment (including electroencephalography (EEG), electromyography (EMG), and accelerometer for tremor evaluation). Hallett has reviewed these syndromes and pitfalls in the diagnosis of them (Hallett, 2010; Hallett et al., 2011).

Medical Examination Prior to Functional Capacity Evaluation

A physician with experience in evaluation of the cardiac, pulmonary, neurological, and musculoskeletal systems should perform a history and physical examination of any injured worker prior to ordering a FCE or other quantitative assessments of physical performance (QPPE). Because of the occurrence of a variety of physical and psychosomatic disorders which could impact the subject's performance on an FCE or QPPE, an experienced physician needs to assess the entire medical history, medication usage, and work-related events leading up to the consideration of such physical assessment, in order to assess the safety of that worker's participation in such an evaluation. This always must include the following: review of outside medical records which may document other findings on previous physical examinations that are not seen at the current time, operative reports, and imaging or neurophysiological studies that may have shown abnormalities that are important in the decision to perform and interpret results from an FCE (Mayer, Gatchel, & Polatin, 2000).

History-taking of the injured worker must not only include the clear investigation of the current symptom complex (back pain, leg weakness, etc.) and any previous diagnostic testing that has been performed to date but should also include evaluation of family history for cardiac, neurological, or musculoskeletal problems that might impact the current evaluation. The injured worker's use of medications should be detailed in the written report, knowing not only what has been prescribed but whether and in what quantities and what dosing schedule the subject actually uses the medication (or not). Various medications can influence heart rate and blood pressure which could impact interpretation of some results of the FCE. Quantitative urine drug toxicology screening is now commercially available (as well as saliva sampling) to document levels of prescribed drugs in the patient's system, or the presence of illicit substances as well. I consider it good practice to perform such random quantitative screening on any patient who is taking prescribed opioids or other pain medications regularly. Such testing could also uncover subjects who have illicit substances which might make exercise testing hazardous (e.g., cocaine or amphetamines in their system).

The *work history* should be sufficiently detailed to understand what the current physical requirements of the job are at the time of injury, as well as the worker's history in previous employment as to his or her work capacity. For example, has there been a recent change of job which increased the physical demands on the worker beyond what the worker's previous employment required? Such physical work demands assessment will require input from the employer in the form of a written job description or, in some cases, a telephone call to the employer to determine the physical demands of the job if no written description is available. When there are discrepancies between the worker's statements as to the real job demands and the written job description, a telephone call to the employer is most useful to clarify these issues, and documentation in the written medical record of any discrepancies should be made.

Psychological assessment of the injured worker is conducted as part of the medical evaluation, and those workers who appear to have significant psychosocial dysfunction which may impact performance will require more detailed examination and testing by a psychologist or psychiatrist.

The physician who orders the FCE should inquire specifically about the presence or absence of the symptoms of depression or anxiety, which are two of the most commonly encountered psychiatric disorders in the injured worker population. In clinical practice, the author utilizes the Pain Disability Questionnaire (PDQ) to derive the functional and psychosocial dysfunction scores and total PDQ score, as a measure of perceived disability (Anagnostis, Gatchel, & Mayer, 2004). Other commonly used standardized measures include the Roland Morris Disability Questionnaire and the Oswestry Back Disability Index.

The author combines this instrument with the NIH PROMIS short forms for fatigue and sleep disturbance, which commonly are elevated in persons with chronic pain (unpublished data). For workers who have an associated known preexisting physical impairment (e.g., osteoarthritis of the knee), the NIH PROMIS physical function short form 2 is a useful quantitative measure for impairment in activities of daily living which may or may not be related to pain or the work-related injury. All the NIH PROMIS forms are available free of charge and have been standardized to the US population. Other useful forms that are widely available include the Western Ontario McMaster University Arthritis Center (WOMAC) scales for hip and knee osteoarthritis and the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire. The 6th edition of the AMA Guides has recognized the usefulness of the DASH questionnaire and the PDQ by incorporating specific instructions on administering and scoring the tests (Rondinelli et al., 2008).

Social history should include an understanding of the significant persons living in the injured worker's home; such family members may be able to give information about the impact of the disability in the home environment or provide added insights into what the worker does outside of the work environment. The use of harmful substances such as tobacco and alcohol is documented in the social history. Such interviews of family members also can uncover unsuspected problems such as obstructive sleep apnea (OSA) syndrome, of which the injured worker may be unaware. OSA can be associated with chronic pain, and in my practice, I have uncovered a large number of working age persons with chronic pain who have previously unrecognized OSA. Treatment of the OSA can be successful in improving the subject's sense of fatigue and daytime alertness and may reduce chronic pain perception. There are available standardized questionnaires for eliciting symptoms of OSA.

Exercise history is an often-neglected aspect of taking a medical history. I recommend asking questions such as the following: "Do you exercise regularly?", and "Tell me about what you do for exercise regularly?" which are open-ended and allow the examiner to learn more about the subject's experience or interest in the subject of exercise. This also provides a useful segue to explain the purpose of an FCE and why the examiner wishes to document the worker's performance in a more detailed way than can be done in the doctor's examining room.

Physical examination of the injured worker must include vital signs, height and weight and body mass index (BMI) determination. It is critically important to document the blood pressure (BP) and heart rate (HR) at rest. Abnormal values of BP and HR should result in repeating the values at the end of the examination. If these remain abnormal, then the physician must undertake appropriate further steps to evaluate or to consult other specialists in the evaluation of the cause. It would be medically negligent to send an injured worker who is not under treatment for hypertension into an FCE setting where dangerous BP elevation might occur. Such further evaluation might include a 12-lead electrocardiography, laboratory measurement of thyroid function, complete blood count and metabolic function (tests for diabetes and abnormalities of the liver and kidney, e.g., estimated glomerular filtration rate, known as e-GFR), or other appropriate tests based on the remainder of the physical exam and history findings. One of the most important reasons to have a physician examine the claimant before undertaking an FCE is to uncover potential risks that were unknown and prevent harm from the performance of an FCE in those workers with unsuspected health problems.

The BMI, which relates as a ratio the weight in kilograms and the square of the height in meters, can be calculated easily using online resources such as from the National Heart, Lung, and Blood Institute (http://www.nhlbi.nih.gov/guidelines/obesity/BMI/bmicalc.htm) or published tables of values. Some electronic health records also calculate this ratio automatically. Persons are defined as obese when the BMI > 30 and as morbidly obese when BMI > 40. Morbid obesity especially can be associated with significant cardiovascular risks, including heart failure, diabetes mellitus, and hyperlipidemia.

The remainder of the physical examination should be focused on the pertinent organ systems relevant to the injury and usually involves the neurological and musculoskeletal systems. In some cases, more specialized testing may be necessary to determine the presence of abnormal function which might impact the capacity to perform an FCE. Such examples might include assessment of the worker's pulmonary function by pulmonary function tests, when the history and physical examination point to significant problems in that area, or electrophysiological evaluation (e.g., needle EMG and nerve conduction studies) when neuromuscular dysfunction is suspected.

The *neurological examination* consists of evaluation of the mental status, speech, cranial nerves, motor functions (strength and tone of muscle), deep tendon reflexes, abnormal reflexes (e.g., Babinski sign), coordination, gait, and station (standing erect, single-legged stance). The *musculoskeletal examination* should look at active versus passive joint range of motion, including any limitations for the major weight bearing joints (ankle, knee, and hip) and presence of atrophy (measured with a centimeter tape measure) of the arm, thigh, or calf muscles. In some disorders, passive motion may be maintained, but active motion is impaired. Such would be the case with a rotator cuff tear and active shoulder flexion and abduction. Atrophy, especially if unilateral, could imply neuromuscular dysfunction (such as injury to the sciatic nerve or nerve roots to the leg). Leg length should be measured when fracture of a lower extremity long bone has occurred or total joint arthroplasty has been performed.

Provocative tests are somewhat less useful, because there may be a subjective component of pain behavior during their elicitation which is easily feigned by an experienced claimant. However, a test such as the drop arm test which when abnormal indicates lack of musculotendinous integrity of the supraspinatus tendon is a specific indicator of supraspinatus (one of the rotator cuff muscles) injury. The elicitation of Waddell's signs has been purported to be useful in the evaluation, although in this author's experience, they are not (Waddell, McCulloch, Kummel et al., 1980). Further discussion later in this chapter will confirm this skepticism. Most importantly, the examining physician should compare his/her abnormal findings on physical examination with the review of previous medical records to determine if the current abnormal findings have been documented previously. When there are new findings or discrepancies with previous findings, these divergences from the previous record should be noted in a report specifically, as they usually are important in understanding the progression or natural history of the injury.

When the findings between the current examiner and those of previous treating physicians and specialists are congruent, and the examination does not reveal abnormal illness behavior, then there is a high likelihood of obtaining a valid result from an FCE. However, when the findings between the current examiner and the previous physicians show noncongruent findings, then the examining physician must decide if the correct diagnosis has been made or if the natural history of the condition has progressed (worsened versus improved) and whether further diagnostic testing is necessary to clarify the diagnosis prior to consideration of FCE. An FCE should not be ordered if the examining physician is not able to state the diagnosis clearly based on objective assessment of the patient using all available data (medical records, history, physical examination, and specialized testing). It is not the responsibility of the therapist who performs the FCE to determine a diagnosis, as that is outside the boundaries of the professional license of the therapist and would risk claim of negligence if harm should result from the FCE due to an unrecognized condition.

Quantitative Assessment of Function

The literature up to the end of the twentieth century on quantitative assessment of function (QAF) for work-related injury has been well reviewed (Mayer et al., 2000). In this chapter, we seek to identify more recent published literature that impacts the topic of QAF. To this end, a medical research librarian-assisted English language literature search was made using the search terms (in various combinations) functional capacity, musculoskeletal measurement, work capacity evaluation and reproducibility of results, disability evaluation/reproducibility of results, musculoskeletal diseases/physiopathology, psychology, and pain measurement. In addition, author searches were conducted of three frequently cited authors (Gatchel RJ, Mayer TG, and Haralson III RH). The time period on which we focused was inclusive of 1999–2012. While this chapter has not the same purpose as a systematic review of the literature would provide, we did attempt a comprehensive review (integrative review) to identify issues especially involving the reproducibility of results and sources of error in the interpretation of QAF when used clinically in the assessment of work-related injury and disability. Over 400 articles were found, and the author attempted to utilize the results objectively, but not following the strict format of a systematic review, such as used by the Cochrane Collaboration.

In Table 16.2, we have identified physiological measures which can give information of use in the determination of functional capacity. The cardiorespiratory parameters of heart rate, blood pressure, respiratory rate, and maximal oxygen consumption are ones with which all physicians are familiar. These measurements are highly objective in that the subject cannot consciously influence them. They are indicators of physical fitness (or, conversely, deconditioning) when used in the setting of exercise testing. The second portion of Table 16.2 identifies strength measures which are clinically available, although somewhat more difficult to obtain: isometric maximal strength and isokinetic strength. These measures can be highly reliable, but subject-related effort is required to produce best results. These measures require special equipment as well. They are utilized in sports medicine-related settings and are definitely associated with clinically relevant strength and fitness. The third portion of Table 16.2 identifies physiological measures which are discussed in the literature on muscle physiology and human motor control. They are physiological parameters which in some cases are rather difficult to measure, but which do not rely on subject effort for the most part. To the author's knowledge, these have never been incorporated into clinical QAF testing in the setting of work disability assessment.

Table 16.2 Physiological measures

Commonly measured
Heart rate
Blood pressure
Respiratory rate
Oxygen consumption (V–O_2 max)
Difficult to measure
Isometric maximal strength
Isokinetic strength (constant velocity of movement)
Motor unit activation (surface EMG)
Research use only
Corticomuscular coherence
Cortical readiness potential (prior to movement)
Somatosensory evoked potential
Motor evoked potential

A probing review of FCEs (one type of QAF) was published in 1998 by authors who are occupational therapists from the USA and Australia (King, Tuckwell, & Barrett, 1998). They focused on issues such as comparing controlled to uncontrolled FCEs, type of training needed to administer the FCE, degree of work simulation, and the therapist's ability to alter the test design. Importantly, they identified common components of FCE to include the following: review of the medical records, self-administered questionnaire, interview of the subject, physical measures and musculoskeletal evaluation, physiological measures and functional measures, and comparison of the test results with the job requirements. The authors gave very practical, detailed advice on the medicolegal implications of these tests and especially concerns which can arise regarding how results must be interpreted in light of understanding the job requirements based on a job analysis.

Researchers in the Netherlands investigated whether the reliability of a 2-day testing protocol for FCE was justified (Reneman, Dijkstra, Westmaas, & Goeken, 2002). In this prospectively conducted study, the authors used a cohort of 50 patients and excluded subjects exhibiting "strong behavioral or psychological problems" as confirmed by a psychologist. They found that the mean performances on day 2 of a 2-day FCE protocol were 6–9 % higher on the second day of testing, a statistically significant finding. They used a stepwise regression model to assess significant independent variables and found that day 1 performance was the strongest predictor of results on day 2 (Reneman et al., 2002). They pointed out that they did not evaluate or control for motivation, physical deconditioning, and pain behavior. They concluded that "a validated measure to assess a person's individual physical intensity level is currently unavailable." They did note that there was good test–retest reliability for lifting and carrying tasks.

Fishbain and colleagues published a review of submaximal effort research. A total of 68 of 328 references were evaluated and determined to involve issues of malingering and chronic pain (Fishbain, Cutler, Rosomoff et al., 1999). They defined malingering as disability exaggeration: "the false and fraudulent simulation or exaggeration of physical or mental disease or defect" (Fishbain et al., 1999). While they agreed that malingering exists, the studies they reviewed to date had not identified clear methods for identifying the malingering patient. Important findings from this review included the inability of reliable discrimination from grip strength effort (a physiological measure on which many FCEs rely as a test of patient effort) and the lack of reliability for facial expressions or forced choice sensory testing as indicators of disability exaggeration. Importantly, they disputed the reliability of the coefficient of variation method of discriminating best effort from malingered effort. These findings are important because the use of grip dynamometry and coefficient of variation differences in performance are commonly utilized by clinical FCE protocols (Sindhu, Schechtman, & Veazie, 2012).

Nonorganic physical findings have long been considered useful by clinicians in the assessment of the patient with chronic pain complaint. In an evidence-based review, Fishbain and colleagues found no convincing association between secondary gain (malingering) and the presence of three or more Waddell's signs on physical examination (Fishbain, Cutler, Rosomoff et al., 2004). The signs as originally described by Gordon Waddell included superficial tenderness, simulation (axial loading pressure on skull inducing back pain), distraction (SLR difference in the supine versus seated positions), regional weakness, and overreaction (Waddell et al., 1980). Once again, this review of the published literature would indicate that Waddell's signs are being misinterpreted by clinicians and are not a reliable indicator of an injured worker who is feigning pathology.

While the FCE has been used traditionally in the assessment of lower back pain disorders, its usefulness for the injured upper extremity worker has been explored in a longitudinal study from Canada of 336 claimants with upper extremity disorders, including specific diagnoses (amputation, fracture) and nonspecific upper extremity pain syndromes. The authors used logistic regression modeling to predict future recurrence and found that no FCE variable was associated with future recurrence. Recurrence was defined as reopening a claim (from insurance data) or filing report of a new injury. Their recurrence rate was 39 %, much higher than reports for lumbar injury (Gross & Battie, 2006). Interestingly, in this well-done study, the authors found that the waist-to-overhead lift task was the best predictor of all the FCE test components, and they concluded that the waist-to-overhead lift task was the only factor that independently associated with claim closure, and hence, the FCE itself contained redundant items in the protocol. In their analysis they noted that whether subjects demonstrated performance that met or exceeded the physical job demands was unrelated to future recovery. They observed that performance-based functional tests could be conceived of as behavioral assessments rather than strict physical capacity tests.

Psychologists have emphasized the strong influence of psychosocial factors that influence effort and performance on the FCE (Geisser, Robinson, Miller et al., 2003). In a critical review, these authors have decried the lack of study of how such psychosocial factors influence the validity and results of FCE testing. They emphasized that fear-avoidance beliefs were significant predictors of increased disability and inability to work. Pain catastrophizing and other negative beliefs can influence physical functioning, which could lower performance on functional capacity testing. These authors emphasized those future developments in QAF measurement must develop more complex models to account for the strongly influential role of psychosocial factors in the interpretation of functional test results.

An excellent systematic review from the University of Amsterdam has assessed the usefulness of functional questionnaires and functional performance tests (Wind, Gouttebarge, & Kuijer, 2005). In their review of the literature, they identified questionnaires to assess functional capacity and whether the context was work, sport, or daily activities. They then analyzed validity (face, content, criterion, construct, and responsiveness) and the reliability based on statistical considerations such as inter-rater correlation, intra-rater correlation, internal consistency, and test-retest measures. They found the Disability Rating Index, the Medical Rehabilitation Follow Along (MRFA) instrument, and the Medical Outcomes Study (MOS) 36-item short-form health survey as having excellent test characteristics using these criteria. Interestingly, in this review, the authors found that no functional test had high levels of both reliability and validity. The tests reviewed included the FCE, Tufts Assessment of Motor Performance (TAMP), EPIC Lift capacity test, progressive iso-inertial lifting evaluation (PILE), Jebsen Hand Function Test, upper extremity function test, and functional performance tests, such as hopping tests. From this review, the authors concluded that “a combination of different methods of measurement seems to be the most desirable in order to achieve a correct assessment…” (Wind et al., 2005). How to combine a variety of measures, such as questionnaire methods, functional tests, and physician clinical examination, remains an unanswered question in the literature (Gouttebarge et al., 2004).

In the rheumatology literature, a well-done systematic review of performance-based methods for physical function in patients with hip or knee osteoarthritis was published. The authors defined strict inclusion criteria including a sample size of at least 50 patients and gave operational definitions for reproducibility (Terwee, Mokkink, Steultjens et al., 2006). Reliability was defined as the ability to differentiate among patients despite measurement errors. Agreement or absolute measurement error was defined, and a minimal important difference of 0.5 standard deviation units was used if not otherwise specified. Construct validity was the ability to measure the concept that the instrument was intended to measure and was considered adequate if a priori hypotheses were defined, and 75 % of the results were concordant with those hypotheses. Responsiveness was the ability of an instrument to detect important change over time. Interpretability was the degree to which qualitative meaning could be assigned to quantitative scores. The authors from this Dutch study assessed 26 performance-based methods. Only 7 % of the methods had positive ratings (good clinimetric properties as defined above). Only the Iowa Level of Assistance Scale (ILAS) had three positive ratings on clinimetric standards. The Physical Activity Restrictions (PAR) was also viewed favorably by the authors for its internal consistency and justification for the choice of activities used (Terwee et al., 2006). While this review was focused on patients with osteoarthritis (as opposed to injured workers), it represented a critical and evidence-based method of assessing the clinimetric properties of the methods reviewed and related their findings to the International Classification of Function (ICF), which is the worldwide standard for disability assessment, promulgated by the World Health Organization. The importance of the ICF as the newest and internationally accepted model for disability is important in devising new strategies and research studies for assessment of work-related injury and performance (Wind et al., 2006).

The use of muscle testing to determine sincerity of effort has warranted close consideration. The authors of one recent study reviewed the measurement parameters that have been utilized such as variability in effort, detected by higher coefficients of variation in repetitive performances, decreased range and velocity of motion, strength ratios, and difference scores (Robinson & Dannecker, 2004). They concluded that, based on the published evidence to date, variability as expressed by a higher coefficient of variation in test performance is not adequate to determine sincerity of effort. They reviewed problems with the rapid exchange grip (REG) test (in which the subject grips with each hand alternately to give the maximal isometric contraction possible); they also found that motion analyses lacked appropriate statistical analysis to justify its use.

Surface EMG is a noninvasive technique to record muscle activation. An older study from 1983 looked at nine subjects who were tested on three different days (Yang & Winter, 1983). The subjects performed five maximal voluntary contractions (MVCs) with no visual feedback about performance. They found that the within-day coefficient of variation values was similar for submaximal and maximal contractions with values ranging from 8 to 10 %. The between-days variability was higher, ranging from 12 to 16 %. Robinson and Danneker reviewed more recent studies on surface EMG and concluded that EMG appears to be a reliable and clinically meaningful means of discriminating effort levels (Robinson & Dannecker, 2004).

Finally, the Cochrane Collaboration holds worldwide respect as a leader in the use of systematic review and meta-analyses to determine efficacy of treatments. Their methodology has been widely discussed, and the interested reader should consult the internet website for details (http://www.thecochranelibrary.com). In 2010, the Cochrane Collaboration published an intervention review on FCE for the prevention of occupational reinjuries (Mahmud, Schonstein, Schaafsma et al., 2010). They performed a comprehensive literature survey from 1980 to 2009 and found no studies that compared FCE to no intervention. They located one study which compared a short-form FCE to the standard long-form FCE (Isernhagen Work Systems). There were no significant differences between the short and long forms of the FCE when the outcome variable was rate of reinjury.

Functional Capacity Evaluation: A Close Look

Mooney reviewed the justification for functional testing in light of California worker compensation regulations and provided necessary characteristics for a valid test (Mooney, 2002). The 2-h testing he described combines a structured interview, paper and pencil assessment of perceived physical capacity, and pain drawing, with measured tasks such as the pinch test and Jamar power grip test, the EPIC lift capacity test, a climbing test equivalent to a 10-foot flight of stairs carrying maximal weight lifted, and carrying test of a load over a hundred-foot course. He confirmed that the best measure by which to gauge disability would be impairment of function, as opposed to subjective ratings of pain. Also, a workshop held by the Institute of Medicine and the National Research Council in 1999 reviewed the measurement of functional capacity in order to develop better and more objective assessments of disability determination for the Social Security Administration (Wunderlich, 1999). The conferees distinguished between the terms *attributes*, which pertain to the characteristics or properties of the body system or individual, and *relational concepts*, which cannot be accounted for solely among the characteristics of an individual, but include other elements beyond the individual's attributes (Wunderlich, 1999, p. 47). These concepts link to the World

Health Organization's conceptualization of function known as the ICF (International Classification of Functioning, Disability and Health) (WHO, 2013). In this model, our understanding of function of the individual involves not only impairments of body function or structure but also his or her limitations in activity and social participation. This broader conceptualization of disability also includes contextual factors such as the environment. In the context of work disability, adaptations to the work environment are not normally addressed in the performance of an FCE. The conferees noted that the current method of disability decision-making by the Social Security Administration does not take into account how the work environment might be adapted to improve the chances of the impaired worker returning to gainful employment. The FCE as currently performed does not address the issue of "reasonable accommodation," a term used by the Americans with Disabilities Act which places some onus on the employer to make such accommodations to maintain employment for workers with disabilities.

One of the workshop authors (Dr. Constantine Lyketsos) opined that if a "gold standard" for disability cannot be found, then a substitute standard would depend on longitudinal assessment, expert opinion, and all data assessment (LEAD) (Wunderlich, 1999, pp. 52–53). Disability is not a static concept, and change (improvement) may occur over time, so repeat assessments could be highly useful in establishing the ability to work. Fleischman has described nine physical ability factors that correlated best with performance based on factor analysis studies of normal subjects; these nine factors included four strength factors (static, dynamic, explosive, and trunk strength), two flexibility factors, an equilibrium factor, a gross-body coordination factor, and stamina (cardiovascular endurance) factor (Wunderlich, 1999, p. 37). Ideally, tests of functional capacity should be able to score performance in each of these nine areas.

In a recently published article, a Delphi survey was conducted to achieve consensus on operational definitions in FCE. A total of 22 international experts participated in the survey, from Australia, Europe, and North America. The consensus was reached on using the World Health Organization ICF as a suitable framework for classification of terms; all the participants agreed that FCE should not be focused solely on disability; and 89 % of participants agreed that the FCE is a performance-based measurement to determine what the person can do safely, not what he or she cannot do. Consensus on definitions was met in only 10 of 19 definitions! The items for which no consensus could be reached included such important terms as work performance, work ability, work tolerance, malingering, aggravation, FCE, physical capacity evaluation, ability, work capacity evaluation, and recovery. From an operational standpoint, these findings are indeed troubling. If a panel of international experts (an "expert" being defined as one who either had published in peer-reviewed literature or developed protocols for FCE tests) cannot reach consensus on basic definitions, then clearly there is much room for interpretation error or misjudgment by the users of such reports. The authors of this study identified two definitions of FCE which had the largest agreement among the experts, despite not meeting the threshold of 75 % agreement. The definition which also followed the ICF framework was: "An FCE is an evaluation of capacity of activities that is used to make recommendations for participation in work while considering the person's body functions and structures, environmental factors, personal factors and health status." The authors concluded that, in future studies, investigators should define their term for what is an FCE and consider using one of the two terms most accepted by this consensus panel (Soer, van der Schans, Groothoff et al., 2008).

King, Tuckwell, and Barrett have reviewed the differences among ten available types of FCE testing for clinical use. These protocols included the following: the Blankenship, the Isernhagen IWS, the ErgoScience PWPE, California WEST-EPIC (Matheson), WorkAbility Mark III (Heyde and Shervington), WorkHab (Roberts and Bradbury), AssessAbility (Coupland), ARCON (Rasch), ERGOS (Work Recovery, Inc.), and Key. Their review article detailed important information on costs, norms or reference criterion, and other information for clinicians. They also put forward their opinion as to what constituted a well-designed FCE, which could not be one-size-fits-all but must be tailored to the specific question from the referral source and use of the study results. They described the principles of standardization, objectivity, reliability, and validity criteria, as part of a scientific approach to FCE practice. Most importantly, they agreed that "an FCE consists of an interview and client history, a physical examination, test components, and a comparison of a client's abilities with the demands of the job" (King et al., 1998). The FCE cannot be interpreted solely as a test without reference to the information obtained from the history and physical examination and review of previous medical records to understand the factors unique to that injured worker which could impact his or her performance in a standardized protocol.

Many FCE protocols make use of the presence of nonorganic signs (NOS). The use of NOS to identify potential malingering has not been well substantiated. The statistical measure of coefficient of variation (CV) has been proposed as a means of assessing effort validity and detection of submaximal effort (presumed to be a sign of malingering), but scientific evidence in favor of this measure is lacking. For example, the use of CV with the isometric grip force has been measured in several protocols, including the REG, the rapid simultaneous grip, and the generation of a bell-shaped curve method of Stokes (Lechner, Bradbury, & Bradley, 1998). These authors of a critical review of NOS pointed out that the studies involving isometric handgrip strength were performed in the setting of evaluation of hand injury, not lower back pain patients.

Psychophysiological studies of pain and physiological response to acute pain have been reported in the chronic lower back pain population (CLBP) (Peters & Schmidt, 1991). In their study, Peters and Schmidt studied 20 male CLBP patients and 20 age-matched controls, with a mean duration of 11.5 years for the CLBP group. They found that the biomechanical model of CLBP seemed to fit their finding of strong lumbar EMG response in the patient group. The CLBP group showed no subjective habituation and was more aroused and anxious than the control group. The investigators noted no difference in the cardiac and respiratory responses of the two groups. In the setting of clinical FCE testing, the cardiovascular response to exercise is relied upon for determination of effort. The lack of difference between CLBP and controls in a more controlled physiological study should lead us to review more recent physiological research and its potential implications for understanding the validity of FCE testing.

Physiological Research and Its Implications

When we step away a bit from the direct issue of how an injured worker, usually with chronic complaints of weakness or pain, performs in a testing situation which has medicolegal implication, we should look into the neurophysiology of fatigue and exercise. Several tantalizing studies have reported information that in this author's opinion, casts doubt on the validity of the entire exercise of FCE. In an intriguing study reported from Japan, several neuroscientists studied eight subjects with an intermittent leg press exercise. The exercise used three bouts of 5-min leg press at 50 % of MVC, separated by a 2-min rest period (Takahashi, Maruyama, Hirakoba et al., 2011). Without going into all the details of the physiological setup, the authors found that muscle fatigue of the lower extremity produced powerful effects on the muscles of the non-exercised upper limb! The corticospinal and intracortical excitability in the hand and arm were depressed by the fatiguing leg exercise, a phenomenon that could not be explained by traditional theories of neuroanatomy and physiology of the motor system. Their results showed a somatotopic spread from proximal arm muscles (such as biceps brachii) down to the hand (first dorsal interosseous muscle), which might be explained by effects of the fatiguing exercise on the premotor areas of cortex, instead of the traditional M-1 area.

In a very recent physiological review of the stimulation of the motor cortex and corticospinal tract, the French neuroscientists reviewed the scientific evidence for central fatigue (Gruet et al., 2013). They concluded that additional mechanisms located "upstream" from the motor cortex contribute to central fatigue. They recommended consideration of advanced techniques such as combining neuroimaging and cortico-muscular coherence methods (EEG–EMG) to identify in the future specific sites for supraspinal failure during exercise.

Conclusions

FCE testing appears, at first glance, to be an easy way to measure important physical functions necessary for decisions about return to work. This author has had clinical experience interpreting FCE for over twenty years. The use of the data obtained by therapists performing FCEs has always required more in-depth review of the medical records, imaging, and other tests, as well as physical examination of the claimant in order to assess properly the validity or usefulness of such data in return-to-work decisions. Over the years, flaws in the FCE test have become more apparent. When an FCE is used to make decisions about a subject who is motivated to return to his or her job, this author has found the results of FCE to be quite useful and supportive of the worker's successful return to work. Unfortunately, in many cases, the worker has anxiety or other inhibitors which seem both situational ("I don't like my employer") and psychosocial (fear of reinjury, fear of retaliation by the employer) in nature. Such individuals do not perform adequately on an FCE, in the sense that the expected positive correlations between their physical findings (muscle strength, flexibility, etc.) and job capacity are discordant. The frequent findings of such incongruities between physical condition and performance over the years led to my interest in understanding the physiological basis of what we are trying to accomplish when we assess human functional capacity. The demonstration of changes in brain function in persons with chronic benign pain lend further strong support to the concept that persons with chronic pain have changes in cognitive and psychological function that may impede physical performance, irrespective of the original pathology from injury.

As clinicians evaluating and treating injured workers, we may find at first glance that these physiological findings appear to be remote from our purpose. However, this review of the published literature has shown problems with significant validity for all or even most of the FCE components. We have chosen not to review in detail the components of the standard FCE, because most of these components have not been well validated. As this evidence-based review details, major problems exist in the interpretation of FCE results in those very workers who may demonstrate abnormal illness behavior, pain catastrophizing, or other maladaptive behaviors that likely led to consideration of FCE testing in the first place to assess the claimant's ability to return to work. Quantitative physical and functional capacity assessment has not yet reached the level of international scientific consensus, and its uses in matters of return to work or disability determination require significant interpretation in light of other medical, psychological, and environmental information not found within the functional capacity test itself.

References

Anagnostis, C., Gatchel, R. J., & Mayer, T. G. (2004). The Pain Disability Questionnaire: A new psychometrically sound measure for chronic musculoskeletal disorders. *Spine, 29*(20), 2290–2302.

Apkarian, A. V., Sosa, Y., Sonty, S., et al. (2004). Chronic back pain is associated with decreased prefrontal and thalamic gray matter density. *Journal of Neuroscience, 24*(46), 10410–10415.

Bandak, E., Amris, K., Bliddal, H., et al. (2012). Muscle fatigue in fibromyalgia is in the brain, not in the muscles: A case–control study of perceived versus objective muscle fatigue. *Annals of the Rheumatic Diseases, 72*(6), 963–966. doi:10.1136/annrheumdis-2012-202340.

Fallon, N., Chiu, Y. H., Li, X., et al. (2013). Ipsilateral cortical activation in fibromyalgia patients during brushing correlates with symptom severity. *Clinical Neurophysiology, 124*, 154–163.

Fishbain, D. A., Cutler, R., Rosomoff, H. L., et al. (1999). Chronic pain disability exaggeration/malingering and submaximal effort research. *Clinical Journal of Pain, 15*(4), 244–274.

Fishbain, D. A., Cutler, R. B., Rosomoff, H. L., et al. (2004). Is there a relationship between nonorganic physical findings (Waddell signs) and secondary gain/malingering? *Clinical Journal of Pain, 20*(6), 399–408.

Gandevia, S. C. (1999). Mind, muscles and motoneurones. *Journal of Science and Medicine in Sport, 2*(3), 167–180.

Geisser, M. E., Robinson, M. E., Miller, Q. L., et al. (2003). Psychosocial factors and functional capacity evaluation among persons with chronic pain. *Journal of Occupational Rehabilitation, 13*(4), 259–276.

Gouttebarge, V., Wind, J., Kuijer, P. F. M., & Frings-Dresen, M. H. W. (2004). Reliability and validity of functional capacity evaluation methods: A systematic review with reference to Blankenship system, Ergos work simulator, Ergo-Kit and Isernhagen work system. *International Archives of Occupational and Environmental Health, 77*(8), 527–537.

Gove, P. B. (Ed.). (1986). *Webster's third new international dictionary of the English language*. Chicago: Merriam-Webster, Inc.

Gross, D. P., & Battie, M. C. (2006). Does functional capacity evaluation predict recovery in workers' compensation claimants with upper extremity disorders? *Occupational and Environmental Medicine, 63*(6), 404–410.

Gruet, M., Temesi, J., Rupp, T., et al. (2013). Stimulation of the motor cortex and corticospinal tract to assess human muscle fatigue. *Neuroscience, 231*, 384–399.

Hallett, M. (2010). Physiology of psychogenic movement disorders. *Journal of Clinical Neuroscience, 17*, 959–965.

Hallett, M., Lang, A. E., Jankovic, J., Fahn, S., et al. (Eds.). (2011). *Psychogenic movement disorders and other conversion disorders*. New York: Cambridge University Press.

Kagan, J. (2012). *Psychology's ghosts: The crisis in the profession and the way back* (p. 149). New Haven, CT: Yale University Press.

King, P. M., Tuckwell, N., & Barrett, T. E. (1998). A critical review of functional capacity evaluations. *Physical Therapy, 78*(8), 852–866.

Kranick, S. M., Gorrindo, T., & Hallett, M. (2011). Psychogenic movement disorders and motor conversion: A roadmap for collaboration between psychiatry and neurology. *Psychosomatics, 52*, 109–116.

Lechner, D., Bradbury, S. F., & Bradley, L. A. (1998). Detecting sincerity of effort: A summary of methods and approaches. *Physical Therapy, 78*(8), 867–888.

Mahmud, N., Schonstein, E., Schaafsma, F., et al. (2010). *Functional capacity evaluations for the prevention of occupational re-injuries in injured workers (Review) The Cochrane Collaboration*. New York: Wiley.

Mayer, T. G., Gatchel, R. J., & Polatin, P. B. (Eds.). (2000). *Occupational musculoskeletal disorders: Function, outcomes and evidence*. Philadelphia: Lippincott Williams & Wilkins.

Mooney, V. (2002). Functional capacity evaluation. *Orthopedics, 25*(10), 1094–1101.

Peters, M. L., & Schmidt, A. J. M. (1991). Psychophysiological responses to repeated acute pain stimulation in chronic low back pain patients. *Journal of Psychosomatic Research, 35*(1), 59–74.

Ranieri, F., & Di Lazzaro, V. (2012). The role of motor neuron drive in muscle fatigue. *Neuromuscular Disorders, 22*, S157–S161.

Reneman, M. F., Dijkstra, P. U., Westmaas, M., & Goeken, L. N. H. (2002). Test-retest reliability of lifting and carrying in a 2-day functional capacity evaluation. *Journal of Occupational Rehabilitation, 12*(4), 269–275.

Robinson, M. E., & Dannecker, E. A. (2004). Critical issues in the use of muscle testing for the determination of sincerity of effort. *Clinical Journal of Pain, 20*(6), 392–398.

Rondinelli, R., Genovese, E., Katz, R. T., et al. (2008). *Guides to the evaluation of permanent impairment* (6th ed.). Chicago: American Medical Association.

Sindhu, B. J., Schechtman, O., & Veazie, P. J. (2012). Identifying sincerity of effort based on the combined predictive ability of multiple grip strength tests. *Journal of Hand Therapy, 25*, 308–319.

Soer, R., van der Schans, C. P., Groothoff, J. W., et al. (2008). Towards consensus in operational definitions in functional capacity evaluation: A Delphi survey. *Journal of Occupational Rehabilitation, 18*, 389–400.

Takahashi, K., Maruyama, A., Hirakoba, K., et al. (2011). Fatiguing intermittent lower limb exercise influences corticospinal and corticocortical excitability in the nonexercised upper limb. *Brain Stimulation, 4*, 90–96.

Terwee, C. B., Mokkink, L. B., Steultjens, M. P. M., et al. (2006). Performance-based methods for measuring the physical function of patients with osteoarthritis of the hip or knee: A systematic review of measurement properties. *Rheumatology, 45*, 890–902.

Waddell, G., McCulloch, H. A., Kummel, E., et al. (1980). Non-organic physical signs in low-back pain. *Spine, 5*, 117–125.

Wind, J., Gouttebarge, V., & Kuijer, P. F. M. (2005). Assessment of functional capacity of the musculoskeletal system in the context of work, daily living, and sport: A systematic review. *Journal of Occupational Rehabilitation, 15*(2), 253–272.

Wind, H., Gouttebarge, V., Kuijer, P. F. M., Sluiter, J. K., Frings-Dresen, M. H. W. (2006). The utility of functional capacity evaluation: The opinion of physicians and other experts in the field of return to work and disability claims. *International Archives of Occupational and Environmental Health, 79*(6), 528–534.

World Health Organization. Retrieved 18 August 2013 from http://www.who.int/classifications/icf/en/

Wunderlich, G. S. (Ed.). (1999). *Measuring functional capacity and work requirements: Summary of a workshop*. Washington, DC: National Academy Press.

Yang, J., & Winter, D. A. (1983). Electromyography reliability in maximal and submaximal isometric contractions. *Archives of Physical Medicine and Rehabilitation, 64*, 417–420.

17

Current American Medical Association Guidelines for Evaluating Musculoskeletal Impairment at Maximum Medical Improvement

Robert Rondinelli and Mohammed Ranavaya

Overview

Physicians, regardless of their specialty, from time to time may face a request from their patients to fill out a form or write a letter certifying an impairment or disability and resulting in some benefits including absence from work. However, the practice of impairment and disability assessment is rarely, if ever, a part of their formal medical or postgraduate training. Indeed, most physicians feel unprepared when asked to perform these evaluations, and a majority of them write their opinions on a subjective basis with little or no objective foundation.

This chapter discusses the most current models of disablement, including their biological, psychological, and social foundations, associated terminology and definitions, and the most common and contemporary disability and compensation systems in the United States, which rating physicians can expect to encounter in clinical practice. This chapter also describes how to evaluate impairment using the most current edition of the most common rating guides.

Medical Disability Evaluation

Terminology and Definitions

The American Medical Association offers the following terms and definitions commonly encountered in a medical disability evaluation: (American Medical Association, 2008).

Aggravation: Permanent worsening of a preexisting condition. A physical, chemical, biological, or other factor results in an increase in symptoms, signs, and/or impairment that never returns to baseline or what it would have been except for the aggravation.

Disability: an umbrella term for activity limitations and/or participation restrictions in an individual with a health condition, disorder, or disease.

Exacerbation: temporary worsening of a preexisting condition after which the individual recovers to his or her baseline functional status, or what it would have been had the exacerbation never occurred.

Impairment: a significant deviation, loss, or loss of use of any body structure or function in an individual with a health condition, disorder, or disease.

Impairment rating: a consensus-derived percentage estimate of loss of activity, which reflects severity of impairment for a given health condition and the degree of associated limitations in terms of activities of daily living (ADLs).

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Independent medical examination (*IME*): a usually one-time evaluation performed by a licensed physician/surgeon who is not treating the patient or claimant, in order to answer questions posed by the party requesting the IME.

Maximum medical improvement (*MMI*): the point at which a condition has stabilized and is unlikely to change (improve or worsen) substantially in the next 12 months, with or without treatment.

Permanency and *MMI* are related concepts and simply mean that a person with an injury, after having received adequate medical, surgical, and rehabilitative treatment and achieved clinical and functional stability, is now as good as they are going to get. Other synonymous terms in use according to jurisdictional preference include fixed and stable, maximum medical recovery, maximum medical stability; medically stationary, etc. In workers' compensation jurisdictions (see below), these terms are useful to enable the injured person to exit the temporary disablement stage of recovery, thereby facilitating claim settlement and case closure.

Models of Disablement: Medical, Social, Biopsychosocial

The "medical model" of disability was the conceptual cornerstone for understanding disablement throughout much of the nineteenth and twentieth centuries, whereby causation of disablement was viewed in terms of an underlying pathology (impairment) arising out of illness or disease. Because management of disability was essentially a medical issue closely linked to diagnosing and treating the underlying pathology, the physician thereby became empowered to rate the associated and disabling consequences of the pathology and impairment (Iezzoni & Freedman, 2008; Novick & Rondinelli, 2000). Anatomical and physiological objectivity continues to be the desired feature of the medical model of disability described above, and this model has worked well for conditions, whereby the diagnosis remains unambiguous, the pathology is well understood, and where treatment strategies and end points can be clearly identified and understood (Rondinelli, 2009; Waddell, Burton, & Aylward, 2008). Today, the medical model still serves as the basis for Social Security Disability determinations.

The "social model" of disability grew out of the disability advocacy movement of the 1970s and 1980s, and was predicated on a view that society imposes disability upon individuals with impairments when it fails to adequately address their special needs in terms of access and accommodation in the home, community, and/or workplace. The resulting disablement can be viewed in terms of restrictions to functioning in terms of individual or institutional prejudicial thinking and discrimination, architectural and other physical barriers to access and transportation, educational segregation, and the lack of accommodation (Oliver, 1996). An understanding of the social model has helped foster enabling strategies to better neutralize social barriers to individuals with impairments, thereby minimizing their disability.

The "biopsychosocial model" of disability (Engle, 1977) is now widely accepted as the preferred conceptual model of disablement, as it simultaneously recognizes the contributions of medical, social, personal, and psychological determinants of disability. The *biological* component refers to the physical and/or mental aspects of an individual's health condition; the *psychological* component recognizes personal and psychological factors that are impacting on that individual's functioning; the *social* component recognizes contextual and environmental factors that may also impact functioning in each particular case.

The Constructs of Impairment and Disability Compared and Contrasted

The International Classification of Functioning, Disabilities and Health (ICF) (World Health Organization, 2001) is depicted in Fig. 17.1. The ICF has replaced the outdated International Classification of Impairments, Disabilities, and Handicaps (ICIDH) (World Health Organization, 1980) as the conceptual model and terminology of disablement. It provides a more comprehensive and interactive (as opposed to linear) framework of disablement based upon the biopsychosocial model described above, in order

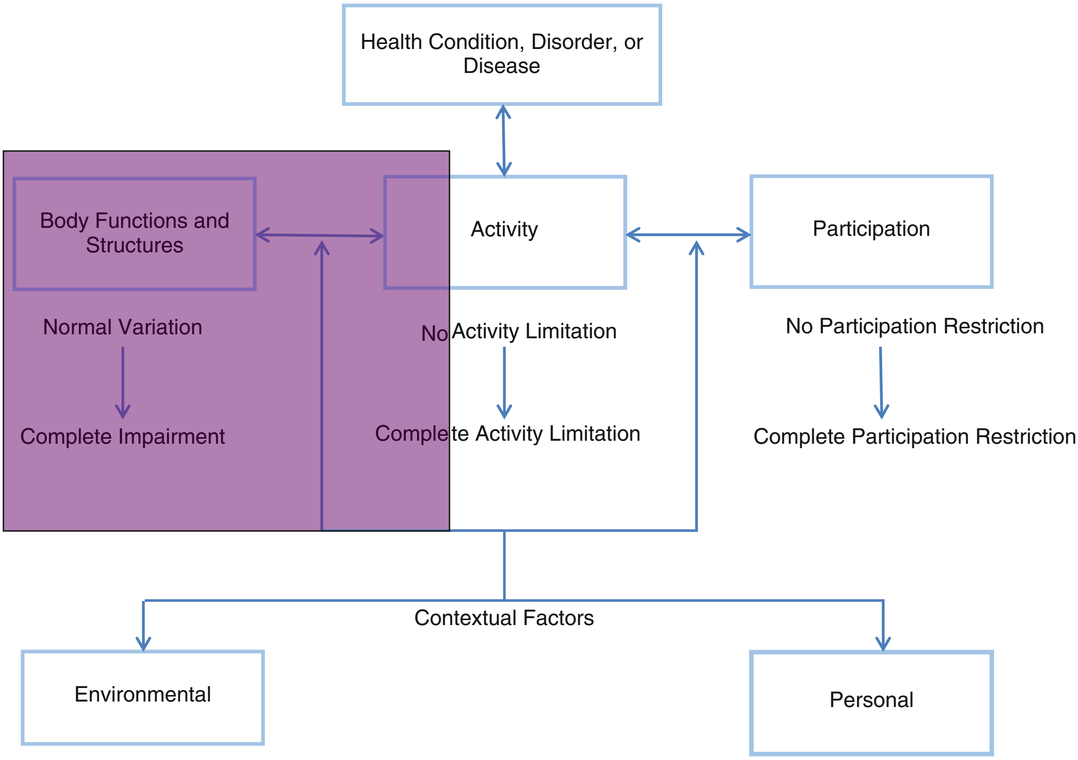


Fig. 17.1 International classification of functioning, disability, and health

to demonstrate the association between an individual with a health condition, the functional consequences of their impairment, and the contextual factors of a personal and environmental nature in each specific case (World Health Organization, 2001).

The components of disablement according to the ICF classification system include:

- *Body functions and body structures*: physiological functions and body parts, respectively
- *Activity*: the execution of a task or action by an individual (typically within their personal sphere)
- *Participation*: involvement in a life situation (typically within a social sphere)
- *Impairments*: problems in body function or structure, such as a significant deviation or loss
- *Activity limitations*: difficulties an individual may have in executing activities
- *Participation restrictions*: problems an individual may experience in involvement in life situations

Within this conceptual framework, the disabling consequences of impairment may be amplified or mitigated by factors unique to the individual with a health condition, interacting with their environment and according to personal choice.

Whereas the constructs of impairment and disability are central to any compensation scheme, they are frequently confused and confounded in practice. Figure 17.2 represents the domains of interest common to most disability compensation systems (McGeary, Ford, McCutchen et al., 2007). To the left is the domain of *medical impairment*, which describes physical or psychological pathology and dysfunction and which is typically defined and measured according to the medical model described above. In the middle is the domain of *activity* which describes the individual's basic mobility and self-care abilities within their personal sphere, which can be defined and measured according to basic or advanced (instrumental) ADLs. Basic ADLs include self-directed activities, such as feeding, toileting, hygiene, bathing, grooming, dressing, and mobility activities, such as transfers (shifting one's position at one point in space, such as lying to sitting, sitting to standing,

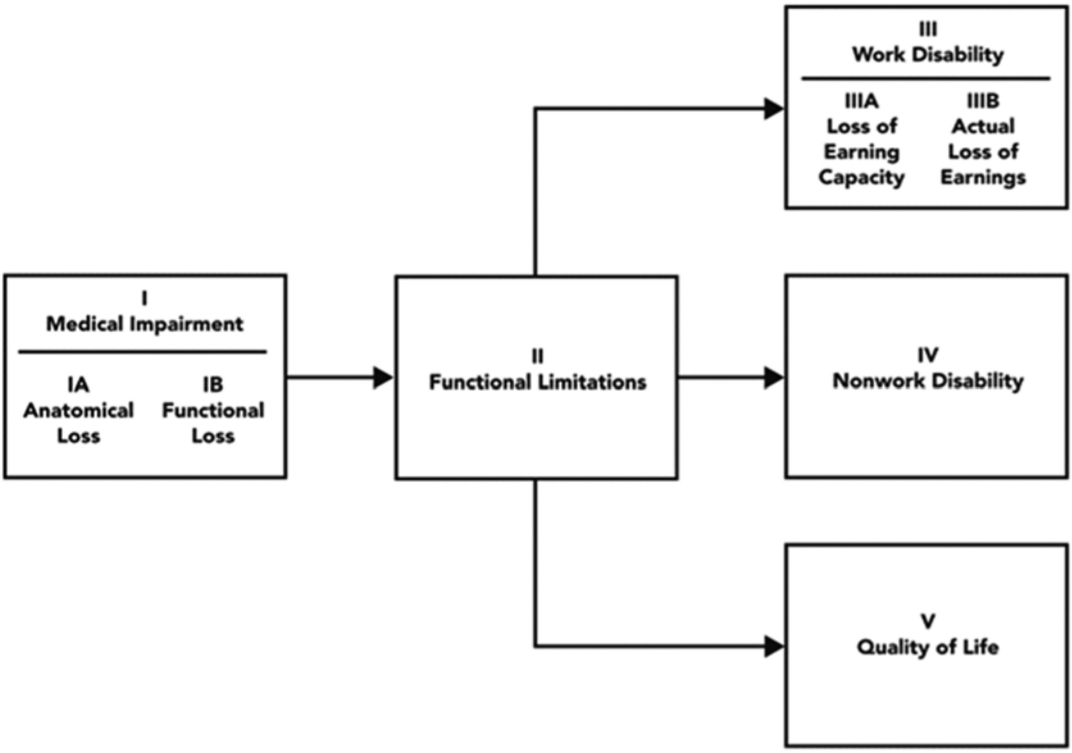


Fig. 17.2 Disabling consequences of impairment

etc.) or ambulation (moving oneself from one position in space to another such as walking, jogging, climbing stairs, etc.). Instrumental activities of daily living (IADLs) involve higher cognitive and intellectual skills in one's personal sphere such as managing finances (e.g., balancing a checkbook), managing one's medications, or preparing a meal safely. The impaired individual may or may not experience limitations to their ability to execute these activities due to their impairment. To the right are three domains useful to summarize functional losses pertaining to life activity and life satisfaction, potentially attributable to disability and therefore compensable. They include losses due to *work disability*, *nonwork disability*, and *quality of life* (*QOL*).

The medical impairment rating provides an objective measure to substantiate and quantify the severity of disability in terms of its underlying organ system pathology and associated loss of ADLs. Therefore, it is a necessary component of any disability determination equation, but not necessarily the sole or adequate determinant. Other domains of disability deserve consideration, and suitable metrics exist to calculate losses to the impaired individual in terms of work disability (loss of earnings and/or earning capacity), but also for nonwork disability (losses in ability to pursue hobbies, recreation, etc.) and QOL (losses in terms of medical burden of care, life satisfaction, etc.). Unfortunately, several of these latter domains are generally overlooked since they are not systematically evaluated and cannot be easily and reliably measured by the physician examiner. Rather, they are often summarily accounted for by a procedural "shortcut," whereby the impairment rating percentage becomes a surrogate for the disability rating according to a predetermined formula that multiplies the impairment percentage times a number of weeks' wages (up to a cap) times a percentage (generally two-thirds to three quarters) of the average weekly wage (up to a cap), resulting in a lump sum payout. The adequacy of the impairment rating as an operational surrogate in such cases is the source of ongoing debate (McGeary et al., 2007; Rondinelli, 2009).

Thus, to summarize, the AMA *Guides* provides the physician examiner with suitable metrics to rate severity of impairment in terms of objective pathology and associated loss of functioning relative to basic ADLs [as noted on the left side of the ICF model (shaded area) depicted in Fig. 17.1 above]. The *Guides*' focus is never on the right side of the model (loss of activity in terms of instrumental ADLs, loss of participation in major life activities) or the impact impairment has on broader issues such as on QOL. Therefore, it is not intended, nor should it be considered, to be a suitable, stand-alone metric for disability evaluations per se (Rondinelli, 2009; Rondinelli, Eskay-Auerbach, Ranavaya et al., 2012).

Major US Disability Systems Compared

Workers' Compensation

Workers' compensation systems in the United States are mandated by both State and Federal legislation in order to provide economic protection for workers who sustain personal injuries resulting out of, and in the course, of employment. Generally, this is accomplished through private insurance plans underwriting the risks of occupational injuries and diseases in return for a premium paid by the employer under the law. Few States serve as the insurer themselves. The need for workers' compensation (WC) laws at the state level arose around the turn of the twentieth century in response to many factors including the societal change from an agrarian society to an industrial age resulting in catastrophic injuries causing several hundred deaths in a single incident, such as a mine explosion in West Virginia in 1907 as well as a New York sewing factory fire in 1911. The rise of labor unions and increasing awareness of workers' rights were other major factors in the enactment of various workers' compensation legislation. In addition, the only alternative legal remedy available to these injured workers, the common law of torts, was inefficient and ineffective in most cases due to its very lengthy and often expensive process, with several unique defenses available to the defendant. The workers' compensation legislation sought to reduce this burden on the injured worker by providing all parties more expedited and responsive process and a no-fault system. Some of the common terms used are delineated next.

Entitlement: An injured claimant is entitled to benefits if his or her injury is determined to be compensable and can be shown to have arisen "out of and in the course of employment." Historically, WC statutes were intended to cover injuries that occurred by "accident" (a chance, unexpected and unintended event) in the workplace at a specific point in time, as opposed to a "disease" entity or condition that arose gradually over time. In reality, this distinction often cannot clearly be made, and coverage is now typically extended to occupational "illness" or disease, as well as impairment resulting from "aggravation" of a preexisting and underlying condition (Novick & Rondinelli, 2000). All WC is predicated upon a "no-fault" concept whereby the employee needs not prove the employer is at fault. Instead, a determination is made that the injury or illness arose "out of and in the course of employment," and a causal relationship is established whereby the injury or illness can be shown to have occurred while the employee was at work and actively involved in employment activity (Novick & Rondinelli, 2000). In addition, the resulting condition must persist for a sufficient duration to extend beyond any statutory waiting period (typically 0–7 days), and the injured worker is required to file a claim within specified time limits.

Benefits: An injured worker is entitled to three types of benefits: survivor benefits in the event of injury or illness resulting in death, medical and rehabilitation expenses, and wage-loss benefits. In the event of death, the surviving spouse and/or children are entitled to funeral expenses and a monthly pension (generally 2/3 of the average monthly wage at time of death up to a maximum cap) which terminates if the spouse remarries or, in the case of children, when they reach the age of 18 (or 22 if they remain a full-time student) or upon marriage. Coverage for medical and rehabilitative expenses is 100 % for authorized services. Wage-loss benefits are paid according to four separate levels of work disability. Temporary disability occurs for the duration of the treatment period and may be total (employee is incapable of any work) or partial (employee is allowed to resume "modified duty" with restrictions) (Novick & Rondinelli, 2000). Upon completion of the treatment phase, at the point of MMI and case closure, the employee may receive compensation for permanent total or partial disability, generally as a lump sum payout calculated according to a predetermined formula specific to each jurisdiction, which takes into account the value of the "whole person" as a number of weeks' pay multiplied by the average weekly wage up to a cap and then multiplied by the impairment percentage of the "whole person."

Physician evaluating and reporting requirements: Within the WC system, physicians may be asked to determine causality of a given impairment within medical probability. They may be asked to complete a work status report during various stages of treatment, indicating whether or not the employee is ready to return to full or modified duty, and to identify activity and material-handling restrictions where applicable. They will be asked to address when MMI has occurred, or is expected to occur, and to issue an impairment rating for work-related condition(s) if MMI has occurred.

Preferred rating guidelines: Jurisdictions vary in the use of rating guidelines, and physician raters must follow the directive of the WC jurisdiction within which they are working in this regard. The AMA *Guides to the Evaluation of Permanent Impairment* (various editions) is the most commonly used rating system, being mandated or recommended in at least 46 of the 53 jurisdictions at this time (American Medical Association, 2008).

The various workers' compensation schemes at the US Federal level are distinct and distinguishable from the State workers' compensation legislation and include the Federal Employers Liability Act (FELA) which is the sole remedy for the injured railroad worker against the railroad, and the Federal Employees' Compensation Act (FECA) which is the sole remedy for job-related injuries and diseases sustained by federal employees, including postal workers as well as Peace Corps members against the federal government. Physicians seeking further information, as well as opportunities to provide services to these programs, should review the Federal Office of Worker's Compensation Programs (OWCP) website at http://www.dol.gov/owcp/. The OWCP also manages the Long Shore and Harbor Workers Act, Federal Black Lung Program, and the Division of Energy Employees Occupational Illness Program.

Social Security Disability Insurance and Supplemental Security Income

The Social Security Administration (SSA) is the largest US disability system, providing assistance to between 33 and 50 % of all persons who qualify as disabled. There are two components of the system: the first, Social Security Disability Insurance (SSDI), exists to benefit individuals who have worked, paid into the Social Security system, and subsequently become disabled before reaching retirement age. The second, Supplemental Security Income (SSI), provides income for indigent individuals who have not worked and are disabled. SSDI is funded by payroll deductions which, in combination with deductions for old age insurance, comprise the Federal Insurance Contribution Act (FICA) tax, with matching contributions from the employer. In contrast, SSI operates as a federal/state partnership funded by general tax revenues (Robinson & Wolfe, 2000).

Criteria of eligibility: Both SSDI and SSI require that a "medically determinable impairment" be established according to accepted criteria and whose resulting incapacitation is so severe as to prevent engaging "in any substantial gainful activity (SGA) by reason of any medically determinable physical or medical impairment that can be expected to result in death or that has lasted or can be expected to last for a continuous period of not less than 12 months." Eligibility for SSDI further requires that the individual has worked in a job covered by SSDI for a requisite number of years (at least 5 of the 10 years prior to onset of disability). In contrast, eligibility for SSI requires demonstration of low-income level and assets according to a means test (Robinson & Wolfe, 2000). SSDI benefits are provided to those considered totally incapacitated, surviving spouse, and children. SSI provides income support for indigent persons who are blind, disabled, or aged (over 65). SSI also provides assistance to children with "medically determinable impairments of comparable severity" to an adult's and if the impairment "limits the child's ability to function independently, appropriately, and effectively in an age-appropriate manner."(Robinson & Wolfe, 2000)

Benefits: Benefits are paid as a monthly stipend of approximately $500.00 for >12 months. SSDI beneficiaries may receive payments until age 65, after which they become eligible for Social Security retirement benefits (Robinson & Wolfe, 2000).

Physician evaluating and reporting requirements: Once an applicant submits an SSA application and nonmedical eligibility has been established, the application is forwarded to the state agency, the Disability Determination Service (DDS), for a medical review. The SSA has developed its own set of medical criteria, the "listing of impairments" which, if met or equaled, will result in an automatic award of benefits (Social Security Administration, 1999). There are separate listings for adults and children arranged by body system. Each listing typically contains a diagnosis and some clinical markers of severity. If listing criteria are not met, the applicant can appeal based upon "residual functional capacity." Physicians seeking to assist applicants who are filing for SSDI or SSI disability should be familiar with the "five-step" appeals process and the listings themselves (SS Ref). This includes the patient's treating physician who may be asked to provide the DDS evaluating team with a clear succinct statement about the patient's ability to do work-related activities as backed by objective evidence. They may also be asked to comment on an applicant's physical and psychological capacities and limitations, in the event that the condition in question does not meet or equal the listings, in order to assist the DDS team in estimating the "residual functional capacities" (Robinson & Wolfe, 2000).

Compensation and Pensioning Under the Veterans Benefits Administration

In 1953, the Veterans Benefits Administration (VBA) was created within the Veterans Health Administration (VHA) to administer the GI Bill and the Department of Veterans Affairs (VA)'s Compensation and Pension Service (C&P) programs.

Criteria of eligibility: Eligibility for VA disability benefits is based on discharge from active military service (full-time service to the Army, Navy, Air Force, Marines, or Coast Guard or as a commissioned officer of the Public Health Service, the Environmental Services Administration, or the National Oceanic and Atmospheric Administration). Only *honorable* and *general* discharges (as opposed to *dishonorable* or *bad conduct* discharges) qualify. Entitlement to compensation is determined by the Adjudication Division of the C&P Service within the VBA and is classified as *service connected* if the disability relates directly to injury or disease incurred while on active duty or as a direct result of VA care or *non-service connected* if determined to have not been incurred while on active duty. *Presumptive service connection* applies to various conditions such as chronic diseases (e.g., hypertension, diabetes mellitus) or tropical diseases (e.g., malaria) and qualifies for compensation if such conditions manifest themselves within 1 year of discharge from active duty (Oboler, 2000).

Benefits: Disability compensation is paid as a monthly stipend to veterans who are disabled due to service-connected injury or disease. The amount of compensation received depends on the amount of impairment caused by the injury or disease, where the rating percentages themselves are expressed according to "the average impairment in earning capacity resulting from such disease and injuries and their residual conditions in civil occupations." Disability compensation is not subject to Federal or State income tax; it varies according to number of dependents; and it is regularly adjusted to reflect changes in cost of living. Other benefits may include disability pensions for veterans of low income according to a means test, who are permanently and totally disabled and who have experienced 90 days or more of active duty, at least 1 day of which was during war time; insurance benefits; and specially adapted housing, motor vehicle modifications, and durable medical equipment (Oboler, 2000).

Physician evaluating and reporting requirements: VA C&P examinations may be performed by physicians, nurse practitioners, physician assistants, psychologists, optometrists, audiologists, and "other qualified" clinical personnel. The VHA oversees and ensures that C&P examiners are adequately qualified, and all C&P examination reports must be assigned by a physician or psychologist. The physician examiner is asked to render an opinion as to the diagnosis of the ratable condition, to address permanency of the condition, and to opine as to whether or not the individual with the condition is considered totally disabled (fails to meet minimal employability criteria), which is defined as physical inability to be employable at a sedentary level or psychiatric or psychological inability to be employed in a loosely supervised situation with minimal exposure to the public (Oboler, 2000). Physician disability evaluations are generally performed at VHA facilities using the Automated Medical Information Exchange (AMIE) data processing system and associated Disability Examination Worksheets and the VA's *Schedule of Rating Disabilities* (*VASR-D*) (Veterans Benefits Administration. Section, 1155).

Private Disability Systems

Disability insurance through private insurance policies pays a portion of the insured's income in the event of a temporary or permanent disability, which prevents the insured from working. The coverage can be provided by an employer as an employee benefit, or individuals can also buy private disability insurance on their own and directly from insurance companies. The criteria of eligibility, entitlement, and specific benefits are governed by contractual language in each case. The main aim of any disability insurance contract is to indemnify the insured against the loss of income. Such written insurance policies are probably one of the most often written contracts entered into (second only to rental car agreements) and least frequently read by the consumer or are usually read by the consumer at the time of the loss rather than before entering into the contract. This leads to potential conflict between the insured and the insurer. In general, most of these private disability insurance contracts stipulate that the injured party is eligible for immediate short-term disability coverage and must remain continuously disabled for a 90-day waiting period in order for the long-term disability policy to take effect. The long-term disability benefits usually provide 2/3 of the income, and the length of coverage varies according to the policy. However, many long-term disability policies provide benefits until age 65 for physical disabilities, or as long as the disability continues, but only for 2 years for mental disabilities.

Group policies are generally more affordable with long-term coverage of a finite nature (typically 2 years for inability to perform ones' *own occupation* (*own occ test*), after which the individual only receives continued coverage if it is determined that he/she is unable to perform *any occupation* according to the policy's definitions. Individualized policies, providing more extended coverage, are also available at higher annual premiums. Finally, physician evaluating and reporting requirements may vary according to the insurance provider. In cases of a dispute with regard to benefits coverage, in general, a case file review or an IME may be obtained from a physician by the insurer or sometimes insured, in order to resolve such issues such as inability to perform one's occupation or any occupation or rehab potential as some policies may require the insured to undergo rehabilitation when indicated.

American Medical Association *Guides to the Evaluation of Permanent Impairment* (AMA *Guides*)

What Are the AMA *Guides*?

The process whereby disability determinations are made requires that an initial impairment rating be obtained, according to standard and specific medical criteria. Since the physician is empowered and charged to render such ratings, the American Medical Association has produced a rating manual to assist physicians in this regard. The American Medical Association *Guides to the Evaluation of Permanent Impairment* (AMA *Guides*) (American Medical Association, 2008) is a standardized, objective reference for this purpose.

Historical Origin/Derivations of the Guides

The AMA *Guides* was originally published in 1971 as a compilation of a series of impairment rating articles for 12 different organ systems which were previously published in the *Journal of the American Medical Association* (*JAMA*) from 1958 to 1970, respectively. It has periodically been updated and revised to the most recent version—the AMA *Guides, 6th Edition*, published in 2008.

Where Are the AMA Guides Currently Being Used?

The AMA *Guides* is now recognized nationally and internationally as the preferred reference for medical impairment ratings. Various editions are required or recommended by statute in the majority of US workers' compensation jurisdictions. The AMA *Guides 6th ed.* has recently been adopted by 15 of these jurisdictions and is the reference mandated by the USDOL in the various disability systems outlined above. It is also adopted and used internationally in workers' compensation and personal injury claims, including nine of ten Canadian provinces, and all three Canadian territories, and is the preferred reference in the Netherlands, Australia, New Zealand, Hong Kong, and Korea. Additionally, several international jurisdictions are using the *Guides-based* impairment rating as a threshold to determine the severity of personal injury in order to access the general damage (pain and suffering) awards available in common law tort claims of personal injuries (e.g., motor vehicle accidents) (Ranavaya & Brigham, 2011).

Key Changes for the Current (Sixth) Edition of the AMA *Guides*

Previous Unanswered Criticism of the AMA *Guides*

Earlier editions of the AMA *Guides* were subject to criticisms (Burd, 1980; Clark, Haldeman, Johnson et al., 1988; Pryor, 1990; Rondinelli, Dunn, Hassanein et al., 1997; Rondinelli, Murphy, Esler et al., 1992) including the following:

- There was failure to provide comprehensive, evidence-based, valid, reliable, reproducible, and unbiased ratings.
- Impairment ratings did not adequately or accurately reflect loss of function.
- Numerical ratings were more representative of "legal fiction than medical reality" (Spieler, Barth, Burton et al., 2000).

A number of changes were recommended to improve the Guides, including:

- Provide some standardized assessment of ADLs associated with physical impairments.
- Apply functional assessment tools to validate the impairment rating scales.
- Include measurement of functional loss into the impairment rating determination process.

In addition, overall improvements in inter-rater and intra-rater reliability and internal consistency were called for (Spieler et al., 2000). Although attempts were made to correct many of these deficiencies, there were persisting problems with the 5th Edition (Rondinelli & Katz, 2002) in terms of confusion about antiquated and inconsistent terminology and definitions of disablement, lack of meaningful and consistent application of functional assessment tools to impairment ratings, lack of internal consistency in impairment rating approach and magnitude of ratings across different organ systems, and resulting errors due to limited validity, reliability, and reproducibility of the ratings themselves.

Five Axioms Used to Define the Changes for the Sixth Edition of the AMA Guides

The AMA adopted a proactive vision embodied by five axiomatic changes to produce the 6th Edition of the Guides. These include:

- The Guides must adopt a terminology and conceptual framework of disablement as put forward by the World Health Organization's International Classification of Functioning, Disability, and Health (ICF) (World Health Organization, 2001).

- The Guides must become more diagnosis based, with those diagnoses being evidence based to the fullest extent possible.
- Rating percentages derived according to the Guides must become functionally based, to the fullest practical extent possible.
- The Guides must stress conceptual and methodological congruity both within and between organ system ratings.
- High priority is given to simplicity, ease of application, and following precedent, where applicable, with the goal of optimizing intra- and inter-rater reliability.

The ICF Model and AMA Definitions

The ICF (World Health Organization, 2001) provides the current conceptual framework and classification and terminology of disablement adopted for AMA *Guides* 6th Edition, and the terminology is imbedded in the AMA definitions of *impairment, disability,* and *impairment rating* listed above. It also serves to identify five possible functional levels for purposes of impairment class distinctions adopted throughout AMA Guides 6th Edition in order to promote conceptual congruity and operational uniformity across organ systems and, in particular, to identify the five possible impairment classes for the "diagnosis-based impairment (DBI)" method for the musculoskeletal organ system (see below).

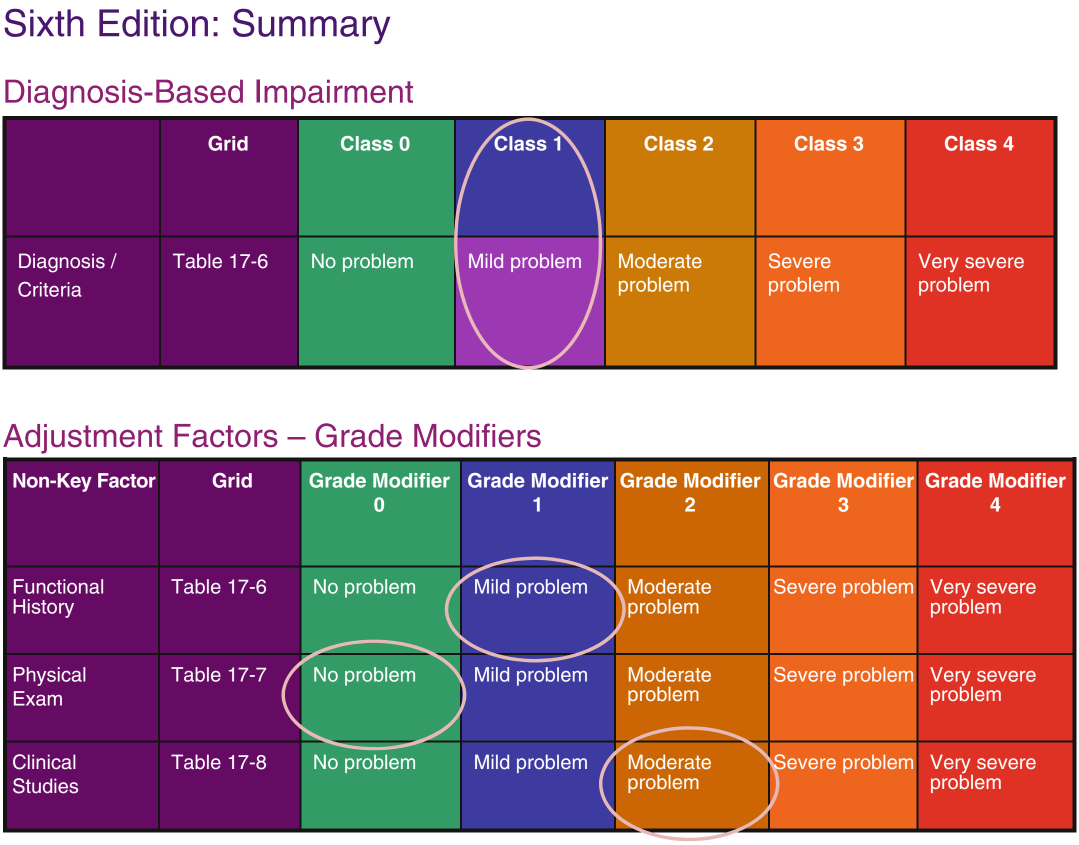
The Diagnosis-Based Impairment Platform Summarized

The AMA *Guides* 6th Edition has built upon the precedent established in the 4th Edition, and further advanced in the 5th Edition of the *Guides*, by placing increasing emphasis upon a diagnosis-based approach to impairment rating. This particularly applies to impairment ratings within the musculoskeletal organ system. DBI grids are provided for each of these anatomical regions as follows:

- Spine: cervical spine, thoracic spine, lumbar spine, and pelvis
- Upper extremity: digits/hand, wrist, elbow, and shoulder
- Lower extremity: foot and ankle, knee and hip.

Each grid has five potential impairment classes (Classes 0–4) consistent with the ICF Classification System, and each covers a broad and precise array of diagnoses ranging from soft tissue conditions (nonspecific, chronic, or recurrent) to muscle-tendon and/or motion-segment injuries (sprains, strains, tendinopathies) and to ligament, bone, and joint injuries (fractures, dislocations, arthrodesis, etc.). The impairment rating using the DBI approach becomes a two-step process, whereby initial assignment to an "impairment class" requires the rating examiner to identify the most appropriate diagnosis, and each diagnostic-based impairment class has an available range of impairment values, with an initial "default" midrange value. The rating is then adjusted within range as a second step, using three separate criteria (functional history, examination findings, and clinical test results) to independently validate the diagnosis and severity of the condition. A simple triangulation method using the metrics associated with each of these results enables a final numerical adjustment upward for less-favorable outcomes or downward for more optimal outcomes according to the specific result in each case.

To illustrate using the musculoskeletal organ system, the first step in the impairment rating (IR) process is to determine permanency at *MMI*. Next is to assign the diagnosis and pick the appropriate impairment class within the appropriate DBI grid. Each impairment class (IC) has an available range of five discrete impairment scores, and the "default" position is the middle score. The second step follows, whereby three separate "grade modifiers" are independently used to score level of severity (i.e., grade on a scale of 0–4) according to functional history (GMFH), physical examination findings (GMPE), and clinical study results (GMCS), respectively. The final step is to calculate the sum of the differences in numerical severity of the impairment grade modifiers minus IC, respectively, to triangulate the final impairment score within the impairment class according to the formula (GMFH−IC) + (GMPE−IC) + (GMCS−IC). If the sum is zero, the final



Sixth Edition: Summary

Diagnosis-Based Impairment

	Grid	Class 0	Class 1	Class 2	Class 3	Class 4
Diagnosis / Criteria	Table 17-6	No problem	Mild problem	Moderate problem	Severe problem	Very severe problem

Adjustment Factors – Grade Modifiers

Non-Key Factor	Grid	Grade Modifier 0	Grade Modifier 1	Grade Modifier 2	Grade Modifier 3	Grade Modifier 4
Functional History	Table 17-6	No problem	Mild problem	Moderate problem	Severe problem	Very severe problem
Physical Exam	Table 17-7	No problem	Mild problem	Moderate problem	Severe problem	Very severe problem
Clinical Studies	Table 17-8	No problem	Mild problem	Moderate problem	Severe problem	Very severe problem

Fig. 17.3 Methodology used in determining diagnosis-based impairment according to AMA *Guides 6th Edition*

IR remains at the default middle value. If the sum is +1 or −1, the IR score moves one position to the right or left, respectively; if it is +2 or −2, it moves two positions to the right or left, respectively (Fig. 17.3).

This methodology simultaneously allows the rater to capture important and useful information on clinical severity and functional outcome for any given condition and to modify the final rating according to precise criteria of severity rather than solely on "clinical judgment." It further provides greater precision and resolution of impairment ratings, with a broader array of diagnostic choices than was previously available under the DRE methodology, and offers a more transparent pathway to the final impairment determination in all cases (Rondinelli et al., 2012).

Practical Application of the AMA Guides 6th Edition

The AMA *Guides* is a tool designed to translate human pathology, arising from a trauma or disease and manifested as a structural and or functional loss at an organ system level, into a percentage estimate of loss to the whole person.

The "Constitution" and "Bylaws" of the AMA Guides 6th Edition (American Medical Association, 2008)

- Concepts and philosophy of Chapter 2 of the *Guides* 6th Edition contain the fundamental principles of the *Guides*.
- No impairment of the body may exceed 100 % of the whole person; no impairment arising

from a member or organ of the body may exceed the amputation value of that member.
- All regional impairments in the same organ or body system shall be combined as prescribed by the existing rule, starting at the same level first and further combined with other regional impairments at the whole person level.
- Rating of the impairment must be done in accordance with the relevant organ or system chapter where the injury primarily arose or where the greatest dysfunction consistent with the pathology remains, but not both.
- Only permanent medical impairment can be rated and only after MMI has been certified.
- A valid impairment evaluation requires a three-step approach as follows: *Step 1* involves *Clinical evaluation* which includes a relevant history obtained both from the claimant and from the review of medical records, relevant physical examination that includes the alleged injured body parts and the related structures. *Step 2*, *Analysis of the findings*, is the second step that discusses how the specific history and the objective findings of the clinical evaluation support conclusions as to relevant diagnoses and MMI. Step 3 includes the *Description of how the impairment rating was calculated* based on the AMA *Guides* criteria. This step is accomplished by including an explanation of each impairment value with reference to the diagnosis and other rating criteria, as well as various table numbers and page numbers referenced from the *Guides*. The aim of this three-step process and report writing is to make the rating sufficiently transparent so that if the first two steps are fully described, any knowledgeable observer may check the finding against AMA *Guides* criteria.
- An evaluating physician must use knowledge, skills, and ability that are generally expected by the medical scientific community to arrive at the correct impairment rating according to the Guides.
- The *Guides* is based on objective criteria. The physician must use clinical knowledge, skills, and abilities in determining whether or not the measurements, test results, or written historical information obtained are consistent and concordant with the pathology being evaluated. If the findings, or an impairment estimate based upon such findings, conflict with established medical principles, they cannot be used to justify an impairment rating.
- Range of motion and strength measurement techniques should be assessed carefully in the presence of apparent self-inhibition secondary to pain or apprehension.
- The *Guides* does not permit rating of future impairment.
- If the *Guides* provides more than one method to rate a particular impairment, the method producing the highest rating must be used (“law of liberality”).
- Subjective complaints that are not clinically verifiable are generally not ratable according to the *Guides*.
- Round all fractional impairment ratings, whether immediate or final, to the nearest whole number, unless otherwise specified.

Medicolegal Considerations

The practitioner who engages in the medicolegal practices of impairment rating and disability determination can frequently be called upon to perform an IME. The physician participating in such an evaluation is encouraged to become familiar with the emerging field of Disability Medicine, described as a subspecialty of clinical medical practice, which encompasses the identification, prediction, prevention, assessment, evaluation, and management of impairment and disability in both human individuals and populations (Ranavaya, 1997). The IME is typically performed at the request of a party to a disputed claim and is provided by a clinician who is not personally treating the claimant, for the purpose of rendering an impartial medical opinion regarding various aspects of the claim. The physician examiner is called upon to review necessary and appropriate records provided in support of the positions being contested and to personally interview and examine the claimant in most cases. The IME physician must then answer a series of interrogatives “within medical probability” relating to the following items of interest:

- What is the diagnosis and causal relationship, if any, to workplace injury?
- What is the current diagnostic and treatment plan?
- Has necessary and appropriate testing been done and treatment been provided? What additional (if any) testing and/or treatment are indicated beyond this point?
- What other medical or nonmedical factors might be having a significant impact upon the outcome of this particular case?
- Is the claimant at "Maximal Medical Improvement (MMI)" with respect to the condition in question? If so, when did MMI occur? If not, when is MMI expected to occur?
- If claimant is at MMI, what is the medical impairment rating?
- What restrictions and accommodations are medically necessary, feasible, and applicable to the workplace in relation to claimant's ability to go to work and be at work, to engage in sustained material handling, and to perform certain activities while on the job?

The IME physician's opinions are expressed "within medical probability," which means the likelihood exceeds 50 % (more likely than not), as opposed to "medical possibility" (likelihood less than or equal to 50 %). Because the IME process places the physician in the role of expert witness, the potential for adversarial relationships exists between the physician examiner and claimants who may find the physician's opinion and or testimony unflattering to their position and thereby deserving action which may have legal consequences for the IME physician. For example, even though the physician examiner is not directly treating the claimant, and the traditional doctor–patient relationship does not exist, he or she is obligated to provide an assessment which conforms to medical standard of care, and, in some instances, malpractice liability may apply. Furthermore, it should be noted that the physician disability evaluator or independent medical examiner, acting as an "expert witness," may no longer be shielded from civil liabilities in the manner typically afforded to any other witness in the judicial process. In the past two decades, various State courts have held independent medical examiners and expert witnesses without any doctor–patient relationship accountable to their examinee in terms of ordinary negligence (Greenberg 1993; Harris 2006), and at least one case (Ritchie v. Krasner, 2009) found that a physician owed a patient/claimant a duty of care even though no formal doctor–patient relationship clearly existed.

In summary, IME physicians should be aware of not only the legal liabilities in the overall practice of their specialty but also the additional liability exposure from their work as an independent medical examiner. It should be noted, however, that even though the recent case law in some jurisdictions has significantly removed the traditional immunity from medical malpractice claims against IME providers with no doctor–patient relationship with their examinees, there still remains a great need in the US judicial system for IME/expert medical witness services. Practitioners interested in the practice of Disability Medicine and intending to serve as independent medical examiners are encouraged to attend several of the high-quality training programs offered in the United States to independent medical examiners and expert witnesses with the goal to empower them with the knowledge, skills, and abilities necessary to practice as an independent medical examiner and/or expert witness in the field of Disability Medicine (Ranavaya, 1997).

Summary and Conclusions

Physicians treating painful and disabling conditions arising from illness or injury in the workplace can expect to be called upon from time to time to address issues of permanency, severity of impairment, and work disability. To assist in these endeavors, they must become familiar with the common terminology of disablement and understand the biopsychosocial model of disability, and be able to perform competent impairment ratings and IMEs as part of the disability determination process. Furthermore, they must become familiar with applicable rules and dictates of the different disability systems serving their patients, and become adaptable to the procedural variance and nuances of the particular jurisdictions within which they practice. They must also be familiar with the applicable edition(s) of the AMA *Guides* in order to provide competent and accurate medical impairment ratings appropriate to WC and personal injury claims upon request. To assist in this regard, we have provided a basic terminology and definitions, illustrated a generally accepted model of disablement, and highlighted the role of the physician examiner in the disability determination process. We have summarized key features of the most common physician impairment rating guide (AMA *Guides*) with respect to origin, purpose, and application to WC and personal injury claims. In addition, we have provided a rationale and illustration for the key changes of the DBI method of impairment rating unique to the 6th Edition of the *Guides*. We have also enumerated our concerns from a medicolegal perspective relating to physician testimony as an expert witness and independent medical examiner involving medical disability claims.

Physicians wishing to learn more are encouraged to visit the following websites for available courses and other educational venues and resources of interest:

- American Medical Association. Available at www.ama-assn.org
- American Academy of Orthopedic Surgeons. Available at www.aaos.org
- American Academy of Disability Evaluating Physicians. Available at www.aadep.org
- American Board of Independent Medical Examiners. Available at www.abime.orghttp://www.abime.org/
- American Congress of Occupational and Environmental Medicine. Available at www.acoem.org

References

American Medical Association. (2008). *Guides to the evaluation of permanent impairment* (6th ed.). Chicago: Author.

Burd, J. G. (1980). The educated guess: Doctors and permanent partial disability percentage. *Journal of the Tennessee Medical Association, 73*, 441.

Clark, W. L., Haldeman, S., Johnson, P., et al. (1988). Back impairment and disability determination: another attempt at objective, reliable rating. *Spine, 13*,332–341.

Engle, G. L. (1977). The need for a new medical model: A challenge for biomedicine. *Science, 196*, 129–136.

Greenberg v.Perkins 845 P.2d 530, 538 (Colo 1993).

Harris v. Kreutzer, 624 S.E. 2d 24, 27 (Va. 2006).

Iezzoni, L. I., & Freedman, V. A. (2008). Turning the disability tide: the importance of definitions. *JAMA, 299*, 332–334.

McGeary, M., Ford, M., McCutchen, S. R., et al., Eds. (2007) IOM Committee on Medical Evaluation of Veterans for Disability Compensation. *A 21st century system for evaluating veterans for disability benefits. The rating schedule.* Washington, DC: The National Academies Press.

Novick, A. K., & Rondinelli, R. D. (2000). Impairment and disability under Workers' Compensation. In R. D. Rondinelli & R. T. Katz (Eds.), *Impairment rating and disability evaluation* (pp. 141–156). Philadelphia, PA: W.B. Saunders.

Oboler, S. (2000). Disability evaluation under the Department of Veterans Affairs. In R. D. Rondinelli & R. T. Katz (Eds.), *Impairment rating and disability evaluation* (pp. 187–211). Philadelphia, PA: W.B. Saunders.

Oliver, M. (1996). *Understanding disability. From theory to practice* (pp. 30–42). New York: St. Martin's Press.

Pryor, E. S. (1990). Flawed promises: A critical evaluation of the American Medical Association Guides to the Evaluation of Permanent Impairment. *Harvard Law Review, 103*, 964–976.

Ranavaya, M.I. (1997). Presidential address. American Academy of Disability evaluating physicians.

Ranavaya, M. I., & Brigham, C. (2011, May–June) International use of the AMA guides to the evaluation of permanent impairment. *Guides Newsletter*.

Ritchie v. Krasner, (No.1.CA-CV08-0099. Filed April 21, 2009).

Robinson, J. P., & Wolfe, C. V. (2000). Social Security Disability Insurance and Supplemental Security Income. In R. D. Rondinelli & R. T. Katz (Eds.), *Impairment rating and disability evaluation* (pp. 159–176). Philadelphia, PA: W.B. Saunders.

Rondinelli, R. D. (2009). Changes for the new AMA guides to impairment ratings, 6th Edition: Implications and applications for physician disability evaluations. *PM&R, 1*(7), 643–656.

Rondinelli, R. D., Dunn, W., Hassanein, K. M., et al. (1997). A simulation of hand impairments: effects on upper extremity function and implications toward medical impairment rating and disability determination. *Archives of Physical Medicine and Rehabilitation, 78*, 1358–1363.

Rondinelli, R., Eskay-Auerbach, M., Ranavaya, M., et al. (2012, Nov–Dec) Commentary on NCCI Report. *Guides Newsletter*.

Rondinelli, R. D., & Katz, R. (2002). Merits and shortcomings of the American Medical Association Guides to the Evaluation of Permanent Impairment. A physiatric perspective. *Physical Medicine & Rehabilitation Clinics of North America, 13*, 355–370.

Rondinelli, R. D., Murphy, J., Esler, A., et al. (1992). Estimation of normal lumbar flexion with surface inclinometry: a comparison of three methods. *American Journal of Physical Medicine & Rehabilitation, 71*, 219–224.

Social Security Administration. (1999). *Disability evaluation under social security* (pp. 64–039). Washington, DC: Office of Disability (SSA Pub. No. 64-039).

Spieler, E. A., Barth, P. S., Burton, J. F., et al. (2000). Recommendations to guide revision of the *Guides to the Evaluation of Permanent Impairment. JAMA, 283*, 519–523.

Veterans Benefits Administration. *Schedule for rating disabilities. Section 1155, Title 38 CFR, Pensions, Bonuses, and Veterans' Relief.*

Waddell, G., Burton, A. K., & Aylward, M. (2008, May–June). A biopsychosocial model of sickness and disability. *Guides Newsletter,* pp. 1–20.

World Health Organization. (1980). *International classification of impairments, disabilities and handicaps: A manual of classification relating to the consequences of disease*. Geneva, Switzerland: WHO.

World Health Organization. (2001). *International classification of functioning, disability, and health (ICF)*. Geneva, Switzerland: Author.

Part III

Intervention Approaches and Techniques

Traditional Medical Intervention Approaches to Musculoskeletal Disorders: A Review

18

Stephanie Jones

Overview

Musculoskeletal pain affects practically every adult at one point in his or her life. Fortunately, not everyone is plagued with recurrent or chronic musculoskeletal pain syndromes; however, chronic musculoskeletal pain disorders are not uncommon. Various studies reveal that the prevalence of certain musculoskeletal pain disorders is fairly low (i.e., 2 % or less for rheumatoid arthritis), while other conditions, such as low back pain, are quite common. For instance, low back pain affects 30–40 % of adults in the general population at any given time. In between these two extremes, neck pain and shoulder pain have a prevalence of 15–20 %, and knee pain, temporomandibular-associated pain, and chronic widespread musculoskeletal pain have prevalence rates of 10–15 %. Based on these statistics, it is not surprising that a majority of patients seen in the chronic pain clinic setting will suffer from a chronic or recurrent musculoskeletal pain complaint (Cimmino, Ferrone, & Cutolo, 2011; Combie, Croft, Linton, LeResche, & Von Korff, 1999).

Rates of many musculoskeletal pain disorders vary significantly by age. For instance, chronic knee pain related to osteoarthritis (OA) is exceedingly common among the elderly. Over one-third of persons over the age of 60 experience knee pain related to osteoarthritis. Conversely, the prevalence of some musculoskeletal pain conditions declines after age 45 (i.e., temporomandibular-associated pain syndromes). Sexual patterns also exist for certain musculoskeletal pain complaints. Neck, shoulder, knee, and back pain are 1.5 times more common in women than in men; the female-to-male gender ratio for temporomandibular-associated pain is about 2:1 and over 4:1 for fibromyalgia (Combie et al. 1999; LeResche, 2000).

Several other risk factors, outside of age and sex, have also been identified in the development of persistent musculoskeletal pain. Repetitive use and disuse of musculoskeletal structures have been associated with pain. Prospective studies have shown that the presence of pain disorders (whether musculoskeletal or other) at baseline has been found to predict onset of a new musculoskeletal pain complaint, and the risk of onset increases with the number of pain disorders present at baseline. There is further evidence that "nonphysical" factors, including psychological factors (depression, negative effect, behavioral problems in adolescents), may increase risk of developing persistent musculoskeletal pain. Even certain genetic factors may increase risk of persistent musculoskeletal pain, at least in the

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development of temporomandibular joint-associated pain disorders (Croft et al., 1995; LeResche, Mancl, Drangsholt, Huang, & Von Korff, 2007; VonKorff, LeResche, & Dworkin, 1993).

Due to high prevalence rates, musculoskeletal pain disorders have a notable societal burden. Persons who experience musculoskeletal pain may often limit their activities due to pain symptoms. Rates of disability from musculoskeletal pain among patients seeking primary care are higher than those patients with musculoskeletal pain in the general population. In a survey of the employed population in the United States, 7.2 % of workers reported losing 2 or more hours of work in the past week due to back pain, arthritis, or other musculoskeletal pain conditions (including time spent at work without being productive due to pain limitation). The mean time lost was 5–5.5 h weekly, and the estimated total annual cost of productive time lost due to back pain, arthritis, and other musculoskeletal pain problems was US$41.7 billion in 2002 (Stewart, Ricci, Chee, Morganstein, & Lipton, 2003).

With such high prevalence and societal burden, it is imperative that pain management specialists fully understand the multitude of factors affecting patients with musculoskeletal pain complaints and practice evidence-based medicine when approaching these patients' care. Due to the vast fund of information regarding the management of chronic musculoskeletal pain syndromes, we have decided to narrow the scope of this chapter by describing treatment strategies based on four subsets of chronic musculoskeletal pain conditions—myofascial pain conditions, ligament and tendon pain conditions, joint pain conditions, and bone-related pain conditions. More detailed management of certain subsets of these conditions may be further delineated in other chapters.

Myofascial Pain

Definitions

The myofascial pain syndrome (MPS) represents the clinical manifestation of muscle referred pain and is characterized by muscle trigger points (TrPs). The original definition of MPS and TrPs was provided by Simons in 1990. Simons defined MPS as a "complex of sensory, motor and autonomic symptoms that are caused by myofascial trigger points." TrPs were defined as "spots of exquisite tenderness and hyperirritability in muscles or their fascia, localized in taut, palpable bands, which mediate a local twitch response of muscle fibers under a specific type of palpation—called snapping—and, if sufficiently hyperirritable, give rise to pain, tenderness and autonomic phenomena as well as dysfunction in areas usually remote from their site, called targets." TrPs can be either active or latent. Active TrPs provoke spontaneous pain and are responsible for the active symptoms of MPS. Latent TrPs have the same characteristics as active TrPs (taut band, local twitch response, and possibly referred pain on compression), but are silent with regard to spontaneous symptomatology. These TrPs can be "activated" with palpation, but are not the active TrPs which contribute to a patient's symptom complex. Latent TrPs should be regarded as signs of "preclinical" MPS and should be sought and identified for treatment to prevent their evolution into active TrPs. TrPs can be further subdivided into "primary" or "secondary." Primary TrPs are found in a muscle which is directly subjected to acute or chronic overload or repetitive overuse. Secondary TrPs may be induced in a muscle (neurogenically or mechanically) by the activity of a nociceptive focus in a different structure (i.e., deep somatic, visceral; Gerwin, 2001; Simons, 1990; Simons & Travell, 1999).

Diagnostic Criteria

Although recognized as a legitimate clinical entity, MPS lacks codified diagnostic criteria developed on the basis of international multicenter studies or expert consensus meetings (Srbely, 2010; Tough, White, Richards, & Campbell, 2007). The criteria most often employed are those redefined by Simons and colleagues (1999). According to his definition, a MPS can be diagnosed if five major criteria and at least one out of three minor criteria are satisfied (see Table 18.1). The major criteria include (a) localized spontaneous pain; (b) spontaneous

Table 18.1 Criteria for diagnosis of a myofascial pain syndrome

Major criteria	Minor criteria
Localized spontaneous pain	Reproduction of spontaneously perceived pain and altered sensations by pressure on the TrP
Spontaneous pain or altered sensations in the expected referred area for a given TrP	Elicitation of an LTR of muscle fibers by transverse "snapping" palpation or by needle insertion into the TrP
Taut, palpable band in an accessible muscle	Pain relieved by muscle stretching or injection of the TrP
Exquisite, localized tenderness in a precise point along the taut band	
Certain degree of reduced range of motion	

pain or altered sensations in the expected referred area for a given TrP (target area); (c) a taut, palpable band in an accessible muscle; (d) exquisite, localized tenderness in a precise point along the taut band; and (e) a certain degree of reduced range of movement when measurable. Minor criteria include (a) reproduction of spontaneously perceived pain and altered sensations by pressure on the TrP, (b) elicitation of an LTR of muscle fibers by transverse "snapping" palpation or by needle insertion into the TrP, and (c) pain relieved by muscle stretching or injection of the TrP. However, the reliability of physical examination for TrPs has been repeatedly questioned, as emphasized by Lucas et al. in a recent review of the published literature on this topic (Lucas, Macaskill, Irwing, Moran, & Bogduk, 2009).

Medical Management

MPS treatment is directed at two primary targets: (1) treatment of the associated TrPs and (2) removal of the causative/perpetuating factors.

TrP Treatment

A number of treatments for the deactivation of TrPs have been described. The results of different studies and reviews demonstrate various modalities and techniques as being effective or ineffective. The principal methodologies are reported here.

Muscle Stretch and Spray and Stretch

Stretch is important in isolated TrPs of early onset, though appears to be somewhat less effective in long-standing, diffuse TrPs. The muscle containing the TrP should be stretched slowly to the point of discomfort. The theory behind the effectiveness of stretch in TrP inactivation is the belief that lengthening the sarcomeres reduces the local consumption of energy and interrupts the "energy crisis," leading to muscle pain and TrP formation. On the other hand, stretching a painful muscle can stimulate sympathetic activity, inducing the TrP mechanism. In order to reduce this rebound phenomenon, it is preferable to first apply a vapocoolant spray to the overlying skin surface, which will inhibit pain as well as the reflex motor and autonomic responses in the CNS; the analgesic effect of cooling also permits more effective relaxation and stretching of the involved muscle groups (Mense, Simons, & Russell, 2001; Simons & Travell, 1999).

Local Tissue Stretch: The TrP Pressure Release

"Pressure release" replaces the old terminology "ischemic compression." The provider applies gentle pressure, gradually increasing pressure on the TrP until an increase in resistance is encountered, correlating with the onset of patient discomfort. Pressure should be maintained, until palpable tension is released, then the finger is advanced further until further resistance is encountered. Again, the pressure is maintained until release of the tension; this process is repeated until tension is released throughout the involved area (Mense et al., 2001).

TrP Injection

TrP injection is the gold standard for treatment of MPS. It is superior to stretching alone and has been shown to be one of the most effective modalities for inactivating TrPs and providing prompt relief of symptoms. Scott, Guo, Barton, and Gerwin (2009) reviewed published reviews and randomized controlled trials on TrP injections and confirmed TrP injections to be an efficacious treatment, safe in the hands of trained clinicians, and that the addition of TrP injections to stretching maneuvers augments clinical outcomes.

In terms of the substances injected, many studies indicate that “dry needling” may be as effective as injection of local anesthetics. Ay, Evcik, and Tur (2010), who used randomized controlled trial, illustrated that both dry needling and lidocaine injection have significant, but comparable, effects in MPS symptomatology. Injections were coupled with home stretching exercises to maximize benefit. The efficacy of dry needling is most likely based on mechanical disruption of the integrity of dysfunctional end plates. Many practitioners still prefer to use local anesthetic for patient comfort, both during the procedure and afterwards, to promote the patient’s tolerance of post-procedure stretching exercises. In general, injection of any solution (including saline) may relieve symptoms by dissipating local sensitizing agents in the region of pain (Ay et al., 2010; Kalichman & Vulfsons, 2010; Mense et al., 2001).

Injection of botulinum toxin has also been anecdotally reported to reduce symptoms in myofascial pain disorders (Ho & Tan, 2007; Lang, 2002). However, a systemic review by Peloso et al. (2007) concluded that there is no supporting evidence for its use in the treatment of MPSs, as injection of botulinum toxin A was not superior to injection of local anesthetic.

Recommended Injection Technique

One recommended technique for injection of TrPs has been described by Hong (1994). The operator should rest the wrist on the patient’s body, then grasp the syringe between the thumb and the last two fingers, using the index finger to depress the plunger. This technique allows the operator improved control of the needle in the event that the patient moves unexpectedly during the procedure. The elicitation of a local twitch response during needle penetration would suggest greater efficacy of the injection.

Correction of Perpetuating Factors

Therapy for MPS should include identification and correction of factors that have promoted TrP formation. Therefore, postural abnormalities should be evaluated and treated, including ergonomic evaluations. Practitioners should address any anatomical defect contributing to muscle imbalance and repetitive strain/trauma (i.e., leg length discrepancy). Other perpetuating factors such as stress/mood disorders and sleep disorders should also be identified and corrected when possible (Edwards, 1988).

Pharmacological Therapy in the Treatment of Myofascial Pain Syndromes

Intramuscular injection of diclofenac has shown significant pain relief in the treatment of MPS. However, this agent is of limited utility in the treatment of chronic MPS due to the multiple adverse risks associated with chronic nonsteroidal anti-inflammatory drug (NSAID) usage (Frost, 1986). In general, nonsteroidal anti-inflammatory drugs have shown limited benefit in the treatment of MPS. Amitriptyline was shown to be somewhat effective in reducing pain (Bendtsen & Jensen, 2000). As a drug class, muscle relaxers have shown little utility in treating MPS, possibly because the underlying pathophysiology in MPS is endplate dysfunction and not true “spasm” (Mense et al., 2001; Simons & Travell, 1999).

One recent open label study showed statistically significant reduction in pain scores among participants with trapezius MPS treated with tizanidine, a presynaptic alpha 2 agonist utilized as a muscle relaxant. In the study, anywhere from 2 mg daily to 4 mg three times daily was utilized, at the researcher’s discretion (Malanga, Gwynn, Smith, & Miller, 2002).

There is considerable overlap between MPSs and fibromyalgia. Thus, medications useful in the treatment of fibromyalgia are often utilized in myofascial pain disorders. Pregabalin, serotonin-norepinephrine reuptake inhibitors, and tramadol have all shown efficacy in the treatment of fibromyalgia. Unfortunately, there are no randomized controlled trials evaluating these agents in the treatment of MPSs. The management of fibromyalgia, a central sensitivity pain disorder, is beyond the scope of this chapter.

Ligament and Tendon Pain Conditions

Overuse disorders of tendons or "tendinopathies" typically affect young people (20–30 years old) and middle-aged people (40–60 years old) and are often difficult to manage. Histologically, these disorders are characterized by angiofibroblastic hyperplasia, including hypercellularity, neovascularization, increased protein synthesis, and disorganization of matrix, but not inflammation (Khan, Cook, Kannus, Maffulli, & Bonar, 2002; Kraushaar & Nirschl, 1999; Maffulli, Testa, Capasso et al., 2004; Rees, Maffulli, & Cook, 2009). The lack of inflammation, as well as poor clinical outcomes and adverse risk associated with repeated corticosteroid injections, has led many practitioners to utilize other injectates for ligament pain (such as platelet-rich plasma (PRP), botulinum toxin, proteinases, and polidocanol). A systematic review of injections used in the treatment of various tendinopathies supports the use of corticosteroid injections for acute tendinopathies but conversely shows that corticosteroid injections are actually worse than other treatments for intermediate- and long-term management of chronic tendinopathies (Coombes, Bisset, & Vicenzino, 2010).

Tendinopathies can often become chronically painful conditions. Rotator cuff tendinopathies, lateral elbow epicondylosis, and Achilles tendinopathy are commonly seen in the chronic pain population. Unfortunately, there is a wide range of treatments but lack of consensus among physicians when treating these disorders. Such incongruency may be attributed to lack of understanding of the etiology of these conditions, including lack of understanding of the nociceptive properties of tendon tissues. Experimental studies have illustrated nociceptive characteristics of tendinous tissues. Gibson, Arendt-Nielson, and Graven-Nielson (2006) illustrated pain provocation in study subjects when hypertonic saline was injected into tendon tissue. Other studies have shown *N*-methyl-D-aspartate and transient receptor potential vanilloid 1 (TRPV1) receptors to be functionally relevant in the pathophysiology of tendon pain, as peritendinous injections of glutamate and capsaicin, respectively, induced tendon nociception (Gibson, Arendt-Nielson, Sessle, & Graven-Nielson, 2009). With little understanding of the pathophysiology of tendon pain, there is little consensus in the treatment of chronic ligament and tendinous pain disorders. For chronic ligament pain, practitioners have injected various compounds around ligaments for years in attempts to produce a sclerosing effect (Dagenais, Haldeman, & Wooley, 2005). Despite the popularity of new injection therapies for tendinopathies, many questions still remain regarding their therapeutic effect as well as their mechanism of action.

General Approach

Relative Rest

Most practitioners agree that patients should be encouraged to avoid activities that continue to load the affected tendon, thereby exacerbating the condition. Relative rest prevents ongoing damage, reduces pain, and promotes healing. However, there are *no clear recommendations* for duration of rest. Practically, patients are often encouraged to avoid activities that exacerbate pain, while avoiding complete immobilization (to prevent atrophy and deconditioning).

Cryotherapy

While beneficial short term, there is little evidence to support cryotherapy in chronic tendinopathies. In the acute tendinopathy, icing may slow the release of blood and inflammatory agents from the surrounding vasculature secondary to reducing tissue metabolism. Authors of a 2004 systematic review of cryotherapy for soft tissue injuries concluded that application of ice should be performed through a wet towel for 10-min periods for greatest efficacy (Bleakley, McDonough, & MacAuley, 2004). While ice may help pain in chronic conditions due to the direct analgesic effects of cryotherapy, there is little evidence to support overall improvement in outcomes with icing in chronic tendinopathies.

Strengthening and Stretching

Once acute pain has subsided, strengthening and stretching exercises should be initiated. Eccentric strength training is particularly effective in treating tendinopathies and helps promote formation of new collagen. Eccentric contraction involves the lengthening of muscle fibers as the muscle contracts, preferentially loading the tendon. Such exercise has proved beneficial in Achilles tendinosus and patellar tendinosus and thus may be helpful in other tendinopathies (Alfredson, Pietila, Jonsson, & Lorentzon, 1998; Cannell, Taunton, Clement, Smith, & Khan, 2001; Ohberg, Lorentson, & Alfredson, 2004).

Neovascularization: A Potential Therapeutic Target for Chronic Tendinopathies?

Ultrasound evaluation of chronic Achilles and patellar tendinopathies, as well as immunohistochemical analyses of biopsies, has shown a possible relationship between a local vasculo-neural ingrowth and chronic tendon pain. Because of this finding, researchers have recently turned their attention towards injection of substances aimed at destruction of neovascularization in the affected tendons. Polidocanol, initially developed as a local anesthetic, is now commonly used as a vascular sclerosing agent. It has a selective effect in the vascular intimae causing vessel thrombosis. Literature suggests at least potential benefit with ultrasound-guided injection of polidocanol towards neovascularization in the intermediate term for patellar and Achilles tendinopathies (Alfredson & Ohberg, 2005; Hoksrud, Ohberg, Alfredson, & Bahr, 2006)

Growth Factors to Stimulate Tendon Healing

In an animal model, growth factors added to a ruptured tendon promote repair of the tendon (Aspenberg & Virchenko, 2004; Molloy, Wang, & Murrell, 2003). PRP has been promoted as an ideal autologous biological blood-derived product that can be exogenously applied to various tissues, where it releases platelet-derived growth factors and subsequently enhances wound healing, bone healing, and tendon healing. When platelets are activated, growth factors are released and enhance the body's natural healing response (Samson, Gerhardt, & Mandelbaum, 2008). Unfortunately, a systematic review revealed little evidence to support administration of growth factors (such as PRP) for tendon healing. In regard to pain, a double-blind randomized controlled trial supported the injection of PRP over corticosteroids in the treatment of lateral epicondylalgia in the long term (Peerbooms, Sluimer, Bruijn, & Gosens, 2010). However, PRP was inferior in the short term. There are no randomized trials investigating the injection of autologous blood for treatment of tendinopathy.

Sodium Hyaluronate

Hyaluronic acid is an unbranched, high molecular weight polysaccharide and is a major component of synovial fluid, cartilage, and surrounding structures of arthroidial joints. The primary role of hyaluronic acid in these tissues is to maintain viscoelastic structural and functional characteristics. Petrella, Cogliano, Decaria, Mohamed, and Lee (2010) investigated the injection of sodium hyaluronate in 331 subjects with chronic severe lateral epicondylalgia and reported that it was largely effective in the short, intermediate, and long terms (moderate evidence).

Botulinum Toxin Injections

Botulinum toxin injections have shown some benefit in the treatment of lateral epicondylalgia. Injections into the painful area, 1 cm from the lateral epicondyle, were largely effective in the short term (moderate evidence). One rationale for this treatment is the notion that botulinum toxin reversibly paralyzes the extensor muscles, thus preventing repetitive microtrauma of the tendinous fibers at their origin from the osseous lateral epicondyle. However, botulinum toxin has been used in various other pain syndromes, and its exact mechanism for relieving pain remains largely unknown. Reduction in local nociceptive neurotransmitters may also be contributing to pain relief related to botulinum toxin injections (Placzek, Drescher, Deuretzbacher, Hempfing, & Meiss, 2007; Wong et al., 2005).

Systemic Analgesics

There is a dearth of literature to support chronic systemic medication management in the treatment of persistent painful tendinopathies. Two small case reports suggested duloxetine at 60 mg daily may be beneficial in the treatment of chronic refractory lateral epicondylitis (Wani, Dhar, Butt, Rather, & Sheikh, 2008). Chronic oral NSAIDs cannot be condoned due to significant adverse risks of chronic usage (primarily GI and renal effects).

Topical Treatments

In an extensive 2012 Cochrane Review, topical NSAIDs showed analgesic benefit over placebo in the treatment of chronic musculoskeletal pain in adults (Derry, Moore, & Rabbie, 2012). However, the studies reviewed were primarily addressing chronic pain in the setting of *osteoarthritis*. Again, there is a dearth of literature regarding the treatment of chronic tendinopathies. A novel method of possibly managing tendinopathies is the application of nitroglycerin to the affected areas. Animal studies have suggested a role for nitric oxide in tendon healing through fibroblastic collagen synthesis (Johnson, Cadwallader, Scheffel, & Epperly, 2007). Nitroglycerin is denitrated by glutathione S-transferase; free nitrite ion is released, which is then converted to nitric oxide. Five studies on chronic tendinopathies have revealed analgesic benefit with the use of topical nitroglycerin in various forms (Kane, Ismail, & Calder, 2008; Paolini, Appleyard, Nelson, & Murrell 2003, 2004, 2005; Paolini, Murrell, Burch, & Ang, 2009).

Other Modalities

Although anecdotally effective, there is weak evidence to support treatments such as extracorporeal shock wave therapy, iontophoresis, and therapeutic ultrasonography (Wilson & Best, 2005).

Pain Related to Joint Conditions

Osteoarthritis has a high prevalence and is a significant cause of disability among the elderly. The most common joint involved in chronic osteoarthritis pain is the knee. Among other mechanisms, peripheral and central sensitization may contribute to pain perception in osteoarthritis (Imamura et al., 2008). Therefore, eliminating the inflammatory component of the pain generator may still not completely resolve the pain syndrome. Central sensitization may explain why some patients may still complain of knee pain after a total knee arthroplasty. The management of arthritis differs significantly between rheumatoid arthritis (or other inflammatory arthropathies) and osteoarthritis. Early referral to a specialist is recommended for any patient with rheumatoid arthritis or possible synovitis. Treatment of RA favors the use of a combination of disease-modifying antirheumatic drugs (DMARDs) and analgesic treatment. Some patients respond rapidly and completely to disease-modifying treatments, further supporting the practice of early referral to appropriate specialists. Some of the analgesics often used are presented in Table 18.2.

Inflammatory Arthropathies

In those patients with persistent pain despite maximal DMARD therapy, other agents should be utilized to improve pain scores and quality of life. Generally, principles for pain treatment in patients with inflammatory arthropathies are the same as for other chronic musculoskeletal disorders. Goals are focused on maximizing function and quality of life, improving analgesia, while minimizing adverse effects of medications and therapies. A multinational panel of expert rheumatologists convened and developed a set of evidence-based guidelines for pain management by pharmacotherapy in inflammatory arthritis (Whittle, Colebatch, Buchbinder et al., 2012).

Paracetamol (Acetaminophen)

A review of the literature reveals 12 short-term randomized controlled trials evaluating the efficacy of paracetamol in the treatment of pain associated with inflammatory arthritis. Although the evidence is weak, there was consensus among the experts that paracetamol is generally safe and effective. There is no consensus on dosing and intervals, and there is variation across countries

Table 18.2 Analgesics in the management of chronic osteoarthritis pain

Drug	Dosage	Potential adverse effects
Systemic agents		
Acetaminophen	Up to 3 g daily in healthy adults	Hepatic and renal toxicity in overdosage
Nonsteroidal anti-inflammatories	Dependent on individual drug	Gastritis, gastrointestinal bleeding, renal toxicity, peripheral edema[a]
Serotonin-norepinephrine reuptake inhibitors	Duloxetine—initiate 30 mg daily, escalate weekly up to at least 60 mg daily, max 120 mg daily as tolerated	Nausea, somnolence Less common—dizziness, tremor, sweating, blurry vision, anxiety
Weak opioids Tramadol, codeine	Tramadol—maximal 400 mg daily[b]	Nausea, vomiting, somnolence, constipation[c]
Topical agents		
Capsaicin	0.025 % cream, QID	Local skin irritation, burning, erythema
Topical NSAID preparations (ketoprofen, diclofenac, ibuprofen)	1 g up to QID	Limited systemic effects, GI and renal toxicity possible

[a] Caution in those with history of GI ulcerative disease, renal dysfunction, elderly

[b] No ceiling dose in full opioid agonists, limited by side effects

[c] No long-term studies to support in chronic OA pain

in the maximum recommended dose. In the United States, it is now recommended to avoid exceeding 3 g daily of acetaminophen.

Nonsteroidal Anti-inflammatory Drugs

NSAIDs continue to be used widely for symptomatic treatment of RA and other inflammatory arthropathies (Emery & Suarez-Almazor, 2003). However, their use has diminished for *chronic* pain due to multiple adverse risks associated with chronic NSAID usage (i.e., GI toxicity, renal toxicity, edema). According to the multinational recommendations on pain management by pharmacotherapy in inflammatory arthritis, NSAIDs should be used at the lowest effective dose, either continuously or on demand, but paracetamol should be considered first in those patients with gastrointestinal comorbidities. When NSAIDs are required, the experts recommend either nonselective NSAIDs in combination with proton pump inhibitors or COX-2 selective inhibitors alone or in combination with PPI, with close surveillance for adverse events. In patients with inflammatory arthritis and preexisting hypertension, cardiovascular, or renal disease, paracetamol should be used first. NSAIDs (including COX-2 selective inhibitors) should generally be avoided or used with caution.

Tricyclic Antidepressants

There are eight randomized controlled trials in patients with RA, and a single trial in ankylosing spondylitis, evaluating the efficacy of tricyclic antidepressants as analgesics. The results of these trials were conflicting, and there is unclear evidence to support tricyclic antidepressants in the treatment of pain in inflammatory arthritis. However, there may be some role, and therefore expert opinion agrees that these agents may be used as adjuvants in the treatment of pain in inflammatory arthritis. There is insufficient evidence to support newer antidepressants (i.e., serotonin-norepinephrine reuptake inhibitors) in the treatment of inflammatory arthritis (Whittle et al., 2012).

Neuromodulators

Surprisingly, there are no data regarding the use of anticonvulsants as analgesics in inflammatory arthritis. Nefopam, a centrally acting non-opioid analgesic, showed benefit over placebo in two short-term trials in RA, but the patients had greater adverse effects (Emery & Gibson, 1986; Richards, Whittle, & Buchbinder, 2012). One study showed benefit of topical capsaicin for knee pain in RA, but local skin irritation was a common effect (Deal, Schnitzer, Lipstein et al., 1991).

Opioids

Ten randomized controlled trials studied "weak" opioids in the treatment of RA-associated pain. There is no clear definition of "weak" vs. "strong" opioid, but codeine, tilidine, pentazocine, dextropropoxyphene, and tramadol were considered "weak." Meta-analysis of pain outcomes after 6 weeks of treatment showed that those patients treated with "weak" opioids reported superior global impression of clinical change (Boureau & Boccard, 1991; Brunnmuller, Zeidler, Alten, & GromnicaIhle, 2004; Lee, Lee, Park et al., 2006). However, those treated with opioids also had significantly more adverse effects than the placebo groups, and, after correcting for adverse effects, there was no difference between weak opioids and placebo in net efficacy.

There is very little evidence if any to support the use of chronic "strong" opioids in the treatment of RA-associated pain. Given the lack of evidence to support the use of strong opioids, and the significant potential for harm, the expert panel recommends that they should only be used in situations where other treatments have failed and supervised by a clinician experienced in the prescription of strong opioids.

Intra-articular Injections

Intra-articular Corticosteroid

A meta-analysis of intra-articular steroid injections to the knee in rheumatoid arthritis supported the effectiveness of the procedure. Five randomized controlled trials comparing intra-articular steroid injections to placebo illustrated that steroid injections improve pain, knee flexion and extension, knee circumference, morning stiffness, and duration of efficacy (up to 22 weeks in the steroid-treated group). Inflammatory arthritis appears to have a more favorable response to intra-articular steroid injections than osteoarthritis (Wallen & Gillies, 2006).

Intra-articular Hyaluronate

Hyaluronic acid is the major constituent of a 1–2 micron layer on the surface of articular cartilage as well as synovial fluid. In slow movements, solutions of hyaluronic acid act as lubricants and may contribute to absorbing shock in fast movements. Hyaluronic acid may serve to protect the articular cartilage surface and soft tissue surfaces from trauma from joint function. In arthritis, a degenerative process, the molecular weight of hyaluronic acid is reduced, thereby affecting its protective properties. Therefore, injection of intra-articular hyaluronic acid may help to reverse these changes and may also have some anti-inflammatory effects. While supported in the treatment of osteoarthritis of the knee, however, there is a paucity of data for hyaluronic acid injections for inflammatory arthritis and therefore cannot be recommended at this time.

Osteoarthritis

Osteoarthritis (OA) is the most common form of arthritis. OA is a major cause of pain and disability among the elderly population, but unfortunately has no cure. Therefore, therapeutic goals are focused on maximizing functionality and quality of life, improving analgesia, and limiting adverse medication effects. Patients with severe OA of the knee or hip who have failed to respond to more conservative measures usually go on to receive total joint arthroplasties (American College of Rheumatology Subcommittee on Osteoarthritis Guidelines, 2000; Felson, 2000). Clinical guidelines for the management of OA enforce the importance of both pharmacological and nonpharmacological approaches (American College of Rheumatology Subcommittee on Osteoarthritis Guidelines, 2000; Zhang et al., 2005). In 2008, Osteoarthritis Research Society International (OARSI) released an evidence-based, expert consensus set of recommendations for the management of hip and knee osteoarthritis (OA; Zhang, Moskowitz, Nuki et al., 2008).

Nonpharmacological Approaches

Patient education and self-management techniques reduce pain scores and improve general well-being. All patients with hip and knee osteoarthritis should be educated about the objectives of treatment and importance of changes in lifestyle, exercise, pacing, weight reduction, and other measures to unload the damaged joint(s). Initially, focus should be on self-driven treatments rather than passive therapies, in an effort to get the patients more self-reliant and active in their treatment. According to the OARSI, the clinical status of patients can be improved by regular phone contact (Zhang et al., 2005). Again, this fact emphasizes the importance of engaging the patients in their management and encouraging them to be active participants in their care.

Weight loss should also be encouraged in those patients who are overweight. Weight reduction and a regular exercise program play an important role in reducing pain in symptomatic OA. For patients with hip OA, exercises in water may be effective to improve aerobic conditioning, allowing the patients to off-load the affected joint(s) (Felson, Zhang, Anthony, Naimark, & Anderson, 1992; Messier et al., 2004). Early in their treatment, patients may also benefit from referral to a physical therapist (PT) for evaluation and instruction in appropriate exercises to reduce pain and improve functional capacity. A comprehensive PT evaluation may also provide appropriate assistive devices (i.e., canes, walkers) when appropriate. Such walking aids can reduce pain in patients with OA of weight-bearing joints (i.e., knees, hips). Provision of assistive devices should be accompanied by appropriate instruction on the optimal use of a cane or crutch in the contralateral hand or frames or walkers for those patients with bilateral joint disease.

The OARSI guidelines also recommend appropriate footwear for all patients with symptomatic hip or knee OA. In some patients with medial tibiofemoral compartment osteoarthritis, lateral-wedged insoles have shown some benefit. These insoles are recommended in 12 out of 13 existing guidelines for the management of knee OA (Zhang et al., 2007).

The use of a TENS (transcutaneous electrical nerve stimulation) unit may improve pain in some individuals with chronic pain in knee osteoarthritis. In a 2004 clinical study, TENS was found to be as effective as exercise and better than placebo for controlling arthritic pain (Cheing & Hui-Chan, 2004). The mechanism of action of TENS in the treatment of painful conditions remains controversial. In studies of experimental joint inflammation, TENS reduced spinal stimulatory neurotransmitters (glutamate, aspartate) and also activated descending modulatory receptors, including opioid, serotonin, and muscarinic receptors, reducing pain behaviors (Sluka, Vance, & Lisi, 2005).

Complementary Alternative Medicine

The scope of this chapter is to focus on traditional medical interventions in the management of chronic musculoskeletal pain syndromes. However, acupuncture is becoming more and more accepted as a complementary and alternative treatment to traditional medical interventions. The 2008 OARSI consensus guidelines on the management of knee and hip OA state that acupuncture may be beneficial in the treatment of symptomatic knee OA, and therefore alternative treatments will be briefly discussed in this chapter. A 2001 systematic review of the evidence for the efficacy of acupuncture in knee osteoarthritis included seven randomized controlled trials and 393 patients. This review suggested that real acupuncture was more effective than a sham procedure in analgesia, but evidence supporting improved function was inconclusive (Ezzo et al., 2001). In addition, a 2007 RCT of 352 patients with knee OA showed a small, but statistically significant improvement in pain intensity in patients 2 and 6 weeks following true acupuncture (Foster et al., 2007).

Pharmacological Therapies

Acetaminophen (Paracetamol)

For mild to moderate OA pain, acetaminophen up to 4 g daily (recently reduced to 3 g daily in the United States due to concerns regarding long-term use and end-organ toxicity) has proven to be an effective analgesic. In a 2006 Cochrane systematic review, acetaminophen was superior to placebo in 5/7 trials, and pooled analysis of data on overall pain showed a small, but statistically significant reduction in pain. However, such a small reduction in pain score is of questionable clinical significance (Towheed, Maxwell, Judd, Catton, & Wells, 2006). Regardless, due to acetaminophen's proven safety record, evidence of even modest improvements in analgesia, and low cost, it is universally accepted as a first-line pharmacotherapy in symptomatic OA, barring medical comorbidities limiting its usage (i.e., significant hepatic dysfunction).

Nonsteroidal Anti-inflammatory Drugs

Oral NSAIDs

Practitioners have become more cognizant of the multiple adverse effects associated with chronic NSAID usage, leading to less prescriptions for chronic pain in osteoarthritis. Adverse effects associated with chronic NSAID usage include gastrointestinal events (perforation, ulceration, GI bleeds), peripheral edema, and renal insufficiency. There are additional cardiovascular risk factors associated with the long-term use of selective COX-2 inhibitors. For these reasons, oral NSAIDs should be limited to short-term pain control in most patients and are especially discouraged in patients over the age of 75 or in those patients with comorbidities increasing risk for GI events (Hochberg, Altman, April, Benkhalti et al., 2012).

Topical NSAIDs

Topical NSAID creams and gels have a much better safety profile in comparison to systemic administration of NSAIDs. Clinical trial data support the efficacy of topical diclofenac, ketoprofen, and ibuprofen for pain relief in patients with osteoarthritis of relatively superficial joints, such as the knee and hand (Altman & Barthel, 2011). As monotherapy, topical NSAIDs can provide analgesia with relatively few adverse effects, in comparison to long-term systemic NSAIDs.

Topical Capsaicin

Topical capsaicin creams contain a lipophilic alkaloid extracted from chili peppers (*Capsicum* spp.), which activates and sensitizes peripheral c-nociceptors by binding and activating the TRPV1 cation channel. Ultimately, this leads to downregulation and degeneration of epidermal nerve fibers, referred to as defunctionalization (Haanpaa & Treede, 2012). A single placebo-controlled trial in 70 patients with knee OA supported the use of topical capsaicin (0.025 % cream four times daily; Deal et al., 1991). Two RCTs support topical capsaicin in the treatment of hand OA (Zhang & Li Wan Po, 1994). Overall, the mean reduction in pain was 33 % with an NNT of 4 after 4 weeks of treatment. Treatment with topical capsaicin is safe, but up to 40 % of patients endorse intolerance to local burning, stinging, or erythema.

Antidepressants

Although tricyclic antidepressants have been utilized in the treatment of other chronic pain syndromes (diabetic peripheral neuropathy, chronic migraine), there is surprisingly little evidence to support their use in the treatment of chronic pain secondary to osteoarthritis. On the other hand, duloxetine (a serotonin and norepinephrine reuptake inhibitor) has shown efficacy in the treatment of painful osteoarthritis. Two pivotal studies were conducted to assess the efficacy of duloxetine in the treatment of chronic pain due to knee osteoarthritis (Chappell, Desaiah, Liu-Seifert et al., 2011; Chappell, Ossanna, Liu-Seifert et al., 2009). The Chappell et al. (2009) study was a 13-week, randomized, placebo-controlled trial of duloxetine (60–120 mg/day) in 174 patients with significant pain associated with osteoarthritis of the knee. The primary efficacy measure evaluated weekly mean 24-h average pain scores. Duloxetine was significantly superior to placebo on the primary efficacy measure starting at week 1 and continuing through the treatment period. There were also significant improvements in many secondary outcomes in the duloxetine group. When evaluating response rates defined by a 30 and 50 % pain reduction, no dose differential was found between the 60 and 120 mg/day groups. There was no difference in serious adverse effects between the duloxetine and placebo groups, supporting the belief that duloxetine is a relatively safe option in an elderly pain population.

The same author conducted another 13-week randomized, double-blind, placebo-controlled trial in 204 patients with symptomatic knee osteoarthritis (Chappell et al., 2011). The patients treated with duloxetine had significantly greater improvement on Brief Pain Inventory pain severity ratings and possibly more importantly physical functioning scores. Treatment-emergent nausea, constipation, and hyperhidrosis were significantly higher in the duloxetine group, and more duloxetine-treated patients left the trial due to medication adverse effects. The authors concluded that treatment with duloxetine 60–120 mg daily was associated with a significant reduction in pain scores and functional improvement in patients with symptomatic knee osteoarthritis and pain. In the treatment of painful osteoarthritis of the knee, the most common adverse events associated with duloxetine included nausea, fatigue, and constipation.

Opioids

In cases where other first-line analgesics are ineffective, one may consider a trial of opioid medications based on studies suggesting improvement in pain scores for musculoskeletal pain. However, all of the studies evaluating opioids in the management of musculoskeletal pain are short term (less than 13 weeks), and this data cannot necessarily be extrapolated to the chronic pain management population. A 2007 meta-analysis of RCTs evaluating opioids in the management of symptomatic osteoarthritis suggests that opioids are more effective than placebo in reducing pain intensity and improving physical function. However, the longest trials available to support the use of opioids in this population were 13 weeks (Avoac, Gossec, & Dougados, 2007, Emkey et al. 2004; Fleischmann et al. 2001, Luger, Mach et al., 2005, 2005; Markenson, Croft, Zhang, & Richards, 2005; Zautra & Smith, 2005). Chronic pain is a long-term, if not indefinite, disorder. Trials evaluating the efficacy of opioids in treating symptomatic osteoarthritis are not long enough to determine the efficacy of opioids in the management of chronic pain. Furthermore, one cannot evaluate the potential adverse effects of chronic opioids using the data from these studies, including tolerance, dependence, and even opioid-induced hyperalgesia. Even in the short-term trials, opioids had significant adverse events in comparison to placebo. According to the 2007 meta-analysis of RCTs evaluating opioids in the management of symptomatic osteoarthritis, the number needed to harm of all class of opioids vs. placebo for major adverse events indicates that of every five patients treated with opioids, one patient discontinued treatment due to the occurrence of a significant adverse event. Very frequent side effects included nausea, somnolence, dizziness, vomiting, and constipation. Because of the questionable long-term benefits on pain and function, one must especially consider the potential for adverse effects from opioid treatment (Avoac et al. 2007).

Because there are data to suggest improvement with opioid therapy in some patients with symptomatic osteoarthritis, many treatment guidelines do recommend a trial of "weak opioids" for those patients who have persistent pain despite maximizing other treatment options. "Weak opioids" include tramadol and codeine. Because of the increased adverse effects associated with "strong opioids," these medications are only suggested in those patients who have persistent refractory pain despite all other therapies, and even then, these patients should likely be considered for total joint replacement when feasible.

Interventional Options for Pain Management in Osteoarthritis

Intra-articular Corticosteroid Injections

A 2005 Cochrane systematic review, updated in 2006, strongly supported the efficacy of intra-articular steroid injections in patients with knee osteoarthritis. This review examined the data from 13 placebo-controlled randomized controlled trials. Moderate pain relief was illustrated at 2 and 3 weeks postinjections, but function was not significantly improved, and evidence for pain relief 4 and 24 weeks after injection was minimal (Bellamy, Campbell, Robinson et al., 2005; Bellamy, Campbell, Robinson, Gee, Bourne and Wells 2006a, 2006b). Currently, there is still not enough data comparing different strengths and types of corticosteroid to suggest one steroid's superiority over another. One randomized controlled trial of 42 patients with symptomatic knee osteoarthritis showed that intra-articular injections of 20 mg triamcinolone hexacetonide were superior to 6 mg of a betamethasone acetate/bisodium phosphate combination at 4 weeks postinjection (Valtonen, 1981).

Intra-articular Hyaluronic Acid

Hyaluronic acid, a large molecular weight glycosaminoglycan, is a major constituent of synovial fluid. Intra-articular injection of hyaluronic acid is widely used and recommended by many guidelines as a useful modality for treating patients with symptomatic knee osteoarthritis. Two large systematic reviews have evaluated the efficacy of intra-articular hyaluronic acid injections for symptomatic osteoarthritis (Arrich et al. 2005; Lo et al. 2003). The pooled data from these two reviews evaluated 22 placebo-controlled trials. There was a reduction in pain at 2–3 months following at least three intra-articular injections at weekly intervals. A Cochrane Review, which included a meta-analysis of 40 placebo-controlled with five different commercially available HA products, found statistically significant improvement in pain on weight bearing when results were pooled (between 1 and 52 weeks postinjections; Bellamy et al., 2006a, 2006b).

There is much less data to support the use of intra-articular hyaluronic acid injections in the treatment of hip osteoarthritis. A placebo-controlled trial in which three intra-articular injections of either hyaluronic acid, corticosteroid, or saline were administered to the hip in osteoarthritis patients found no significant differences between the study groups in pain on walking, WOMAC (Western Ontario and McMasters University Osteoarthritis Index) and Lequesne indices at 14, 28, or 90 days after the course of injections. (Quistgaard et al. 2006).

Bone-Related Pain Conditions

Bone Pain in Degenerative Joint Disease

Bone and joint pain may be difficult to distinguish at times, since advanced joint degeneration eventually activates nociceptors in the surrounding bony structures. Therefore, the treatment of bone-related pain in degenerative joint conditions should likely follow the same guidelines for treatment of pain in symptomatic joint arthritis.

Malignant Bone Pain

Perhaps one of the most difficult pain syndromes to treat is bone pain related to metastatic bony lesions or primary bone cancers. Although also a cancer pain syndrome, bone pain can be appropriately grouped under the treatment of musculoskeletal pain subtypes. We will focus this portion of the chapter on the treatment of bone pain in the context of metastatic or primary bone cancers.

The third most common metastatic site is bone, second only to lung and liver metastases. In widespread metastatic disease, bony metastasis is involved in 60–84 % of cases. In males, the primary site for bone metastases is usually cancer of the lung or prostate and in females, cancer of the breast. At autopsy, up to 85 % of patients who expired from breast, prostate, or lung cancer had evidence of bony involvement. Metastatic bone pain is the most common cause of refractory pain in cancer patients (Foley, 1985). The most common primary bone tumors include multiple myeloma, osteosarcoma, and Ewing's sarcoma.

Pathophysiology of Malignant Bone Pain

In the absence of bony fracture, the mechanism of pain in bone malignancy is poorly understood. Several mechanisms have been postulated. Many nerves are found in the periosteum, making this structure very sensitive to nociceptive input. Other nerves enter bone via the blood vessels. Since periosteum is such a sensitive structure, one mechanism of pain is postulated to be stretching of the periosteum in the presence of tumor expansion. Mechanical stress due to weakened bone also activates nociceptors at the periosteum. Nerve entrapment by tumor destruction or encasement, or direct nerve involvement by the tumor, is another mechanism of pain in bone malignancy. Tumor involvement of bone disturbs the normal process of bone turnover, and pain results as a mix of nociceptive as well as neuropathic mechanisms. Osteoclasts are activated, creating an acidic microenvironment from apoptosis, and thereby activating ion-sensing nociceptive fibers. Also, increased bony metabolism releases pro-hyperalgesic endothelins, prostaglandins, and cytokines, which activate nociceptive fibers. Overlying reactive muscle spasm is often common in malignant bony pain (Luger, Mach, et al. 2005). Pain from bony malignancy is manifested in many different ways. There is usually a baseline continuous pain, with severe paroxysms of stabbing pain with dynamic activity. Referred pain, muscle spasms, and lancinating pain are also common pain subtypes, especially in the setting of nerve involvement or compression. Pain may escalate tremendously during activities such as standing, walking, sitting, turning, lifting, or coughing.

Multidisciplinary Approach to Malignant Bone Pain

Because management of refractory pain in the setting of bony malignancy is so challenging, the best approach to managing these difficult patient scenarios involves utilizing resources from several different subspecialties. In the event of bony instability, such as in the setting of pathologic fractures, orthopedic specialists may assist in stabilizing the bone or joint in order to reduce severe pain associated with movement. External beam radiation to bony metastasis is a mainstay of treatment for painful skeletal-related events (SREs), and radiation oncologists may assist in management of pain in these instances. Oncologists are well versed in the management of malignant pain and can appropriately utilize opioids using the WHO (World Health Organization) analgesic ladder. However, when the pain persists despite maximal opioid therapy, pain specialists are often consulted to assist in developing a more effective treatment strategy.

Pharmacological Management of Malignant Bone Pain

Opioids

The WHO analgesic ladder for the management of cancer pain recommends the initiation of weak opioids for moderate pain not responsive to simple analgesics and/or adjuvants and strong opioids for moderate to severe pain refractory to weak opioids. In pain related to bony malignancy, most patients have a continuous baseline pain, even at rest. The goal is to optimize around-the-clock analgesia and then have breakthrough analgesics available for incident pain. Because the levels of opioids needed to address incident pain often produce bothersome or intolerable sedation, stimulants may be added to counteract stimulation (Bruera, et al. 1992).

For incident pain, IV opioids are the fastest route for quick onset. However, logistically, IV opioid therapy (i.e., patient-controlled intravenous analgesia) has limited availability. Another rather fast-acting route for opioid delivery is the transmucosal route. Oral transmucosal fentanyl is available commercially and, due to rapid onset in comparison to oral routes of opioid administration, has a promising role for the treatment of incident pain in bony malignancy (Portenoy, et al. 2006).

Bisphosphonates

Bisphosphonates are pyrophosphate analogues where oxygen is replaced by a carbon atom with various side chains. Bisphosphonates bind at areas of increased bone activity, are released during bone resorption, and are potent inhibitors of osteoclast activity. Through reducing osteoclast activity and survival, they indirectly reduce bone resorption. They are now indicated in the treatment of malignancy-associated hypercalcemia and in the prevention of SRE in bony metastases, which includes malignancy-associated bone pain. A 2008 article reviewed the benefits of bisphosphonates in the treatment of bone malignancy. When specifically addressing analgesic benefit, aminobisphosphonates were found to be superior for pain reduction. Zoledronic acid emerged as yielding the highest analgesic benefit in prostate cancer metastases to the bone, ibandronate led to rapid and significant improvements in metastatic bone pain scores in breast cancer patients, zoledronic acid showed benefit in relieving metastatic bone pain from various primary tumor types (i.e., multiple myeloma), and there is unclear evidence if IV bisphosphonates are superior to oral analogues. Bisphosphonate therapy is unfortunately not without risk. With intravenous administration, 15–30 % of patients develop an acute phase reaction, including a transient fever, arthralgias, and myalgias, but usually only with the first treatment. Renal toxicity has been associated with the administration of bisphosphonate therapy, usually associated with high-dose therapy, or rapid IV administration, including acute tubular necrosis and focal segmental glomerulosclerosis. Probably the most feared complication associated with bisphosphonate therapy in cancer patients is osteonecrosis of the jaw, defined as "an area of exposed bone in the maxillofacial region that did not heal within 8 weeks after identification by a health care provider, in a patient exposed to bisphosphonates and no XRT to the craniofacial region." The main risk factors identified for developing this devastating complication include underlying cancer, monthly long-term exposure to intravenous nitro-bisphosphonates, and dental trauma/surgery (Coleman, 2008).

Despite the risks associated with bisphosphonate therapy, consensus guidelines suggest that all patients with multiple myeloma and radiologically confirmed bony metastases from breast cancer should receive bisphosphonates from time of diagnosis of bone metastases; controversy lies in defining duration of treatment, but at this time, should likely be continued indefinitely. Bisphosphonates are recommended not only for analgesic benefit but also to reduce other SREs, such as pathologic fractures (Gralow et al. 2009; Hillner, Ingle, Chlebowski, et al. 2003; Terpos et al. 2009).

Nonsteroidal Anti-inflammatory Drugs, NSAIDs

NSAIDs' mechanism of action involves inhibition of the cyclooxygenase pathway of arachidonic acid breakdown, thus decreasing the formation of prostaglandins. Suggested mechanisms of pain relief in bone metastases include the notion that a reduction in edema, which increases the intraosseous pressure and thereby stretches the periosteum, can lead to pain relief with NSAID therapy. Also, reduction in prostaglandin-induced pain sensitization may explain some of the analgesia associated with NSAID usage. Although beneficial in the treatment of pain associated with bony malignancy, NSAID therapy is limited secondary to side effects involving the gastrointestinal tract, kidneys, and cardiovascular system (Mercadante, 1997).

Chemotherapy or Hormone therapy for Malignant Bone Pain

In certain cancer subtypes, chemotherapy or hormone therapy may be beneficial for the treatment of bony metastases. The analgesic effect of systemic chemotherapy depends on the chemosensitivity of the primary cancer. Lymphoma, multiple myeloma, and testicular cancer have better response to systemic chemotherapy than renal or hepatocellular cancers. Osteosarcoma, a primary bone cancer, has shown improved survival with the addition of chemotherapy. Metastatic bone lesions in hormone-sensitive breast cancers and prostate cancers have responded to hormonal therapies (Mercadante, 1997).

Radiotherapy: Indications for external beam radiation therapy to malignant bone lesions include pain, increased risk for pathologic fracture, neurologic complications (i.e., spinal cord compression), nerve root pain, and cranial nerve involvement (Mercadante and Fulfaro 2007). Proposed mechanisms for pain relief with radiotherapy in malignant bone lesions include direct tumor shrinkage, inhibition of the release of pronociceptive pain mediators, effect on host cells that produce pain mediators or osteolytic substances, direct reduction of osteoclast activity, and possibly disturbances of the neuronal transmission of pain. Roughly one-third of all radiotherapy treatments in metastatic bone lesions are performed for analgesic benefit (Janjan, 2006; Lin & Ray, 2006; Mercadante and Fulfaro 2007).

A meta-analysis illustrated that more than 40 % of patients treated with external beam radiation can expect at least 50 % reduction in pain scores; fewer than 30 % can expect complete pain remission at 1 month (Agarawal, Swangsilpa, Van Der Linden, et al. 2006). Side effects from external beam radiation therapy include fatigue, overlying skin erythema, nausea/diarrhea (in treatment fields including the upper abdomen and possibly esophagitis in thoracic fields), myelosuppression (especially if treatment occurs after chemotherapy), and unfortunately further bone weakening (Mercadante and Fulfaro 2007).

Radioisotopes

"Radiopharmaceuticals" are radioactive substances selectively taken up by bone, which minimize radioactive exposure to normal soft tissues. These substances, including strontium-89 and samarium-153, decay by beta emission and are selective for osteoclasts. They may be indicated in those patients with multiple bony metastases with pain refractory to more traditional analgesics. Systemic radioisotope therapy takes 1–3 weeks to take effect. Toxicity from treatment includes thrombocytopenia and neutropenia, emphasizing the importance of proper patient selection. Care should be taken to evaluate the patient's marrow function, performance status, and recent exposure to other marrow suppressants (Baumann et al. 2005; Mercadante and Fulfaro 2007).

Interventional Approaches

About 20–30 % of patients with pain related to malignant bone lesions have refractory symptoms despite maximal analgesic therapy and radiation therapy. These patients may be appropriate for more invasive treatment options.

Vertebral Augmentation

In those patients with vertebral body metastases, vertebral augmentation may be a treatment option. This procedure involves the percutaneous injection of polymethyl methacrylate (PMMA) bone cement into a vertebral body with a metastatic lesion. Although a promising technology which may improve pain and function, especially in the short term, there have been some limitations in the quality of evidence used to justify widespread use of this invasive procedure (Hollingworth and Jarvik 2006). In one prospective study, 13 patients with intractable pain related to spinal metastases had significant improvement in global quality-of-life scores and function by markedly decreasing their back pain and reducing their intake of pain medications after percutaneous vertebroplasty (Cheung, Chow, Holden, et al. 2006). Although complications are rare, local complications typically result from cement-related irritation, compression, ischemia, and needle trauma, while systemic complications result from intravascular leakage, including reports of pulmonary cement embolization, and even death (Barragan-Campos, Vallee, Lo, et al. 2006).

Radiofrequency Ablation

Percutaneous CT-guided radiofrequency ablation of refractory lesions can reduce pain, improve quality of life, and reduce analgesic use in those patients with pain refractory to more conservative measures. In one study, 92 % of 12 patients with metastatic lesions and refractory pain experienced a three-point decrease in average pain intensity from baseline to week 4 after radiofrequency ablation treatment to refractory lesions. Proposed mechanisms of such treatments include neurolysis of adjacent nociceptive nerve fibers, mechanical decompression of tumor volume, destruction of tumor cells that produce nociceptive cytokines, and inhibition of osteoclasts (Callstrom, Charboneau, Goetz, et al. 2002).

Conclusions

Persistent musculoskeletal pain is a common complaint among chronic pain patients. Musculoskeletal pain encompasses a wide range of disorders, including dysfunction of ligaments, joints, and/or bone. Regardless of treatment approaches, the diligent pain practitioner should remember to focus on not only reduction in pain scores but also improvement in patient functionality. While this chapter focused primarily on traditional medical interventions in the treatment of musculoskeletal pain, an interdisciplinary treatment model has shown better efficacy in improving patient outcomes. A more detailed discussion of the interdisciplinary treatment approach is outlined in another chapter of the present handbook. For best patient outcomes, practitioners should utilize a multifaceted approach to the treatment of musculoskeletal pain complaints. Systemic analgesics, topical treatments, physical therapy, intramuscular injections, and intra-articular injection therapies are all evidence-based treatment modalities. Ideally, treatment should be tailored to each individual patient for the best outcomes and avoidance of complications.

References

Agarawal, J. P., Swangsilpa, T., van der Linden, Y., et al. (2006). The role of external beam radiotherapy in the management of bone metastases. *Clinical Oncology (Royal College of Radiologists), 18*, 747–760.

Alfredson, H., & Ohberg, L. (2005). Sclerosing injections to areas of neo-vascularization reduce pain in chronic Achilles tendinopathy: A double-blind randomized controlled trial. *Knee Surgery, Sports Traumatology, Arthroscopy, 13*, 338–344.

Alfredson, H., Pietila, T., Jonsson, P., & Lorentzon, R. (1998). Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. *American Journal of Sports Medicine, 26*, 360–366.

Altman, R. D., & Barthel, H. R. (2011). Topical therapies for osteoarthritis. *Drugs, 71*(10), 1259–1279.

American College of Rheumatology Subcommittee on Osteoarthritis Guidelines. (2000). Recommendations for medical management of osteoarthritis of the hip and knee: 2000 update. *Arthritis and Rheumatism, 43*, 1905–1915.

Arrich, J., Piribauer, F., Mad, P., Schmid, D., Klaushofer, K., & Mullner, M. (2005). Intra-articular hyaluronic acid for the treatment of osteoarthritis of the knee: A systematic review and meta-analysis. *CMAJ, 172*, 1039–1043.

Aspenberg, P., & Virchenko, O. (2004). Platelet concentrate injection improves Achilles tendon repair in rats. *Acta Orthopaedica Scandinavica, 75*, 93–99.

Avoac, J., Gossec, L., & Dougados, M. (2007). Efficacy and safety of opioids for osteoarthritis: A meta-analysis of randomized controlled trials. *Osteoarthritis and Cartilage, 15*, 957–965.

Ay, S., Evcik, D., & Tur, B. S. (2010). Comparison of injection methods in myofascial pain syndrome: A randomized controlled trial. *Clinical Rheumatology, 29*, 19–23.

Barragan-Campos, H. M., Vallee, J. N., Lo, D., et al. (2006). Percutaneous vertebroplasty for spinal metastases: Complications. *Radiology, 238*, 354–362.

Baumann, G., Charette, M., Reid, R., & Sathya, J. (2005). Radiopharmaceuticals for the palliation of painful bone metastases: A systematic review. *Radiotherapy and Oncology, 75*, 258–270.

Bellamy, N., Campbell, J., Robinson, V., Gee, T., Bourne, R., & Wells, G. (2006). Viscosupplementation for the treatment of osteoarthritis of the knee. *Cochrane Database of Systematic Reviews,* (2):CD005321.

Bellamy, N., Campbell, J., Robinson, V., Gee, T., Bourne, R., & Wells, G. (2005). Intra-articular corticosteroid for treatment of osteoarthritis of the knee. *Cochrane Database of Systematic Reviews,* (4):ID #CDC005328.

Bellamy, N., Campbell, J., Robinson, V., Gee, T., Bourne, R., & Wells, G. (2006). Intra-articular corticosteroid for treatment of osteoarthritis of the knee. *Cochrane Database of Systematic Reviews,* (2):CD005328.

Bendtsen, L., & Jensen, R. (2000). Amitriptyline reduced myofascial tenderness in patient s with chronic tension-type headache. *Cephalalgia, 20*, 603–610.

Bleakley, C., McDonough, S., & MacAuley, D. (2004). The use of ice in the treatment of acute soft-tissue injury: A systematic review of randomized controlled trials. *American Journal of Sports Medicine, 32*, 251–261.

Boureau, F., & Boccard, E. (1991). Placebo-controlled study of the analgesic efficacy of a combination of paracetamol and codeine in rheumatoid arthritis. *Acta Therapeutica, 17*, 123–136.

Bruera, E., et al. (1992). The use of methylphenidate in patients with incident cancer pain receiving regular opiates. A preliminary report. *Pain, 50*, 75–77.

Brunnmuller, U., Zeidler, H., Alten, R., & GromnicaIhle, E. (2004). Effective analgesic therapy with tilidine/naloxone for patients with rheumatoid arthritis. *Aktuelle Rheumatologie, 29*, 35–39.

Callstrom, M. R., Charboneau, J. W., Goetz, M. P., et al. (2002). Painful metastases involving bone: Feasibility of percutaneous CT- and US-guided radio-frequency ablation. *Radiology, 224*, 87–97.

Cannell, L. J., Taunton, J. E., Clement, D. B., Smith, C., & Khan, K. M. (2001). A randomized clinical trial of the efficacy of drop squats or leg extension/leg curl exercises to treat clinically diagnosed jumper's knee in athletes: Pilot study. *British Journal of Sports Medicine, 35*, 60–64.

Chappell, A. S., Desaiah, D., Liu-Seifert, H., et al. (2011). A double-blind, randomized, placebo-controlled study of the efficacy and safety of duloxetine for the treatment of chronic pain due to osteoarthritis of the knee. *Pain Practice, 11*(1), 33–41.

Chappell, A. S., Ossanna, M. J., Liu-Seifert, H., et al. (2009). Duloxetine, a centrally acting analgesic, in the treatment of patients with osteoarthritis knee pain: A 13-week, randomized, placebo-controlled trial. *Pain, 146*(3), 253–260.

Cheing, G. L., & Hui-Chan, C. W. (2004). Would the addition of TENS to exercise training produce better physical performance outcomes in people with knee osteoarthritis than either intervention alone? *Clinical Rehabilitation, 18*, 487–497.

Cheung, G., Chow, E., Holden, L., et al. (2006). Percutaneous vertebroplasty in patients with intractable pain from osteoporotic or metastatic fractures: A prospective study using quality-of-life assessment. *Canadian Association of Radiologists Journal, 57*, 13–21.

Cimmino, M. A., Ferrone, C., & Cutolo, M. (2011). Epidemiology of chronic musculoskeletal pain. *Best Practice and Research Clinical Rheumatology, 25*, 173–183.

Coleman, R. E. (2008). Risks and benefits of bisphosphonates. *British Journal of Cancer, 98*, 1736–1740.

Combie, I. K., Croft, P. R., Linton, S. J., LeResche, L., & Von Korff, M. (Eds.). (1999). *Epidemiology of pain*. Seattle, WA: IASP Press.

Coombes, B. K., Bisset, L., & Vicenzino, B. (2010). Efficacy and safety of corticosteroid injections and other injections for management of tendinopathy: A systematic review of randomized controlled trials. *Lancet, 376*, 1751–1767.

Croft, P. R., Papageorgiou, A. C., Ferry, S., Thomas, E., Jayson, M. I., & Silman, A. J. (1995). Psychologic distress and low back pain. Evidence from a prospective study in the general population. *Spine, 20*, 2731–2737.

Dagenais, S., Haldeman, S., & Wooley, J. R. (2005). Intraligamentous injection of sclerosing solutions (prolotherapy) for spinal pain: A critical review of the literature. *The Spine Journal, 5*, 310–328.

Deal, C. L., Schnitzer, T. J., Lipstein, E., et al. (1991). Treatment of arthritis with topical capsaicin: A double-blind trial. *Clinical Therapeutics, 13*, 383–395.

Derry, S., Moore, R. A., & Rabbie, R. (2012). Topical NSAIDs for chronic musculoskeletal pain in adults (Review). *The Cochrane Collaboration,* 1–93.

Edwards, R. H. (1988). Hypotheses of peripheral and central mechanisms underlying occupational muscle pain and injury. *European Journal of Applied Physiology and Occupational Physiology, 57*, 275–281.

Emery, P., & Gibson, T. (1986). A double-blind study of the simple analgesic nefopam in rheumatoid arthritis. *British Journal of Rheumatology, 25*, 72–76.

Emery, P., & Suarez-Almazor, M. (2003). Rheumatoid arthritis. *Clinical Evidence, 9*, 1349–1371.

Emkey, R., Rosenthal, N., Wu, S. C., Jordan, D., & Kamin, M. (2004). CAPSS-114 Study Group. Efficacy and safety of tramadol/acetaminophen tablets (Ultracet) as add-on therapy for osteoarthritis pain in subjects receiving a COX-2 nonsteroidal anti-inflammatory drug: A multicenter, randomized, double-blind, placebo-controlled trial. *Journal of Rheumatology, 31*, 150–156.

Ezzo, J., Hadhazy, V., Birch, S., Lixing, L., Kaplan, G., Hochberg, M., et al. (2001). Acupuncture for osteoarthritis of the knee: A systematic review. *Arthritis and Rheumatism, 44*, 819–825.

Felson, D. T. (2000). Osteoarthritis: New insights. Part 2: Treatment approaches. *Annals of Internal Medicine, 133*, 726–737.

Felson, D. T., Zhang, Y., Anthony, J. M., Naimark, A., & Anderson, J. J. (1992). Weight loss reduces the risk for symptomatic osteoarthritis in women. The Framingham Study. *Annals of Internal Medicine, 116*, 772–779.

Fleischmann, R. M., Caldwell, J. R., Roth, S. H., Tesser, J. R. P., Olson, W., & Kamin, M. (2001). Tramadol for the treatment of joint pain associated with osteoarthritis: A randomized, double-blinded, placebo-controlled trial. *Current Therapeutic Research, 62*, 113–128.

Foley, K. M. (1985). The treatment of cancer pain. *New England Journal of Medicine, 313*, 84–95.

Foster, N. E., Thomas, E., Barlas, P., Hill, J. C., Young, J., Mason, E., et al. (2007). Acupuncture as an adjunct to exercise based physiotherapy for osteoarthritis of the knee: Randomized controlled trial. *BMJ, 335*(7617), 436.

Frost, A. (1986). Diclofenac versus lidocaine as injection therapy in myofascial pain. *Scandinavian Journal of Rheumatology, 15*, 153–156.

Gerwin, R. D. (2001). Classification, epidemiology, and natural history of myofascial pain syndrome. *Current Pain and Headache Reports, 5*, 412–420.

Gibson, W., Arendt-Nielson, L., & Graven-Nielson, T. (2006). Referred pain and hyperalgesia in human tendon and muscle belly tissue. *Pain, 120*, 113–123.

Gibson, W., Arendt-Nielson, L., Sessle, B. J., & Graven-Nielson, T. (2009). Glutamate and capsaicin-induced pain, hyperalgesia and modulatory interactions in human tendon tissue. *Experimental Brain Research, 194*, 173–182.

Gralow, J. R., Biermann, J. S., Farooki, A., Fornier, M. N., Gagel, R. F., Kumar, R. N., et al. (2009). NCCN Task Force report: Bone health in cancer care. *Journal of the National Comprehensive Cancer Network, 7*(Suppl 3), S1–S35.

Haanpaa, M., & Treede, R.-D. (2012). Capsaicin for neuropathic pain: Linking traditional medicine and molecular biology. *European Neurology, 68*, 264–275.

Hillner, B. E., Ingle, J. N., Chlebowski, R. T., et al. (2003). American Society of Clinical Oncology 2003 update on the role of bisphosphonates and bone health issues in women with breast cancer. *Journal of Clinical Oncology, 21*, 4042–4057.

Ho, K. Y., & Tan, K. H. (2007). Botulinum toxin A for myofascial trigger point injection: A qualitative systematic review. *European Journal of Pain, 11*, 519–527.

Hochberg, M. C., Altman, R. D., April, K. T., Benkhalti, M., et al. (2012). American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip and knee. *Arthritis Care and Research, 64*(4), 465–474.

Hoksrud, A., Ohberg, L., Alfredson, H., & Bahr, R. (2006). Ultrasound-guided sclerosis of neovessels in painful chronic patellar tendinopathy: A randomized controlled trial. *American Journal of Sports Medicine, 34*, 1738–1746.

Hollingworth, W., & Jarvik, J. G. (2006). Evidence on the effectiveness and cost-effectiveness of vertebroplasty: A review of policy makers' responses. *Academic Radiology, 13*, 50–55.

Hong, C.-Z. (1994). Considerations and recommendations regarding myofascial trigger point injection. *Journal of Musculoskeletal Pain, 2*, 29–59.

Imamura, M., Imamura, S. T., Kaziyama, H. H., Targino, R. A., Hsing, W. T., de Souza, L. P., et al. (2008). Impact of nervous system hyperalgesia on pain, disability, and quality of life in patients with knee osteoarthritis: A controlled analysis. *Arthritis and Rheumatism, 59*, 1424–1431.

Janjan, N. (2006). Palliation and supportive care in radiation medicine. *Hematology/Oncology Clinics of North America, 20*, 187–211.

Johnson, G. W., Cadwallader, K., Scheffel, S. B., & Epperly, T. D. (2007). Treatment of lateral epicondylitis. *American Family Physician, 76*, 846.

Kalichman, L., & Vulfsons, S. (2010). Dry needling in the management of musculoskeletal pain. *Journal of the American Board of Family Medicine, 23*, 640–646.

Kane, T. P., Ismail, M., & Calder, J. D. (2008). Topical glyceryl trinitrate and noninsertional Achilles tendinopathy: A clinical and cellular investigation. *American Journal of Sports Medicine, 36*, 1160–1163.

Khan, K. M., Cook, J. L., Kannus, P., Maffulli, N., & Bonar, S. F. (2002). Time to abandon the "tendinitis" myth. *BMJ, 324*, 626–627.

Kraushaar, B. S., & Nirschl, R. P. (1999). Tendinosis of the elbow (tennis elbow). Clinical features and findings of histological, immunohistochemical, and electron microscopy studies. *Journal of Bone and Joint Surgery (American), 81*, 259–278.

Lang, A. M. (2002). Botulinum toxin therapy for myofascial pain disorders. *Current Pain and Headache Reports, 6*, 355–360.

Lee, E. Y., Lee, E. B., Park, B. J., et al. (2006). Tramadol 37.5-mg/acetaminophen 325-mg combination tablets added to regular therapy for rheumatoid arthritis pain: A 1-week, randomized, double-blind, placebo-controlled trial. *Clinical Therapeutics, 28*, 2052–2060.

LeResche, L. (2000). Epidemiologic perspectives on sex differences in pain. In R. B. Fillingim (Ed.), *Sex, gender, and pain: Vol. 17. Progress in pain research and management* (pp. 233–249). Seattle, WA: IASP Press

LeResche, L., Mancl, L. A., Drangsholt, M. T., Huang, G., & Von Korff, M. (2007). Predictors of onset of facial pain and temporomandibular disorders in early adolescence. *Pain, 129*, 269–278.

Lin, A., & Ray, M. E. (2006). Targeted and systemic radiotherapy in the treatment of bone metastasis. *Cancer and Metastasis Reviews, 25*, 669–675.

Lo, G. H., LaValley, M., McAlindon, T., & Felson, D. T. (2003). Intra-articular hyaluronic acid in treatment of knee osteoarthritis: A meta-analysis. *JAMA, 290*, 3115–3121.

Lucas, N., Macaskill, P., Irwing, L., Moran, R., & Bogduk, N. (2009). Reliability of physical examination for diagnosis of myofascial trigger points: A systematic review of the literature. *Clinical Journal of Pain, 25*, 80–89.

Luger, N., Mach, D., et al. (2005). Bone cancer pain: From model to mechanism to therapy. *Journal of Pain and Symptom Management, 29*, 5s.

Maffulli, N., Testa, V., Capasso, G., et al. (2004). Similar histopathological picture in males with Achilles and patellar tendinopathy. *Medicine and Science in Sports and Exercise, 36*, 1470–1475.

Malanga, G. A., Gwynn, M. W., Smith, R. S., & Miller, D. (2002). Tizanidine is effective in the treatment of myofascial pain syndrome. *Pain Physician, 5*(4), 422–432.

Markenson, J. A., Croft, J., Zhang, P. G., & Richards, P. (2005). Treatment of persistent pain associated with osteoarthritis with controlled-release oxycodone tablets in a randomized controlled clinical trial. *Clinical Journal of Pain, 21*, 524–535.

Mense, S., Simons, D. G., & Russell, I. J. (2001). *Muscle pain. Understanding its nature, diagnosis, and treatment* (p. 385). Philadelphia, PA: Lippincott Williams & Wilkins.

Mercadante, S. (1997). Malignant bone pain: Pathophysiology and treatment. *Pain, 69*, 1–18.

Mercadante, S., & Fulfaro, F. (2007). Management of painful bone metastases. *Current Opinion in Oncology, 19*, 308–314.

Messier, S. P., Loeser, R. F., Miller, G. D., Morgan, T. M., Rejeski, W. J., Sevick, M. A., et al. (2004). Exercise and dietary weight loss in overweight and obese older adults with knee osteoarthritis: The Arthritis, Diet, and Activity Promotion Trial. *Arthritis and Rheumatism, 50*, 1501–1510.

Molloy, T., Wang, Y., & Murrell, G. (2003). The roles of growth factors in tendon and ligament healing. *Sports Medicine, 3*, 381–394.

Ohberg, L., Lorentson, R., & Alfredson, H. (2004). Eccentric training in patients with chronic Achilles tendinosis: Normalized tendon structure and decreased thickness at follow-up. *British Journal of Sports Medicine, 38*, 8–11.

Paolini, J. A., Appleyard, R. D., Nelson, J., & Murrell, G. A. (2003). Topical nitric oxide application in the treatment of chronic extensor tendinosis at the elbow: A randomized, double-blinded, placebo-controlled clinical trial. *American Journal of Sports Medicine, 31*, 915–920.

Paolini, J. A., Appleyard, R. C., Nelson, J., & Murrell, G. A. (2005). Topical glyceryl trinitrate application in the treatment of chronic supraspinatus tendinopathy: A randomized, double-blinded, placebo-controlled clinical trial. *American Journal of Sports Medicine, 33*, 806–813.

Paolini, J. A., Murrell, G. A., Burch, R., & Ang, R. (2009). Randomized, double-blind, placebo-controlled, multicenter dose-ranging clinical trial of a new topical glyceryl trinitrate patch for chronic lateral epicondylosis. *British Journal of Sports Medicine, 43*, 299–302.

Paoloni, J. A., Appleyard, R. C., Nelson, J., & Murrell, G. A. (2004). Topical glyceryl trinitrate treatment of chronic noninsertional Achilles tendinopathy: A randomized, double-blind, placebo-controlled trial. *Journal of Bone & Joint Surgery, 86*, 916–922.

Peerbooms, J. C., Sluimer, J., Bruijn, D. J., & Gosens, T. (2010). Positive effect of an autologous platelet concentrate in lateral epicondylitis in a double-blind randomized controlled trial: Platelet-rich plasma versus corticosteroid injection with a 1-year follow-up. *American Journal of Sports Medicine, 38*, 255–262.

Peloso, P., Gross, A., Haines, T., Trinh, K., Goldsmith, C. H., Burnie, S., et al. (2007). Medicinal and injection therapies for mechanical neck disorders. *Cochrane Database of Systematic Reviews, 21*, 411–417.

Petrella, R. J., Cogliano, A., Decaria, J., Mohamed, N., & Lee, R. (2010). Management of tennis elbow with sodium hyaluronate periarticular injections. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology, 2*, 4.

Placzek, R., Drescher, W., Deuretzbacher, G., Hempfing, A., & Meiss, A. L. (2007). Treatment of chronic radial epicondylitis with Botulinum toxin A: A double-blind, placebo-controlled, randomized multicenter study. *Journal of Bone and Joint Surg, 89*, 255–260.

Portenoy, R. K., Taylor, D., Messina, J., & Tremmel, L. (2006). A randomized, placebo-controlled study of fentanyl buccal tablet for breakthrough pain in opioid-treated patients with cancer. *Clinical Journal of Pain, 22*(9), 805–811.

Quistgaard, E., Christensen, R., Torp-Pederson, S., & Bliddal, H. (2006). Intra-articular treatment of hip osteoarthritis: A randomized trial of hyaluronic acid, corticosteroid and isotonic saline. *Osteoarthritis and Cartilage, 14*, 163–170.

Rees, J. D., Maffulli, N., & Cook, J. (2009). Management of tendinopathy. *American Journal of Sports Medicine, 37*, 1855–1867.

Richards, B. L., Whittle, S. L., & Buchbinder, R. (2012). Neuromodulators for pain management in rheumatoid arthritis. *Cochrane Database of Systematic Reviews, 1*, CD008921.

Samson, S., Gerhardt, M., & Mandelbaum, B. (2008). Platelet rich plasma injection grafts for musculoskeletal injuries: A review. *Current Reviews in Musculoskeletal Medicine, 1*, 165–174.

Scott, N. A., Guo, B., Barton, P. M., & Gerwin, R. D. (2009). Trigger point injections for chronic non-malignant musculoskeletal pain: A systematic review. *Pain Medicine, 10*, 54–69.

Simons, D. G. (1990). Muscular pain syndromes. *Advances in Pain Research and Therapy, 17*, 1–41.

Simons, D. G., Travell, J. G., & Simons, L. S. (1999). *Myofascial pain and dysfunction: Vol. 1: The upper half of body* (pp. 278–307). Baltimore: Lippincott William & Wilkins.

Sluka, K. A., Vance, C. G., & Lisi, T. L. (2005). High-frequency, but not low-frequency transcutaneous electrical nerve stimulation reduces aspartate and glutamate release in the spinal cord dorsal horn. *Journal of Neurochemistry, 95*, 1794–1801.

Srbely, J. Z. (2010). New trends in the treatment and management of myofascial pain syndrome. *Current Pain and Headache Reports, 14*, 346–352.

Stewart, W. F., Ricci, J. A., Chee, E., Morganstein, D., & Lipton, R. (2003). Lost productive time and cost due to common pain conditions in the UW workforce. *JAMA, 290*, 2443–2454.

Terpos, E., Sezer, O., Croucher, P. I., Garcia-Sanz, R., et al. (2009). The use of bisphosphonates in multiple myeloma: Recommendations of an expert panel on behalf of the European Myeloma Network. *Annals of Oncology, 20*(8), 1303–1317.

Tough, E. A., White, A. R., Richards, S., & Campbell, J. (2007). Variability of criteria used to diagnose myofascial trigger point syndrome: Evidence from a review of literature. *Clinical Journal of Pain, 23*, 276–286.

Towheed, T. E., Maxwell, L., Judd, M. G., Catton, M., & Wells, G. (2006). Acetaminophen for osteoarthritis. *Cochrane Database of Systematic Reviews, 1*, CD004257.

Valtonen, E. J. (1981). Clinical comparison of triamcinolone hexacetonide and betamethasone in the treatment of osteoarthrosis of the knee joint. *Scandinavian Journal of Rheumatology. Supplement, 41*, 1–7.

VonKorff, M., LeResche, L., & Dworkin, S. F. (1993). First onset of common pain symptoms: A prospective study of depression as a risk factor. *Pain, 55*, 251–258.

Wallen, M., & Gillies D. (2006). Intra-articular steroids and splints/rest for children with juvenile idiopathic arthritis and adults with rheumatoid arthritis. *Cochrane Database of Systematic Reviews,* (1):CD002824.

Wani, Z. A., Dhar, S. A., Butt, M. F., Rather, Y. H., & Sheikh, S. (2008). Case report: Duloxetine in treatment of refractory chronic tennis elbow: Two case reports. *Journal of Medical Case Reports, 2*, 305.

Whittle, S. L., Colebatch, A. N., Buchbinder, R., et al. (2012). Multinational evidence-based recommendations for pain management by pharmacotherapy in inflammatory arthritis: Integrating systematic literature research and expert opinion of a broad panel of rheumatologists in the 3e Initiative. *Rheumatology, 51*, 1416–1425.

Wilson, J. J., & Best, T. M. (2005). Common overuse tendon problems: A review and recommendations for treatment. *American Family Physician, 72*, 811–818.

Wong, S. M., Hui, A. C., Tong, P. Y., Poon, D. W., Yu, E., & Wong, L. K. (2005). Treatment of lateral epicondylitis with botulinum toxin: A randomized double-blind, placebo-controlled trial. *Annals of Internal Medicine, 143*, 793–797.

Zautra, A. J., & Smith, B. W. (2005). Impact of controlled-release oxycodone on efficacy beliefs and coping efforts among osteoarthritis patients with moderate to severe pain. *Clinical Journal of Pain, 21*, 471–477.

Zhang, W., Doherty, M., Arden, N., Bannwarth, B., Bijlsma, J., Gunther, K. P., et al. (2005). EULAR evidence based recommendations for the management of hip osteoarthritis: Report of a task force of the EULAR Standing Committee for international Clinical Studies Including Therapeutics (ESCISIT). *Annals of the Rheumatic Diseases, 64*, 669–681.

Zhang, W. Y., & Li Wan Po, A. (1994). The effectiveness of topically applied capsaicin. A meta-analysis. *European Journal of Clinical Pharmacology, 46*, 517–522.

Zhang, W., Moskowitz, R. W., Nki, G., Abramson, S., Altman, R. D., Arden, N., et al. (2007). OARSI recommendations for the management of hip and knee osteoarthritis, Part I: Critical appraisal of existing treatment guidelines and systematic review of current research evidence. *Osteoarthritis and Cartilage, 15*, 981–1000.

Zhang, W., Moskowitz, R. W., Nuki, G., et al. (2008). OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis and Cartilage, 16*, 137–162.

19

The Biopsychosocial Approach to the Assessment and Intervention for People with Musculoskeletal Disorders

Dennis C. Turk

Overview

A hallmark of musculoskeletal disorders is the presence of persistent pain. In 2007–2009, 21 % (50 million) of the US adults aging 18 and older had doctor-diagnosed arthritis (Center for Disease Control and Prevention, 2010). About 25 % of those with arthritis report severe pain (Hootman, Helmick, & Brady, 2012). In 2008, there were over 7.3 million emergency department visits and more than 2.3 million hospital inpatient stays that were related to back problems in 2008 (Agency for Health Research and Quality, 2011). Overall, chronic pain, which is primarily musculoskeletal, is a prevalent problem that transcends national boundaries and age. One recent large-scale survey (18 countries, 42,249 respondents) found that the 12-month prevalence of chronic pain was 37.3 % in developed countries and 41.1 % in developing countries (Tsang et al., 2008). According to estimates in the recent report of the Institute of Medicine (2011), 100 million American adults have some form of chronic pain. Chronic pain is a common occurrence among children and adolescents, as well, affecting up to 25 % of children and adolescents (Perquin et al., 2000). This makes chronic pain more common than heart disease, diabetes, and cancer combined. Chronic pain also has a negative impact on health and quality of life. It is consistently shown to be associated with negative mood and physical dysfunction, and there is strong evidence that it contributes to depression (Banks & Kerns, 1996) and decreased activity levels (Long, Palermo, & Manees, 2008; van den Berg-Emons, Schasfoort, de Vos, Bussmann, & Stam, 2007).

Because of the negative impact of chronic pain on direct healthcare costs and indirect costs (disability payments, lost productivity), it is also exceedingly expensive for society. In 2003, arthritis among adults over age 18 cost the United States $128 billion in direct costs (medical expenditures), and indirect costs (lost wages) accounted for approximately 2 % of the annual gross domestic products (Center for Disease Control and Prevention, 2007). The direct costs of back pain related to physician services, medical devices, medications, hospital services, and diagnostic test have been estimated to be $91 billion/year (Luo, Pietrobon, Sun, Liu, & Hey, 2004), with the indirect costs related to employment and household activities were estimated to be between $7 billion and $20 billion (Dagenais, Caro, & Haldeman, 2008; Ricci et al., 2006; Stewart, Ricci, Chee, Morganstein, & Lipton, 2003). The Institute of Medicine's recent report estimated that the total direct and indirect cost of chronic pain to the US economy ranges between

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$560 and $630 billion annually (in 2010 dollars) (Institute of Medicine, 2011), and this is only for adults excluding those in the military, Veterans Health Care System, incarcerated, and hospitalized in psychiatric facilities. These astronomical figures, though, mask the incalculable impact of pain on individuals experiencing it directly and their significant others. For example, the spouses of patients with chronic pain report higher levels of distress than the spouses of pain-free individuals or spouses of patients with other chronic medical conditions (Flor, Turk, & Scholz, 1987; Shanfield, Heiman, Cope, & Jones, 1979). In short, people with chronic pain and those who are close to them suffer a great deal, and individuals with chronic pain are at risk for having additional health problems that can contribute even further to a lower overall quality of life.

With the astronomical numbers cited above, we might expect that persistent pain is well managed or, in the words of the Institute of Medicine (2011), adequate pain management is "a moral imperative." A tremendous amount of effort has been expended in an attempt to understand the neurophysiological, biochemical, and genetic bases of pain. Most recently, a number of investigators have used sophisticated procedures, such as positron emission tomography (PET scans) and functional magnetic resonance imaging (fMRI) to image structures and information processing within the brain (e.g., Apkarian, Hashmi, & Baliki, 2011; Tracey, 2008). In addition to attempting to understand pain, these efforts have as their ultimate goal to relieve pain and suffering. With the increased knowledge, innovative surgical and pharmacological interventions have developed, with many more on the horizon. Despite these efforts and the advances made, there continue to be a significant number of individuals for whom no treatable objective pathology is observed and for whom pain persists despite extensive efforts to ameliorate the symptoms and accompanying suffering (Turk, Swanson, & Wilson, 2011; Turk, Wilson, & Cahana, 2011).

Pain serves a protective function in acute circumstances. However, in select individuals, pain may persist past the point of resolution or in excess of any identifiable physical pathology. There may be limited object physical pathology identified and, yet, despite this, may become a chronic and disabling condition where the pain does not appear to have any obvious useful function. There have been some suggestions regarding "plasticity" within the nervous system, where prolonged pain leads to neurophysiological changes and increased sensitization within the central nervous system (CNS) that perpetuate the experience of pain even when the initial cause has resolved (e.g., Staud, Bovee, Robinson, & Price, 2008; Yunus, 2007). Regardless of the initial cause or any maintaining factors, chronic pain is unremitting and carries significant physical, emotional, social, and economic burdens for the individual, their families, and society.

The traditional approach in healthcare in general, but chronic pain in particular, has embraced a dualistic perspective that conceptualized the mind and body as functioning separately and independently. The inadequacy of the dualistic model contributed to a growing recognition that psychosocial factors, such as emotional stress, could impact the reporting of symptoms, medical disorders, and response to treatment. Engel (1977) was one of the first to call for the need of a new approach to the traditional biomedical reductionistic philosophy that dominated the field of medicine since the time of ancient Greeks and codified by Descartes in the mid-seventeenth century. There is an accumulating body of evidence indicating that the development and persistence of chronic pain is best understood in the context of a biopsychosocial perspective framework.

An Integrated Biopsychosocial Model

The biopsychosocial model focuses on both disease and illness, with illness being viewed as the complex interaction of biological, psychological, and social factors (Flor & Turk, 2011; Gatchel, Peng, Peters, Fuchs, & Turk, 2007). The biopsychosocial model presumes some form of physical pathology or at least physical changes in the muscles, joints, or nerves that generate sensory input transmitted to the brain. At the periphery, nociceptive fibers transmit sensations that may or may not be interpreted as "pain." Such sensation is not yet considered pain until subjected to higher-order psychological and mental processing that involves perception, appraisal, and behavior. Perception involves the interpretation of nociceptive input. Appraisal processes involve the meaning that is attributed to the noxious sensory input, expectations, and influences subsequent behaviors. A person may choose to ignore the pain and continue walking, socializing, and engaging in previous levels of activity such as working or household activities (Linton & Buer, 1995) or may choose to refrain from most activity and assume the sick role and accompanying disability. In turn, this interpersonal role is shaped by responses from significant others that may promote either healthy or maladaptive responses.

An integrative, biopsychosocial model of pain suggests the stimulus of tissue injury and the subjective experience of pain is a series of complex electrical and biochemical events (Flor & Turk, 2011). Four distinct physiological processes have been identified in pain: transduction, transmission, modulation, and perception.

- *Transduction* or receptor activation is the process where one form of energy (chemical, mechanical, or thermal) is converted into another (in this case, the electrochemical nerve impulse in the primary afferents). Noxious stimuli lead to electrical activity in the appropriate sensory nerve endings.
- *Transmission* refers to the process by which coded information is relayed to those structures of the CNS whose activity produces the sensation of pain. The first stage of transmission is the conduction of impulses in primary afferents to the spinal cord. At the spinal cord, activity in the primary afferents activates spinal neurons that relay the nociceptive message to the brain. This message elicits a variety of responses, ranging from withdrawal reflexes to the subjective perceptual events. In addition, the responses of CNS neurons to noxious stimuli are variable because they are subject to inhibitory influences elicited by peripheral stimulation or originating within the brain itself.
- *Modulation* refers to the neural activity leading to control of the nociceptive transmission pathway. The activity of this modulatory system is one reason why people with apparently severe injuries may deny significant levels of pain.

Although we are far from understanding all the complexities of the human brain, we know that there are specific pathways in the CNS that control pain transmission, and there is evidence that these pathways can be activated by the psychosocial factors described earlier. Of note, there is growing evidence for the role of neural plasticity or central sensitization in various chronic pain conditions (Woolf, 2011). Evidence for abnormal "windup" at the level of the dorsal horn of the spinal cord of peripheral nociceptive signals, as well as abnormal descending pain inhibition, has been demonstrated in animal models of pain for over 30 years. In the last decade, however, there has been an explosion in research utilizing methods to markers of central sensitization in clinical populations (Woolf, 2011), and there is growing evidence for central sensitization both in the way of abnormal windup of secondary pain as assessed via temporal summation (Staud et al., 2003; Staud, Nagel, Robinson, & Price, 2009) and abnormal descending pain modulation as assessed by conditioned pain modulation (Arendt-Nielsen et al., 2010; King et al., 2009) for a variety of chronic pain conditions. Notably, there is some evidence suggesting that these assessments are associated with psychological variables, including catastrophizing (Goodin et al., 2009) and expectancy (Goffaux, Redmond, Rainville, & Marchand, 2007; Tracey & Bushnell, 2009). The application of these psychophysical measures in clinical research among chronic pain populations may help to advance our modeling of the complex interaction between our physiological and psychological experience.

The final process involved with pain is *perception.* Somehow, the neural activity of the nociceptive transmission neurons induces a subjective experience. How this comes about is obscure, and it is not even clear in which brain structures the activity occurs that produces the perceptual event. The question remains: "How do objectively observable neural events produce subjective experience?” Because pain is fundamentally a subjective experience, there are inherent limitations to understanding it.

From an integrative biopsychosocial perspective, pain is viewed as a subjective perception that results from the transduction, transmission, and modulation of sensory input, filtered through a person’s genetic composition, and prior learning history, and modulated further by their current physiological state, idiosyncratic appraisals, expectations, present mood state, and sociocultural environment. The preconditions for chronic pain, including predisposing factors, precipitating stimuli, precipitating responses, and maintaining processes, were all required to explain the processes involved (Flor & Turk, 2011). The existence of a physiological predisposition or diathesis involving a specific body system is the first component of this model. This predisposition consists of a reduced threshold for nociceptive activation that may be related to genetic variables, previous trauma, or social learning experiences, and it results in a physiological response stereotypy of the specific body system. The existence of persistent aversive external or internal stimuli (pain related or other stressors) with negative meaning (e.g., various aversive emotional stimuli such as familial conflicts or pressures related to employment) activates the sympathetic nervous system and/or muscular processes as unconditioned and conditioned stimuli and motivates avoidance responses. Aversive stimuli may be characterized by “excessive” intensity, duration, or frequency of an external or internal stimulus. A behavioral, cognitive, or physiological repertoire that is inadequate or maladaptive to reduce the impact of these aversive environmental or internal stimuli on the individual is among the precipitating responses. Operant and respondent learning of behavioral, verbal-subjective, and physiological pain responses may maintain the pain experiences.

Flor and Turk (2011) suggested that an important role is played by the cognitive processing of external or internal stimuli related to the experience of stress and pain: for example, increased perception, preoccupation with and over-interpretation of physical symptoms, or inadequate perception of internal stimuli such as muscle tension levels.

Moreover, they suggest that the nature of the coping response—active avoidance, passive tolerance, or depressive withdrawal—may determine the type of problem that develops, as well as the course of the illness. Flor and Turk (2011) further proposed that subsequent maladaptive physiological responding, such as increased and persistent sympathetic arousal and increased and persistent muscular reactivity, as well as sensitization of central structures including the cortex, may induce or exacerbate pain episodes. Thus, they suggested that learning processes in the form of respondent conditioning of fear of activity (including social, motor, and cognitive activities), social learning, and operant learning of pain behaviors—but also operant conditioning of pain-related covert and physiological responses, as described previously—make a contribution to the chronicity of pain.

The primary focus of the biopsychosocial model is on the person experiencing pain, rather than on symptoms and pathophysiology. In this model, the emphasis is shifted from focusing on pathophysiology that may have been involved in the initiation of nociception to the patient’s thoughts and feelings, in addition to conditioning factors, as these will all influence behavior. From this perspective, assessment of, and consequently treatment of, the patient with persistent pain requires a broader strategy than those based on the previous dualistic body-mind models described that examine and address the entire range of psychosocial and behavioral factors, in addition to, but not to the exclusion of, biomedical ones.

In short, the biopsychosocial model of chronic pain places particular emphasis on the role of learning factors in the onset, exacerbation, and maintenance of pain for those patients with persistent pain problems. A range of factors predispose individuals to develop chronic or recurrent acute pain; however, the predisposition is necessary but not sufficient. In addition to anticipation, avoidance, and contingencies of reinforcement, cognitive factors (particularly expectations) are also of central importance in our biopsychosocial model of chronic pain. Conditioned reactions are viewed as self-activated on the basis of learned expectations, as well as being automatically evoked. The critical factor in the biopsychosocial model, therefore, is not that events occur together in time, but that people learn to predict them and to summon appropriate reactions. It is the individual's processing of information that results in anticipatory anxiety and avoidance behaviors.

The biopsychosocial perspective on pain management focuses on self-management and on providing the individual experiencing pain with techniques to gain a sense of control over the effects of pain on his or her life, as well as actually modifying the affective, behavioral, cognitive, and sensory facets of the experience. Behavioral experiences help to show those experiencing pain that they are capable of more than they assumed, thereby increasing their sense of personal competence. An assumption is that, in the absence of cure of persistent pain, long-term maintenance of behavioral changes will occur only if the person experiencing pain has learned to attribute success to his or her own efforts. There are suggestions that these treatments can result in changes in beliefs about pain, coping style, and reported pain severity, as well as direct behavior changes. Furthermore, treatments that result in increases in perceived control over pain and decreased catastrophizing also are associated with decreases in pain severity ratings and functional disability (Jensen, Turner, & Romano, 2001; Turner, Jensen, & Romano, 2000), as well as changes in physiological activity (Flor, Turk, & Birbaumer, 1985).

Assessment

How we think about pain influences the way in which we go about evaluating patients. Many physicians and the lay public alike assume that some underlying pathology is both a necessary and sufficient cause of the symptoms experienced and reported. Consequently, assessment usually begins with a thorough history and physical examination, followed, when deemed appropriate, by laboratory tests and diagnostic procedures in an attempt to identify or confirm the presence of an underlying pathology that *causes* the symptoms—the so-called pain generator. In the absence of identifiable organic pathology, the healthcare provider may assume that the report of symptoms stems from psychosocial factors and may request a psychosocial evaluation to detect the emotional factors underlying the patient's report. Thus, there is a duality where the report of symptoms is attributed to *either* somatic or psychogenic mechanisms. This dichotomous view has been the predominant model that has been the basis for medical practice dating back several hundreds if not thousands of years. It is, however, incomplete and is not supported by available research or the current understanding of chronic pain (Flor & Turk, 2011).

Although the traditional biomedical approach may be appropriate for assessing acute pain (and even here psychosocial factors should be considered), several puzzling observations challenge the presumed isomorphism between pain and organic etiology. For example, the organic bases for some of the most common and recurring acute (e.g., primary headache; Robbins & Lipton, 2010) and chronic [e.g., back pain and fibromyalgia (FM)] pain problems are largely unknown (Abeles, Solitar, Pillinger, & Abeles, 2008; Link et al., 2008) while, on the other hand, asymptomatic individuals may have structural abnormalities such as herniated discs that would explain pain *if* it were present (e.g., Borenstein et al., 2001; M. Jensen, Brant-Zawadzki, Obuchowski, Modic, & Malkasian Ross, 1994; M.P. Jensen, Turner, & Romano, 1994; M.P. Jensen, Turner, Romano, & Lawler, 1994). Thus, we lack explanations for patients with no identified organic pathology who report severe pain and pain-free individuals with significant, objective pathology. Nevertheless, in order to understand and appropriately treat a patient whose primary symptom is pain begins with a comprehensive history and physical examination. Patients are usually asked to describe the intensity, characteristics (e.g., stabbing and burning), location, and moderating influences on their pain. Physical examination procedures and sophisticated laboratory and imaging techniques are readily available for use in attempting to detect relevant organic pathology to confirm hypotheses developed from the history and physical examination.

Quantifying the Pain Severity

The response to the apparently simple question of *How much does it hurt?* is more complex than it may at first appear. Pain resides within an individual, and there is currently no *pain thermometer* (e.g., categorical rating scale, numerical rating scale, visual analog scale) that provides an objective quantification of the quantity or intensity of nociception, but only provides an estimate of the pain as perceived by an individual. Thus, it can only be assessed indirectly based on a patient's overt communication, both verbal and behavioral. Currently, there are no specific biomarkers that have consistently been demonstrated to be associated with the presence or characteristics of pain reported by patients. However this is currently an area of active research. But, any such biomarkers would only be surrogates for the subjective experience of pain. Often, patients are asked to quantify their pain by providing a single, general rating of pain: *Is your usual level of pain 'mild,' 'moderate,' or 'severe?'* or *Rate your typical pain on a scale from 0 to 10, where 0 equals no pain and 10 is the worst pain you can imagine.* More valid information may be obtained by asking about *current* level of pain or pain over the past week and by having patients maintain regular diaries of pain intensity with ratings recorded several times each day (e.g., at meals and bedtime) for several days or weeks as described below. There are a number of simple methods that can be used to evaluate current pain intensity—numerical scale, descriptive ratings scales, visual analog scales, and box scales (M.P. Jensen & Karoly, 2011).

Pain Diaries. The pain diary is useful for assessing fluctuations in the patient's pain and for determining variables related to the pain experience. They play a major role in clinical practice. Currently, a large number of diariy formats are available that have been adapted to the specific problem, the type of treatment, or the specific type of patient who comes for treatment. In general, patients complete a pain diary at regular intervals (e.g., hourly, end of day, three times/day) or, in the case of episodic pain, whenever the pain occurs. Pain intensity, pain duration, and activity interference related to the pain can all be derived from diaries. Diaries are quite flexible and may include items such as amount and type of activity, medication use, mood, and stressful events. Pain diaries have also successfully been used with children (cf. Metsahonkala, Sillanpaa, & Tuominen, 1997). The pain diary is an instrument for the continuous assessment of pain intensity, as well as important influences on, and responses to, the pain. The discussion of relationships between pain and pain-eliciting or pain-increasing events and medication intake that have been revealed in the pain diary is an important part of the treatment of the chronic pain patient. Clinical investigators often worry about reactive effects of pain diaries in the sense that the patients might experience greater pain when they focus more on their pain. However, neither clinical experience nor experimental evidence supports this notion (Cruise, Broderick, Porter, Kaell, & Stone, 1996).

A concern about paper-and-pencil diaries is that patients may not follow the directions regarding when they are to be completed and may "fill forward" or "fill backward." That is, patients may complete a daily diary in advance of the interval (e.g., week) so as not to be burdened by the task, or they may complete the daily diary for the entire week at the end of the week, or a week diary immediately before seeing a healthcare provider. These strategies interfere with the intent of the diary per se and reduce the validity of the data collected.

One strategy to avoid these respondent strategies is to use electronic diaries that prompt response intervals and that do not permit forward or backward filling. Electronic diaries have been introduced that are easy to use for the patients and greatly simplify the often cumbersome scoring procedure (cf. Lewis, Lewis, & Cumming, 1995). The use of palmtop computers and two-way pagers has a unique advantage over paper-and-pencil diaries, namely they can be programmed so that patients cannot go back and retrospectively complete the diaries or change ratings once entered. The use of this technology has primarily been in research hold promise for use in clinical practice as well. However, some limitations (e.g., software problems, hardware problems, participant/operator problems, issues of data analysis) have been identified, and more research is required to develop means for overcoming these (Turk, Burwinkle, & Showlund, 2007).

Pain Quality, and Location

In addition to intensity described previously, pain is known to have different sensory and affective qualities. Understanding the quality of a patient's pain through assessment can identify treatments that are effective for certain types of pain, independent of pain severity. Characteristics of pain (e.g., aching, stabbing) are also important as they may assist selection of treatment. The *McGill Pain Questionnaire* (MPQ; Melzack, 1975) assesses three categories of word descriptors of pain qualities—sensory, affective, and evaluative—and includes a body diagram for patients to identify the area of their pain. An abbreviated version of this scale (*Short-Form McGill Pain Questionnaire;* Melzack, 1987) has also been developed and is one of the most frequently used measures to assess pain characteristics. In addition, assessment can be enhanced through the use of simple pain diagrams that ask patients to indicate on a drawing of the human body the location of their pain (Wolfe, 2003).

The MPQ consists of several parts including a descriptive scale (Present Pain Intensity), with numbers assigned to each of the five adjectives (namely, 1 = mild, 2 = discomforting, 3 = distressing, 4 = horrible, and 5 = excruciating). A second part includes the front and back of a drawing of a human figure on which patients indicate the location of their pain. Finally, a pain-rating index is derived based on patients' selection of adjectives listed in 20 separate categories reflecting sensory, affective, and cognitive components of pain. The MPQ provides a great deal of information. However, it takes much longer to complete than simple ratings of pain severity. The MPQ may be inappropriate for use when frequent ratings of pain are required (e.g., hourly following surgery). A short form of the MPQ scale consisting of 15 adjectival descriptors representing the sensory and affective dimensions of the pain experience each of which is rated on a 4-point scale (0 = none, 1 = mild, 2 = moderate, and 3 = severe) may be more efficient (Melzack, 1987). One of the concerns, however, about the short-form MPQ is that it does not contain many descriptors that are commonly reported by patients with neuropathic pain. In an attempt to rectify this problem, a recent version of the SF-MPQ has been developed that includes the most commonly neuropathic pain descriptors (e.g., "electric shock-like") by Dworkin et al. (2009). An additional concern of the original SF-MPQ is that the range of the scale (0–4) is limited and may impede detection of small differences. The SF-MPQ-2 attempted to reduce this problem by using an 11-point scale (0–10). The reliability and validity of the SF-MPQ-2 was reported in the original publication.

History, Physical, and Laboratory Findings

The general goals of the history and medical evaluation are to (1) determine the necessity of additional diagnostic testing; (2) determine if medical data can explain the patient's symptoms, symptom severity, and functional limitations; (3) make a medical diagnosis; (4) evaluate the availability of appropriate treatment; (5) establish the objectives of treatment; and (6) determine the appropriate course for symptom management if a complete cure is not possible. Relying exclusively on a medical examination to diagnose a chronic pain disorder, though, can be risky. Although clinical judgment is oftentimes relied on during routine clinical assessment of chronic pain patients, agreement among physicians is surprisingly low, even when using standard mechanical devices (Gladman et al., 2004). An additional complexity is that patient reports of pain severity often demonstrate modest associations with objective physical and laboratory findings: as noted there is no direct linear relationship between the amount of detectable physical pathology and the reported pain intensity. Significant numbers of patients who report chronic pain demonstrate no physical pathology using plain radiographs, computed axial tomography scans, or electromyography [an extensive literature is available on physical assessment, radiographic, and laboratory assessment procedures to determine the physical basis of pain (e.g., Blankenbaker et al., 2008; Borenstein et al., 2001; M. Jensen, Brant-Zawadzki, et al., 1994; Link et al., 2008)], making a precise pathological diagnosis difficult or impossible. Despite these limitations, the patient's history and physical examination remain the basis of medical diagnosis and can provide a safeguard against over-interpreting findings from diagnostic imaging that are largely confirmatory, and can be used to guide the direction of further evaluation efforts.

Difficulties in assessing the physical contributions to chronic pain are well recognized. There are no universal criteria for scoring the presence or importance of a particular sign (e.g., positive radiographs, limitation of spinal mobility), quantifying the degree of disability or establishing the association of these findings with treatment outcome. Interpretation of biomedical findings relies on clinical judgments and medical consensus based on a physician's experience and, in some instances, quasi-standardized criteria (Turk & Robinson, 2010).

There remains a good deal of subjectivity both in the manner in which physical examinations are performed and diagnostic findings are interpreted (Hunt et al., 2001; Nitschke, Nattrass, Disler, Chou, & Ooi, 1999). The inherent subjectivity of physical examination is most evident when it is noted that agreement between physicians is better for items of patient history than for some items of the physical examination. The reproducibility of physical evaluation findings, even among experienced physicians, is modest at best. For example, inter-observer agreement in physical examination of spinal motion and muscle strength, even when using standard mechanical assessment devices such as dynamometers, can be surprisingly poor (Hunt et al., 2001).

The discriminative power of common objective signs of pathology determined during physical examination has also been questioned. Physical and laboratory abnormalities correlate poorly with reports of pain severity (Turk & Robinson, 2010). Again, there is no direct linear relationship between the amount of detectable physical pathology and the intensity of the pain reported.

Some of the variability in results may be associated with the patient's behavior during the examination. Measures of flexibility or strength often reflect nonphysical subjective state as much as actual physical capabilities. Thus, although physical examination is more objective than patient reports, patient motivation, efforts, and psychosocial state influence it. Once again, as noted, for significant numbers of patients, no physical pathology can be identified using plain radiographs, computed axial tomography (CAT scans), magnetic resonance imaging (MRI), diagnostic electromyography, or quantitative sensory testing to validate the report of pain severity. Conversely, individuals with objective pathology may report no pain (e.g., Blankenbaker et al., 2008; M. Jensen, Brant-Zawadzki, et al., 1994). Even with sophisticated advances in imaging technology, there continues to be a less than perfect correlation between identifiable pathology and reported pain, as we noted earlier. In sum, routine clinical assessment of chronic pain patients is frequently subjective and often unreliable. It is often not possible to make any precise pathological diagnosis or even to identify an adequate anatomical origin for the pain.

Despite the limitations noted, the patient's history and physical examination remain the basis of medical diagnosis and may be the best defense against over-interpreting results from diagnostic imaging and laboratory tests. In general, physicians must be cautious not to over-interpret either the presence or absence of objective findings. Thus, although the assessment of pain may at first seem to be a deceptively easy task, this assessment is complicated by the psychological, social, and behavioral characteristics of the individual that will influence the report which is subjective, and may have only limited association with objective pathology. Therefore, in addition to this standard medical approach, an adequate pain assessment also requires consideration of the contribution of a myriad of psychosocial and behavioral factors that influence the subjective report and experience.

Psychosocial Contributions

Any physical abnormalities that are identified may be moderated by coexisting psychosocial influences. The complexity of pain is especially evident when pain persists over time, as a range of psychological, social, and economic factors interact with physical pathology to modulate patients' reports of pain and the impact of pain on their lives. In the case of chronic pain, healthcare providers need to search not only for the physical source of the pain through examination and diagnostic tests but also examine the patient's mood, fears, expectancies, coping efforts, resources, responses of significant others, and the impact of pain on the patients' lives. Turk and Okifuji (1999) have suggested that three central questions should guide assessment of people who report pain: (1) What is the extent of the patient's disease or injury (physical impairment)? (2) What is the magnitude of the illness? That is, to what extent is the patient suffering, disabled, and unable to enjoy usual activities? (3) Does the individual's behavior seem appropriate to the disease or injury, or is there any evidence of amplification of symptoms for any of a variety of psychological or social reasons or purposes? In the next section I will focus on the second two questions, specifically, the extent of the patient's disability and behavioral influences on the patient pain, distress, and suffering.

Brief Psychosocial Screening

Although psychosocial factors are important contributors to the experience of chronic pain, not all patients with chronic pain require an in-depth, comprehensive assessment. Healthcare providers should include a preliminary psychosocial screening, in combination with taking a history and performing a physical examination, and also as they monitor patients' progress during treatment and follow-up as a means to facilitate measurement-based healthcare. These screenings should help the provider determine whether a more comprehensive evaluation (possibly conducted by a mental health professional) should be considered. Several general areas should be covered in such screenings—pain characteristics (modifiers, patterns, descriptors, as well as severity), pain impact (physical and emotional functioning), coping resources and methods used, history and current substance use/misuse, and how others respond to the patient and his or her pain. A heuristic method may be used during interviews (see Turk & Robinson, 2010). There are also several relatively brief questionnaires that can be used to assist in this initial screening (e.g., Brief Pain Questionnaire, Cleeland & Ryan, 1994; Multidimensional Pain Inventory (MPI), Kerns, Turk, & Rudy, 1985; Short Form-36, Ware & Sherbourne, 1992). These measures may also be included as components within a more comprehensive assessment.

Interview

In addition to a standard medical evaluation, an appropriate patient assessment requires an evaluation of the myriad of psychosocial and behavioral factors that influence the subjective report of the characteristics of the pain, which can be done through interviewing. Pending the outcome of an initial screening interview, patients can be referred for a more extensive psychological interview with a mental health specialist.

When conducting either screening or more detailed interviews, in addition to collecting factual information, the healthcare professional should observe the behavior of the patient while attending to the patients' and significant others' thoughts and feelings (Turk, Meichenbaum, & Genest, 1983). Specifically, the extent that patients adhere to their therapeutic intervention may depend on their emotional state, their beliefs about the cause of their pain, and the likelihood and pathway to treatment. A habitual pattern of maladaptive thoughts may contribute to a sense of hopelessness, dysphoria, and unwillingness to engage in activity for fear of amplifying pain and causing additional tissue damage, and this may be especially problematic if the patient erroneously believes the pain can be (must be) completely eliminated. Thus, the interviewer should determine both the patient's and, when possible, significant others' expectancies and goals for treatment and be aware of any dissonance between these factors. Attending to the temporal association of these cognitive, affective, and behavioral events, their specificity versus generality across situations and the frequency of their occurrence in relation to the pain experience will help to provide context to the patient's circumstance and may identify triggering events or pain moderators.

Patients with chronic pain problems often consume a variety of medications (Sarzi-Puttini et al., 2012). It is important to discuss a patient's current medications during the interview, as many pain medications are associated with side effects that may cause or mimic emotional distress (Christo, Grabow, & Raja, 2004). Healthcare providers should not only be familiar with medications used for the treatment of chronic pain but also with side effects from these medications that result in fatigue, sleep difficulties, and mood changes to avoid misdiagnosis of depression. Moreover, when conducting an interview with chronic pain patients, the healthcare provider should focus not simply on "factual information," but they should also observe specific behaviors.

In addition, it is important to adopt the patient's perspective and inquire about both the patient's and the spouse's expectancies and goals for treatment. Attention should focus on the patient's reports of specific thoughts, behaviors, emotions, and physiological responses that precede, accompany, and follow pain episodes or flare-ups, as well as the environmental conditions and consequences associated with cognitive, emotional, and behavioral responses in these situations. During the interview, the clinician should attend to the temporal association of these cognitive, affective, and behavioral events, their specificity versus generality across situations, and the frequency of their occurrence, in order to establish salient features of the target situations, including the controlling variables. The interviewer should seek information that will assist in the development of potential alternate responses, appropriate goals for the patient, and possible reinforcers for these alternatives.

Table 19.1 Screening questions

Clinical issues

- Has the pain persisted for 3 months or longer despite appropriate interventions and in the absence of progressive disease?
- Does the patient report nonanatomical changes in sensation (e.g., glove anesthesia)?
- Does the patient seem to have unrealistic expectations of the healthcare provider or treatment offered?
- Does the patient complain vociferously about treatments received from previous healthcare providers?
- Does the patient have a history of previous painful or disabling medical problems?
- Does the patient have a history of substance abuse?
- Does the patient display many pain behaviors (e.g., grimacing and moving in a rigid and guarded fashion)?

Legal and occupational issues

- Is litigation pending?
- Is the patient receiving disability compensation?
- Was the patient employed prior to pain onset?
- Was the patient injured on the job?
- Does the patient have a job to which he or she can return?
- Does the patient have a history of frequent changing of jobs?

Psychological issues

- Does the patient report any major stressful life events just prior to the onset or exacerbation of pain?
- Does the patient demonstrate inappropriate or excessive depressed or elevated mood?
- Has the patient given up many activities (social recreational, sexual, occupational, physical) because of pain?
- Is there a high level of marital or family conflict?
- Do the patient's significant others provide positive attention to pain behaviors (e.g., take over their chores and rub their back)?
- Is there anyone in the patient's family who has chronic pain?
- Does the patient have no plans for increased or renewed activities if their pain is reduced?

The healthcare provider should also be alert for any *red flags* that may serve as an impetus for a more thorough evaluation by pain specialists. Table 19.1 contains a broad list of topics that might be considered during an interview. These can be stated as questions that may be followed up depending on the patient's responses. The positive responses to any one or a small number of these questions should not be viewed as sufficient to make a referral for more extensive evaluation, but, when a preponderance of them is positive, referral should be considered. Generally, a referral for evaluation may be indicated: where disability greatly exceeds what would be expected based on physical findings alone, when patients make excessive demands on the healthcare system, when the patient persists in seeking medical test and treatments when these are not indicated, when patients display significant psychological distress (e.g., depression, anxiety), when the patient displays evidence of substance abuse including continual nonadherence to the prescribed regimen, or when there are significant interpersonal problems that are attributed to the presence of a chronic pain state.

In addition to interviews, a number of assessment instruments designed to evaluate patients' attitudes, beliefs, and expectancies about themselves, their symptoms, and the healthcare system have been developed. Standardized assessment instruments have advantages over semi-structured and unstructured interviews. They are easy to administer, require less time, and, most importantly, they can be submitted to analyses that permit determination of their reliability and validity. These standardized instruments should not be viewed as alternatives to interviews, but rather that they may suggest issues to be addressed in more depth during an interview. Several assessment instruments are described below (for comprehensive reviews, see Turk & Melzack, 2011).

Assessment of Functional Activities

The impact of chronic pain on function can be subdivided into patients' physical capacities, the ability of patients to perform activities of daily living, and their ability to function in adult roles like work. Focus groups indicate that people with persistent pain report that their overall physical functioning was degraded due to their pain, supporting the recommendation that assessment of functioning should accompany pain assessment (Turk et al., 2003, 2008). The ability (or inability) to perform necessary and desired functions, in turn, can significantly impact quality of life. Physical and laboratory diagnostic measures are useful primarily to the degree that they are correlated with symptoms and functional ability. However, the traditional measures of function performed as part of the physical examination are not direct measures of symptoms or function, but are only approximations that may be influenced by patient motivation and desire to convey the extent of their pain, distress, and suffering to the physician. As noted, commonly used physical examination maneuvers, such as muscular strength and ranges of motion, are only weakly correlated with actual functional capacity. It is important to keep in mind that most functional tests depend on patients' voluntary effort and are based on proxies for objective capabilities (Turk, Okifuji, Sinclair, & Starz, 1996). Similarly, radiographic indicators have been shown to have little predictive value for the long-term physical capacity of a patient, including the ability to return-to-work or usual routine activities.

Poor reliability and questionable validity of physical examination measures have led to the development of self-report, functional-status measures to quantify symptoms, function, and behavior directly, as well as the severity of pain when performing specific activities (e.g., ability to walk up stairs or lift specific weights, to sit for specific periods of time) associated with different types of painful conditions (e.g., osteoarthritis, low back pain). Research has demonstrated the importance of assessing overall health-related quality of life (HRQOL) in chronic pain patients in addition to function (Gladman et al., 2007; Salaffi, Sarzi-Puttini, Ciapetti, & Atzeni, 2009). Some of the common functional used assessment scales include the *Roland-Morris Disability Scale* (1983), the *Sickness Impact Profile* (Bergner, Bobbitt, Carter, & Gilson, 1981), and the *Oswestry Disability Index* (Fairbank, Couper, Davies, & O'Brien, 1980). These scales ask patients to report on their ability to engage in specific activities, such as sitting, standing, and walking. The items tend to be quite specific. For example, one item from the Oswestry Disability Index asks patients to indicate whether their pain prevents them from *sitting at all, from sitting more than 10 minutes, sitting more than 1/2 hour, or sitting more than hour, or whether they are able to sit for as long as they like.* A number of disease-specific functional activity scales have also been developed (e.g., the *Fibromyalgia Impact Questionnaire*, Bennett, 2005; *Neck Disability Index*, Vernon & Mior, 1991) and may be appropriate to use when assessing patients with a specific diagnosis.

Despite the obvious limitations of self-report instruments of physical function, they have several advantages. They are economic, efficient, and enable the assessment of a wide range of behaviors that are relevant to the patient, some of which may be private (sexual relations). Although the validity of such self-reports or the ability to perform functional activities is often questioned, studies have revealed fairly high correspondence among self-reports, disease characteristics, physicians or physical therapists' ratings of functional abilities, and objective functional performance (Deyo, 1988).

Ideally, a biopsychosocial evaluation of musculoskeletal disorders that involves injured workers should include having a vocational rehabilitation counselor perform a comprehensive evaluation of the work status of pain patients and their potential for vocational rehabilitation. In many situations, though, the job of assessing vocational disability falls on the physician or psychologist on the multidisciplinary team. There are no standardized instruments to assess the vocational status of people with chronic pain. In the absence of a standard instrument, the clinicians assessing these patients should address the following issues: (1) Is the patient currently working? (2) If the patient is not working, is this related to his or her health? (3) How long has the patient been out of the work force? (4) Is he or she receiving any kind of work disability benefits? Which ones?

Assessment of Emotional Distress

The results of numerous studies suggest that chronic pain is often associated with emotional distress, particularly depression, anxiety, anger, and irritability (Gallagher & Verma, 2004; McBeth, Macfarlane, Benjamin, & Silman, 2001). The presence of emotional distress in people with chronic pain presents a challenge when assessing symptoms such as fatigue, reduced activity level, decreased libido, appetite change, sleep disturbance, weight gain or loss, and memory and concentration deficits, as these symptoms can be the result of pain, emotional distress, or treatment medications prescribed to control pain. Instruments have been developed specifically for pain patients to assess psychosocial distress, the impact of pain on patients' lives, feeling of control, coping behaviors, and attitudes about disease, pain, and healthcare providers (Turk & Melzack, 2011).

Both the Beck Depression Inventory (BDI) and BDI-2 (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961; Beck, Steer, Ball, & Ranieri, 1996) and the *Profile of Mood States* (POMS, McNair & Lorr, 1971) have well-established reliability and validity in the assessment of symptoms of depression and emotional distress, and they have been used in numerous clinical trials in psychiatry and an increasing number of studies of patients with chronic pain. In research in psychiatry and chronic pain, the BDI provides a well-accepted criterion of the level of psychosocial distress in a sample and its response to treatment. The POMS (McNair & Lorr, 1971) assesses six mood states—tension–anxiety, depression–dejection, anger–hostility, vigor–activity, fatigue–inertia, and confusion–bewilderment—and also provides a summary measure of total mood disturbance. Although the discriminant validity of the POMS scales in patients with chronic pain has not been adequately documented, it has scales for the three most important dimensions of emotional functioning in chronic pain patients (depression, anxiety, anger), and it also assesses three other dimensions that are very relevant to chronic pain and its treatment, including a positive mood scale of vigor-activity. The scores must be interpreted with caution, and the criteria for levels of emotional distress may need to be modified to prevent false positives (e.g., Turk & Okifuji, 1994).

Assessment of Fear of Activity and Activity Avoidance

A number of studies have implicated the role of the patient's idiosyncratic appraisals of his or her symptoms, expectations regarding the cause of the symptoms, and the meaning of the symptoms, in addition to organic factors, as essential in understanding the individual's report of pain and subsequent disability (Carragee, Alamin, Miller, & Carragee, 2005; Jarvik et al., 2005; M.P. Jensen, Romano, Turner, Good, & Wald, 1999; M.P. Jensen, Turner, & Romano, 1994; M.P. Jensen, Turner, Romano, & Lawler, 1994). Fear of activity that might either amplify pain or cause further damage has been shown to play an important role in musculoskeletal disorders, particularly back pain (Vlaeyen & Linton, 2012). Many patients with chronic pain, especially those who attribute their symptoms to traumas, are fearful of engaging in activities that they believe may either contribute to further injury or exacerbate their symptoms. Avoidance of activities may, in the short term, lead to symptom reduction; but, over time, restriction of activities is likely to lead to decreased functional capacities as a result of deconditioning. Also, avoidance of activity has the unfortunate consequence of preventing corrective feedback.

Healthcare providers may inadvertently contribute to avoidance of activity by providing patients with cervical collars that restrict neck movements and advising them to avoid activities that hurt (i.e., hurt = harm). They may contribute to the patient's anxiety that something is seriously wrong with their bodies by continuing to order sophisticated diagnostic tests in search of occult physical pathology.

Two self-report measures have been shown to be particularly useful in assessing fear of activity: the *Tampa Scale for Kinesiophobia* (Kori, Miller, & Todd, 1990) and the *Fear of Activity and Behavior Questionnaire* (Waddell, Newton, Henderson, Somerville, & Main, 1993). Responses to these measures have been shown to predict disability and response to treatment (Vlaeyen & Linton, 2012).

Assessment of Coping and Psychosocial Adaptation to Pain

Historically, "traditional" psychosocial measures that are designed to evaluate psychopathological tendencies have been used to identify specific individual differences associated with reports of pain, even though these measures were usually not developed for, or standardized on, samples of medical patients. Thus, it is possible that responses by medical patients may be distorted as a function of the disease or the medications that they take. For example, as noted, common measures of depression ask patients about their appetites, sleep patterns, and fatigue. Similarly, the commonly used MMPI includes items related to physical symptoms, such as the presence of pain in the back of the neck, the ability to work, feelings of weakness, and beliefs regarding health status in comparison with friends. Because disease status and medication can affect responses to such items, patients' scores may be elevated, distorting the meaning of the responses. More recently, a number of assessment instruments have been developed for use specifically with pain patients. Instruments have been developed to assess psychosocial distress, the impact of pain on patients' lives, feelings of control, coping behaviors, and attitudes about disease, pain, and healthcare providers and the patient's plight (for a detailed review and critique, see DeGood & Cook, 2011).

A sample of an instrument developed to assess both psychosocial and behavioral factors associated with chronic pain is the *West Haven-Yale Multidimensional Pain Inventory* (MPI, Kerns et al., 1985). This 60-item questionnaire is divided into three sections, with the first assessing the patient's perception of pain severity, the impact of pain on their life, affective distress, feelings of control, and support from significant people in their lives. The second section assesses the patient's perceptions of the responses of significant people to their complaints of pain. The third section examines the change in patients' performance of common activities such as household chores and socializing (see DeGood & Cook, 2011).

Assessment of Overt Expressions of Pain

Patients display a broad range of responses that communicate to others that they are experiencing pain, distress, and suffering (what are called pain behaviors). Pain behaviors include verbal reports, paralinguistic vocalizations (e.g., sighs, moans), motor activity, facial expressions, body postures and gesturing (e.g., limping, rubbing a painful body part, grimacing), functional limitations (reclining for extensive periods of time), and behaviors designed to reduce pain (e.g., taking medication, use of the healthcare system). Although there is no one-to-one relationship between these pain behaviors and self-report of pain, they are at least modestly correlated.

A number of different observational procedures have been developed to quantify pain behaviors (Keefe, Somers, Williams, & Smith, 2011). Several investigators using the *Pain Behavior Checklist* (Turk, Wack, & Kerns, 1985) have found a significant association between these self-reports and behavioral observations. Behavioral observation scales can be used by patients' significant others as well. Healthcare providers can use observational methods to systematically quantify various pain behaviors and note the factors that increase or decrease them. For example, observing the patient in the waiting room, while being interviewed, or during a structured series of physical tasks.

As previously described, pain is a complex, subjective phenomenon comprising a range of factors and is uniquely experienced by each person. Wide variability in pain severity, quality, and impact may be noted in reports of patients attempting to describe what appear to be objectively identical phenomena. In addition, patients have a different frame of reference from that of the caregiver. These unique views may complicate communication between patient and caregiver and may prevent direct comparisons among patients from different backgrounds and with different experiences. Patient's descriptions of pain are also colored by cultural and sociological influences. It is the unique experiences of each patient that make assessment of pain so difficult. Because of the subjectivity inherent in pain, suffering, and disability are difficult to prove, disprove, or quantify in a completely satisfactory fashion. As discussed previously, response to the simple question, *How much does it hurt?* is, indeed, far from simple. The experience and report of pain are influenced by multiple factors, such as cultural conditioning, expectancies, current social contingencies, mood state, and perceptions of control. Physical pathology and the resulting nociception are important, albeit, not the sole contributors to the experience of pain. It is important to acknowledge the central importance of patients' self-reports, along with their behavior in pain assessment. It is highly unlikely that we will ever be able to evaluate pain without reliance on the person's perceptions. The central point to keep in mind is that it is the *patient* who reports pain and not the pain itself that is being evaluated.

Treatment based on a biopsychosocial perspective should address any identified pathology as a first step. However, for the majority of chronic musculoskeletal pain problems, there is no cure. There are, of course, some exceptions. For example, the patient with severe knee joint deterioration due to osteoarthritis may be "cured" following knee replacement, as may some patients who are surgically treated for severe spinal canal claudication. Those who do not benefit from such disease-modifying interventions, or for whom there are no comparable interventions, will continue to experience at least some levels of pain. For these patients, consideration needs to be given to how to help them to function as effectively as possible and to maintain a reasonable level of health-related quality of life despite persistent pain. For this large majority, a comprehensive intervention based on the biopsychosocial model that may include medication, symptomatic interventions (e.g., epidural steroids), nonpharmacological somatic modalities (e.g., physical therapy), and psychosocial interventions (e.g., relaxation, problem solving, pacing of activities, goal versus symptom directed, stress management) as an integrated package may be most appropriate. It is useful to view such comprehensive treatment from a cognitive-behavioral perspective because this perspective is applicable to any combination of modalities, individualized to meet patients' needs and unique characteristics (Flor & Turk, 2011).

Cognitive-Behavioral Perspective on the Treatment of Chronic Musculoskeletal Pain

The cognitive-behavioral (CB) perspective has become the most commonly accepted psychological treatment choice for use with chronic pain patients (e.g., Eccleston, Williams, & Morley, 2009; Gatchel & Okifuji, 2006; Hoffman, Papas, Chatkoff, & Kerns, 2007). The CB perspective suggests that behaviors and emotions are influenced by interpretations of events, rather than solely by the objective characteristics of an event itself. Rather than focusing on the contribution of cognitive and emotional factors to the perception of a set of symptoms in a static fashion, emphasis is placed on the reciprocal relationships among physical, cognitive, affective, and behavioral factors. According to the CB perspective, it is peoples' idiosyncratic attitudes, beliefs, and unique representations that filter and interact reciprocally with emotional factors, social influences, behavioral responses, and sensory phenomena. Moreover, peoples' behaviors elicit responses from significant others that can reinforce both adaptive and maladaptive modes of thinking, feeling, and behaving. Thus, a reciprocal and synergistic model is proposed.

Assumptions of the Cognitive-Behavioral Perspective

There are five central assumptions that characterize the CB perspective:

- The first assumption is that all people are active processors of information, rather than passive reactors to environmental contingencies. People attempt to make sense of the stimuli from the external environment by filtering information through organizing attitudes derived from their prior learning histories and by general strategies that guide the processing of information. People's responses (overt as well as covert) are based on these appraisals and subsequent expectations, and they are not totally dependent on the actual consequences of their behaviors (i.e., positive and negative reinforcements and punishments). From this perspective, anticipated consequences are as important in guiding behavior as are the actual consequences.
- A second assumption of the CB perspective is that one's thoughts (e.g., appraisals, attributions, and expectations) can elicit or modulate affect and physiological arousal, both of which may serve as impetuses for behavior. Conversely, affect, physiology, and behavior can instigate or influence thinking processes. Thus, the causal priority depends on where in the cycle the person chooses to begin. Causal priority may be less of a concern than the view of an interactive process that extends over time, with the interaction of thoughts, feelings, physiological activity, and behavior.
- CB perspectives are unique in that they emphasize the reciprocal effects of the person on the environment and the influence of environment on the person and his or her behavior. The third assumption of the CB perspective, therefore, is that behavior is reciprocally determined by both the environment and the person. People not only passively respond to their environment but also elicit environmen-

tal responses by their behavior. In a very real sense, people create their environments.

- A fourth assumption is that if people have learned maladaptive ways of thinking, feeling, and responding, then successful interventions designed to alter behavior should focus on these maladaptive thoughts, feelings, and physiology, as well as behaviors and not on one to the exclusion of the others. There is no expectancy that changing only thoughts, or feelings, or behaviors will necessarily result in changes in the other two areas.
- The final assumption is that, in the same way as people are instrumental in the development and maintenance of maladaptive thoughts, feelings, and behaviors, they can, are, and should be considered active agents of change of their maladaptive modes of responding. People with chronic pain, no matter how severe, despite common beliefs to the contrary, are not helpless pawns of fate. They can and should become instrumental in learning and carrying out more effective modes of responding to their environment and their plight.

From the CB perspective, people with pain are viewed as having negative expectations about their own ability to control certain motor skills without pain. Moreover, pain patients tend to believe they have limited ability to exert any control over their pain. Such negative, maladaptive appraisals about the situation and personal efficacy may reinforce the experience of demoralization, inactivity, and overreaction to nociceptive stimulation. These cognitive appraisals and expectations are postulated as having an effect on behavior, leading to reduced efforts and activity, which may contribute to increased psychosocial distress (helplessness) and subsequent physical limitations.

If we accept that pain is a complex, subjective phenomenon that is uniquely experienced by each person, then knowledge about idiosyncratic beliefs, appraisals, and coping repertoires becomes critical for optimal treatment planning and for accurately evaluating treatment outcome. People with persistent pain have beliefs, appraisals, and expectations about pain, their ability to cope, social supports, their disorder, the medicolegal system, the healthcare system, and their employers, all of which are important because they may facilitate or disrupt the sufferer's sense of control. These factors also influence patients' investment in treatment, acceptance of responsibility, perceptions of disability, adherence to treatment recommendations, support from significant others, expectancies for treatment, and acceptance of treatment rationale.

Cognitive interpretations also affect how patients present symptoms to others, including healthcare providers. Overt communication of pain, suffering, and distress will enlist responses that may reinforce pain behaviors and impressions about the seriousness, severity, and uncontrollability of pain. That is, reports of pain may induce physicians to prescribe more potent medications, order additional diagnostic tests, and, in some cases, perform surgery (Turk & Okifuji, 1997). Family members may express sympathy, excuse the patient from responsibilities, and encourage passivity, thereby fostering further physical deconditioning. The CB perspective integrates the operant conditioning emphasis on external reinforcement and respondent view of conditioned avoidance within the framework of information processing. Indeed, people with persistent pain often have negative expectations about their own ability and responsibility to exert any control over their pain. Moreover, they often view themselves as helpless. Such negative, maladaptive appraisals about their condition, situation, and their personal efficacy in controlling their pain and problems associated with pain reinforce their experience of demoralization, inactivity, and over-reaction to nociceptive stimulation. These cognitive appraisals are posited as having a negative effect on behavior, leading to reduced effort, reduced perseverance in the face of difficulty, and reduced activity and increased psychosocial distress.

The CB perspective on pain management focuses on providing the patient with techniques to gain a sense of control over the effects of pain on his or her life, as well as actually modifying the affective, behavioral, cognitive, and sensory facets of the experience. Behavioral experiences help to show patients with that they are capable of more than they assumed, increasing their sense of personal competence. It is important to distinguish the CB perspective from cognitive and behavioral techniques (e.g., self-monitoring to identify relationship among thoughts, mood, and behavior; distraction using imagery; and problem solving). Although many treatment studies and clinics report that they use a cognitive-behavior therapy, "CBT," the components can be quite varied, and there is no consensually agreed upon standard set of components that comprise CBT. From the CB perspective, the assumption is that long-term maintenance of behavioral changes will occur only if the person with chronic pain has learned to attribute success to his or her own efforts. There are suggestions that these treatments can result in changes of beliefs about pain, coping style, and reported pain severity, as well as direct behavior changes. Furthermore, treatment that results in increases in perceived control over pain and decreased catastrophizing also results in decreases in pain severity and functional disability. When successful rehabilitation occurs, there is a major cognitive shift from beliefs about helplessness and passivity to resourcefulness and ability to function regardless of pain, and from an illness conviction to a rehabilitation conviction (e.g., Tota-Faucette, Gil, Williams, & Goli, 1993; Turner et al., 2000).

The complexity of chronic pain that we have described suggests that no single healthcare professional or discipline is likely to prove effective for a large number of patients by itself. Over the past 30 years, this observation has resulted in the development of interdisciplinary pain rehabilitation programs (IPRP) designed to deal with the complexities. The perspective offers a way to think about patients and people in general, and it does not require training as a mental health professional or training in the use of specific techniques used to bring about change. Not all patients with persistent pain require a comprehensive rehabilitation program.

This approach is not feasible as there are not a sufficient number of facilities to treat the large number of individuals with chronic pain. Most patients with persistent pain are, and should be, treated in primary care. However, the CB perspective can be useful in thinking about all patients with persistent pain and how treatments are presented regardless of the healthcare provider training or practice.

Interdisciplinary Pain Rehabilitation

Patients with the most recalcitrant chronic pain problems whose lives have been seriously impacted have been shown to benefit from comprehensive rehabilitation programs that include an interdisciplinary team. In IPRPs, patients are usually treated in groups. Patients work on at least four generic issues simultaneously: physical, pharmacological, psychosocial, and vocational. Programs usually emphasize physical conditioning, medication management, acquisition of coping and vocational skills, and gaining knowledge about pain and how the body functions. Individual and group counseling address patient needs. The emphasis is on what the patient accomplishes, not on what the provider accomplishes. The providers envision themselves as teachers, coaches, and sources of information and support. IPRP requires the collaborative efforts of many healthcare providers including, but not limited to, physicians, nurses, psychologists, physical therapists, occupational therapists, vocational counselors, social workers, and support staff. The healthcare providers must act as a team, with extensive interactions among the team members (see also Chap. 22 in this Handbook).

For many chronic pain patients, the factors that lead them to report persistent pain remain obscure. Traditional diagnostic processes have failed to identify a remediable cause of pain. These patients require treatment because of the disruption of their lives that they ascribe to pain. Indeed, their healthcare providers must feel comfortable abandoning the search for cure and, instead, accept palliation as a viable outcome. The goal is to improve the patient's ability to function, not to cure the disease that has led to pain. Hence, the diagnostic process must identify the areas of functional impairment and disability, and treatment must address all of the factors that contribute to disability. In contrast to traditional medical therapy, patients cannot be passive recipients of the ministrations of providers. Such patients must accept responsibility and work to achieve the benefits of treatment. The effects of an IPRP are greater than the sum of its parts.

Common features of all programs include physical therapy, medication management, education about how the body functions, psychosocial treatments (e.g., coping skills learning, problem solving, communication skills training), vocational assessment, and therapies aimed at improving function and the likelihood of return-to-work (Loeser & Turk, 2004). IPRPs usually have a standard daily and weekly format that providers can tailor to individual patient needs. The overall length of a program depends in part on unique patient requirements. The goals of IPRPs should be specific, definable, operationalizable, and realistic in nature. As they have evolved, IPRPs have become performance based, goal directed, and outcome driven (Loeser & Turk, 2004): integration of outcomes related to patients' pain and functional limitations due to pain, how these behaviors influence patients' physical capacity, how others respond to the patient, the influence of psychosocial factors that contribute directly and indirectly to patients' physical and emotional status, and the potential for rehabilitation are essential. The treatment team must build an alliance with patients to instill acceptance of self-management.

Psychosocial strategies generally target alteration of behavior, rather than the patient's personality (Turk, 1997). Patients learn coping skills (e.g., problem solving, distraction, relaxation, activity pacing, interpersonal communication) because this is frequently a deficiency that has led to the patient's many difficulties. Issues that patients raise receive attention in either the group format or in individual therapy, as needed. As depression is so often a component of the chronic pain problem, it may warrant both psychosocial as well as pharmacological interventions. Psychologists provide relaxation and consolidation sessions that allow the patients to work on newly acquired skills and explore educational topics and new psychological skills.

Another important aspect of IPRP is education. Topics cover a wide array of the areas confronting those with chronic pain. Variations around the themes described earlier continue to evolve, based on availability of resources, policies of major payers, theoretical constructs, as well as the preferences and biases of those who establish such treatment facilities.

Given constraints on healthcare resources, there is a growing interest in accountability, measurement-based care, and evidence-based treatment outcome data. All components of healthcare delivery are under scrutiny to determine whether they are not only clinically effective but also cost-effective. The effectiveness of pain treatment facilities and, in particular, IPRPs have been debated and singled out by some third-party payers for special criticism (Federico, 1996). Often, the debates have been acrimonious, centering on anecdotal information and hearsay. Surprisingly, the dialog largely ignores the growing body of outcomes research published over the past quarter century. Referring physicians and third-party payers tend to rely on salient cases, usually failures, treating them as representative and relying upon them as the basis for criticizing IPRPs. Conversely, IPRPs often respond based on their clinical experience and the recall of particular successes that are viewed as representative of the outcomes from their facility, rather than systematically collected empirical data. There are, however, a growing number of studies, reviews, and meta-analyses that support the clinical success of IPRPs (e.g., Gatchel & Okifuji, 2006; Guzman, Esmail, Karjalinen, Malmivaara, Irvin, & Bombadier, 2001; Hoffman et al., 2007).

Despite the recalcitrance of the pain problems of the patients treated, they generally support the efficacy of IPRPs on multiple outcome criteria, including reductions in pain, medication consumption, healthcare utilization, and emotional distress; increases in activity and return-to-work; and closure of disability claims (e.g., Turk & Okifuji, 1998a, 1998b). Moreover, examining the available outcome data, Turk and Okifuji (1998a, 1998b) concluded that the outcomes for IRPS are more clinically effective, more cost-effective, and with fewer iatrogenic complications than alternatives, such as surgery, spinal cord stimulation, and conventional medical care.

It is important to understand that IPRPs rarely eliminate all pain. Moreover, the success rates are modest, yet comparable to more traditional treatments with costs that are often less than the alternatives and with fewer adverse effects. Attention needs to be given to attempting to identify characteristics of responders so that treatment may be prescribed to improve the likely outcomes. Moreover, long-term follow-ups are required to demonstrate maintenance of benefits over time and generalization of outcomes beyond the clinical context. It is important to acknowledge that IPRS are not going to eliminate all pain for all patients. We should not be naïve to assume that the major lifestyle changes required will continue without some long-term continuity of care and reinforcement of skills learned and encouragement for persistence in the face of a chronic disorder.

Patient Uniformity Myth

As noted in describing the complexity of chronic pain and the variability in patient characteristics, it becomes evident that chronic pain patients are a heterogeneous group. Despite this fact, few attempts have been made to individualize treatments matched to unique patient characteristics. It is common to see patients with a wide range of diagnoses and locations of pain, not to mention demographics, and psychosocial differences treated with the identical treatments (e.g., pain rehabilitation). In short, we have adopted the *patient uniformity myth* where all patients with the same diagnosis, no matter how vague, are treated in a similar fashion. However, there is a great deal of published data suggesting that attention needs to be given to identifying the characteristics of patients who improve and those who fail to improve (Rusu, Boersma, & Turk, 2012; Turk, 1990).

Identifying responses to treatment by groups of patients with different characteristics (e.g., demographics, personality, diagnosis) has a long tradition in pain treatment outcome research. Attempts to identify subgroups of chronic pain patients reviewed have tended to focus on single variables. Rehabilitative outcomes, however, are likely to be determined by the interactive effects of multiple factors. Single factors may not be adequate to account for a statistically significant or clinically meaningful proportion of the variance in outcomes. The delineation of homogeneous subgroups among pain patients would provide a framework for the development of specific, optimal treatment regimens for specific pain-patient subgroups when treatment can be matched to assessment or relevant variables areas (1) that are reasonably distinct and not highly correlated, (2) when valid measures of these response classes are available, and (3) when treatments that affect these response classes are available.

Although patient subgroups have been identified, few attempts have been made to evaluate the differential efficacy of treatments customized to patient subgroup characteristics, although some preliminary attempts have been reported (e.g., Hutten, Hermens, & Zilvold, 2001; Thieme, Turk, & Flor, 2007). Clinical investigations should, therefore, be conducted to determine the relative utility of different treatment modalities based on the match of treatment to patient characteristics and to predict which patients are most likely to benefit from what combination of therapeutic modalities. Thus, rather than accepting the *pain-patient homogeneity myth,* the field might be advanced by asking: “What treatment, provided by who, in what way, is most effective for which patients, with what specific problem, and under which set of circumstances?”.

It is important to acknowledge that the identification of subgroups, regardless of the methods used, does not mean that the resulting classification will incorporate all features of the patients. Subgroups should be viewed as prototypes, with significant room for individual variability with a subgroup. Thus, matching treatment to subgroup characteristics will also need to consider and address unique characteristics of the individual patient. The subgroup customization should fit somewhere between the idiographic approach and the generic *nomothetic* approach that has characterized much of the pain treatment outcome studies. At this point, whether treatment tailoring will produce greater therapeutic effects than providing completely idiographic or generic treatments can only be viewed as a reasonable hypothesis. The fact that significant proportions of chronic pain patients are not successfully treated by generic approaches makes investigation of treatment matching of particular relevance.

Conclusions

Pain is not a monolithic entity. Pain is, rather, a concept used to focus and label a group of perceptions, behaviors, thoughts, and emotions. Pain has many dimensions, including sensory and affective components, location, intensity, time course and the memories, meaning, and anticipated consequences that it elicits. It has become abundantly clear that no isomorphic relationship exists among tissue damage, nociception, and pain report. The more recent conceptualizations discussed view pain as a perceptual process resulting from the nociceptive input, which is modulated on a number of different levels in the CNS.

In this chapter, a conceptual, biopsychosocial model was presented as a way to organize thinking about people with chronic pain. A broad scope assessment that addresses each component of the model—*bio*, *psycho*, *social*—was described. The likelihood that any one treatment, unless it is curative, will be able to address the complex issues involved is unrealistic. The CB perspective on human functioning was posed as a helpful way to think about people with persistent musculoskeletal pain, regardless of specific pharmacological, medical, or psychosocial treatment modalities that might be crafted to meet the unique characteristics of those experiencing chronic pain. As was noted, the current state of knowledge suggests that pain must be viewed as a complex phenomenon that incorporates physical, psychosocial, and behavioral factors. Failure to incorporate each of these factors will lead to an incomplete understanding and inadequate treatment.

References

Abeles, M., Solitar, B. M., Pillinger, M. H., & Abeles, A. M. (2008). Update on fibromyalgia therapy. *American Journal of Medicine, 121*, 555–561.

Agency for Health Research and Quality. (2011). *Healthcare Cost and utilization Project*. Retrieved May 24, 2011, from http://www.hcup-us.ahrq.gov/reports/statbriefs/sb105.jsp.

Apkarian, A. V., Hashmi, J. A., & Baliki, M. N. (2011). Pain and the brain: Specificity and plasticity of the brain in clinical chronic pain. *Pain, 152*(3 Suppl), S49–S64.

Arendt-Nielsen, L., Nie, H., Laursen, M. B., Laursen, B. S., Madeleine, P., Simonsen, O. H., et al. (2010). Sensitization in patients with painful knee osteoarthritis. *Pain, 149*, 573–581.

Banks, S. M., & Kerns, R. D. (1996). Explaining high rates of depression in chronic pain: A diathesis-stress framework. *Psychological Bulletin, 119*, 95–110.

Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. F. (1996). Comparison of Beck Depression Inventories -IA and -II in psychiatric outpatients. *Journal of Personality, 67*, 588–597.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*, 561–571.

Bennett, R. (2005). The Fibromyalgia Impact Questionnaire (FIQ): A review of its development, current version, operating characteristics and uses. *Clinical and Experimental Rheumatology, 23*, S154–S162.

Bergner, M., Bobbitt, R., Carter, W., & Gilson, B. (1981). The Sickness Impact Profile: Development and final revision of a health status measure. *Medical Care, 19*, 787–805.

Blankenbaker, D. G., Ullrick, S. R., Davis, K. W., De Smet, A. A., Haaland, B., & Fine, J. P. (2008). Correlation of MRI findings with clinical findings of trochanteric pain syndrome. *Skeletal Radiology, 37*, 903–909.

Borenstein, D. G., O'Mara, J. W., Jr., Boden, S. D., Lauerman, W. C., Jacobson, A., Platenberg, C., et al. (2001). The value of magnetic resonance imaging of the lumbar spine to predict low-back pain in asymptomatic subjects: A seven-year follow-up study. *Journal of Bone & Joint Surgery [American Edition]., 83-A*, 1306–1311.

Carragee, E. J., Alamin, T. F., Miller, J. L., & Carragee, J. M. (2005). Discographic, MRI and psychosocial determinants of low back pain disability and remission: A prospective study in subjects with benign persistent back pain. *Spine Journal., 5*, 24–35.

Center for Disease Control and Prevention. (2007). National and state medical expenditures and lost earnings attributable to arthritis and other rheumatic conditions—United States, 2003. *Morbidity and Mortality Weekly Report, 56*(1), 4–7.

Center for Disease Control and Prevention. (2010). Prevalence of doctor-diagnosed arthritis and arthritis attributable activity limitations—United States, 2007–2009. *Morbidity and Mortality Weekly Report, 59*(39), 1261–1263.

Christo, P. J., Grabow, T. S., & Raja, S. N. (2004). Opioid effectiveness, addiction, and depression in chronic pain. *Advances in Psychosomatic Medicine, 25*, 123–137.

Cleeland, C. S., & Ryan, K. M. (1994). Pain assessment: Global use of the Brief Pain Inventory. *Annals of the Academy of Medicine of Singapore., 23*, 129–138.

Cruise, C. E., Broderick, J., Porter, L., Kaell, A., & Stone, A. A. (1996). Reactive effects of diary self-assessment in chronic pain patients. *Pain, 67*, 253–258.

Dagenais, S., Caro, J., & Haldeman, S. (2008). A systematic review of low back pain costs of illness studies in the United States and internationally. *Spine Journal., 8*, 8–20.

DeGood, D. E., & Cook, A. J. (2011). Assessment of pain beliefs, coping, and self-efficacy. In D. C. Turk & R. Melzack (Eds.), *Handbook of pain assessment* (3rd ed., pp. 67–97). New York: Guilford Press.

Deyo, R. A. (1988). Measuring the functional status of patients with low back pain. *Archives of Physical Medicine and Rehabilitation, 69*, 1044–1053.

Dworkin, R. H., Turk, D. C., Revicki, D. A., Harding, G., Coyne, K. S., Peirce-Sandner, S., et al. (2009). Development and initial validation of an expanded and revised version of the Short-form McGill Pain Questionnaire (SF-MPQ-2). *Pain, 144*, 35–42.

Eccleston, C., Williams, A. C., & Morley, S. (2009). Psychological therapies for the management of chronic pain (excluding headache) in adults. *Cochrane Database of Systematic Review,* (2), CD007407.

Engel, G. L. (1977). The need for a new medical model: A challenge for biomedical science. *Science, 196*, 129–136.

Fairbank, J. C., Couper, J., Davies, J. B., & O'Brien, J. P. (1980). The Oswestry low back pain disability questionnaire. *Physiotherapy, 66*, 271–273.

Federico, J. (1996). The cost of pain centers: Where is the return. In M. Cohen & J. Campbell (Eds.), *Pain treatment centers at a crossroads: A practical and conceptual reappraisal* (pp. 249–256). Seattle: IASP Press.

Flor, H., & Turk, D. C. (2011). *Chronic pain: An integrated biobehavioral perspective*. Seattle: IASP Press.

Flor, H., Turk, D. C., & Birbaumer, N. (1985). Assessment of stress-related psychophysiological reactions in chronic back pain patients. *Journal of Consulting and Clinical Psychology, 53*, 354–364.

Flor, H., Turk, D. C., & Scholz, O. B. (1987). Impact of chronic pain on the spouse: Marital, emotional and physical consequences. *Journal of Psychosomatic Research, 31*, 63–71.

Gallagher, R. M., & Verma, S. (2004). Mood and anxiety disorders in chronic pain. In R. H. Dworkin & W. S. Breitbart (Eds.), *Psychosocial aspects of pain: A handbook for health care providers* (pp. 589–606). Seattle: IASP Press.

Gatchel, R. J., & Okifuji, A. (2006). Evidence-based scientific data documenting the treatment-and cost-effectiveness of comprehensive pain programs for chronic pain management. *Journal of Pain., 7*, 779–793.

Gatchel, R. J., Peng, Y. B., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin, 133*, 581–624.

Gladman, D. D., Cook, R. J., Schentag, C., Feletar, M., Inman, R. I., Hitchon, C., et al. (2004). The clinical assessment of patients with psoriatic arthritis: Results of a reliability study of the spondyloarthritis research consortium of Canada. *Journal of Rheumatology, 31*, 1126–1131.

Gladman, D. D., Mease, P. J., Strand, V., Healy, P., Helliwell, P. S., Fitzgerald, O., et al. (2007). Consensus on a core set of domains for psoriatic arthritis. *Journal of Rheumatology, 34*, 1167–1170.

Goffaux, P., Redmond, W. J., Rainville, P., & Marchand, S. (2007). Descending analgesia—When the spine echoes what the brain expects. *Pain, 130*, 137–143.

Goodin, B. R., McGuire, L., Allshouse, M., Stapleton, L., Haythornthwaite, J. A., Burns, N., et al. (2009). Associations between catastrophizing and endogenous pain-inhibitory processes: Sex differences. *Journal of Pain., 10*, 180–190.

Guzman, J., Esmail, R., Karjalinen, K., Malmivaara, A., Irvin, E., & Bombadier, C. (2001). Multidisciplinary rehabilitation for chronic low back pain: Systematic review. *British Medical Journal, 322*, 1511–1516.

Hoffman, B. M., Papas, R. K., Chatkoff, D. K., & Kerns, R. D. (2007). Meta-analysis of psychological interventions for chronic low back pain. *Health Psychology, 26*, 1–9.

Hootman, J. M., Helmick, C. G., & Brady, T. J. (2012). A public health approach to addressing arthritis in older adults: The most common cause of disability. *American Journal of Public Health, 102*, 426–433.

Hunt, D. G., Zuberbier, O. A., Kozolowski, A. J., Robinson, J., Berkowitz, J., Schultz, I. Z., et al. (2001). Reliability of the lumbar flexion, lumbar extension and passive straight leg raise test in normal populations embedded within a complete physical examination. *Spine, 26*, 2714–2718.

Hutten, M. M. R., Hermens, H. J., & Zilvold, G. (2001). Differences in treatment outcome between subgroups of patients with chronic low back pain using lumbar dynamometry and psychological aspects. *Clinical Rehabilitation, 15*, 479–488.

Institute of Medicine. (2011). *Relieving pain in America: A blueprint for transforming prevention, care, education, and research*. Washington, DC: The National Academics Press.

Jarvik, J. G., Hollingworth, W., Heaqgerty, P. J., Haynor, D. R., Boyko, E. J., & Deyo, R. A. (2005). Three-year incidence of low back pain in an initially asymptomatic cohort. Clinical and imaging risk factors. *Spine, 30*, 1541–1548.

Jensen, M., Brant-Zawadzki, M., Obuchowski, N., Modic, M. T., & Malkasian Ross, J. S. (1994). Magnetic resonance imaging of the lumbar spine in people without back pain. *New England Journal of Medicine, 331*, 69–73.

Jensen, M. P., & Karoly, P. (2011). Self-report scales and procedures for assessing pain in adults. In D. C. Turk

& R. Melzack (Eds.), *Handbook of pain assessment* (3rd ed., pp. 19–44). New York: Guilford Press.

Jensen, M. P., Romano, J. M., Turner, J. A., Good, A. B., & Wald, L. H. (1999). Patient beliefs predict patient functioning: Further support for a cognitive-behavioral model of chronic pain. *Pain, 81*, 95–104.

Jensen, M. P., Turner, J. A., & Romano, J. M. (1994). Correlates of improvement in multidisciplinary treatment of chronic pain. *Journal of Consulting and Clinical Psychology, 62*, 172–179.

Jensen, M. P., Turner, J. A., & Romano, J. M. (2001). Changes in beliefs, catastrophizing, and coping are associated with improvements in multidisciplinary pain treatment. *Journal of Consulting and Clinical Psychology, 69*, 655–662.

Jensen, M. P., Turner, J. A., Romano, J. M., & Lawler, B. K. (1994). Relationship of pain-specific beliefs to chronic pain adjustment. *Pain, 57*, 301–309.

Keefe, F. J., Somers, T. J., Williams, D. A., & Smith, S. J. (2011). Assessment of pain behaviors. In D. C. Turk & R. Melzack (Eds.), *Handbook of pain assessment* (3rd ed., pp. 134–150). New York: Guilford Press.

Kerns, R. D., Turk, D. C., & Rudy, T. E. (1985). The West Haven-Yale Multidimensional Pain Inventory (WHYMPI). *Pain, 23*, 345–356.

King, C. D., Wong, F., Currie, T., Mauderli, A. P., Fillingim, R. B., & Riley, J. L. (2009). Deficiency in endogenous modulation of prolonged heat pain in patients with Irritable Bowel Syndrome and Temporomandibular Disorder. *Pain, 143*, 172–178.

Kori, K. S., Miller, R. P., & Todd, D. D. (1990). Kinesiophobia: A new view of chronic pain behavior. *Pain Management, 3*, 35–43.

Lewis, B., Lewis, D., & Cumming, G. (1995). Frequent measurement of chronic pain: An electronic diary and empirical findings. *Pain, 60*, 341–347.

Link, T. M., Steinbach, L. S., Ghosh, S., Ries, M., Lu, Y., Lane, N., et al. (2008). Osteoarthritis: MR imaging findings in different stages of disease and correlation with clinical findings. *Radiology, 226*, 373–381.

Linton, S. J., & Buer, N. (1995). Working despite pain: Factors associated with work attendance versus dysfunction. *International Journal of Behavioral Medicine, 2*, 252–262.

Loeser, J. D., & Turk, D. C. (2004). Multidisciplinary pain clinics. *Seminars in Neurosurgery, 15*, 13–29.

Long, A. C., Palermo, T. M., & Manees, A. M. (2008). Brief report: Using actigraphy to compare physical activity levels in adolescents with chronic pain and healthy adolescents. *Journal of Pediatric Psychology, 33*, 660–665.

Luo, X., Pietrobon, R., Sun, S. X., Liu, G. G., & Hey, L. (2004). Estimates and patterns of direct health care expenditures among individual with back pain in the United States. *Spine, 29*, 79–86.

McBeth, J., Macfarlane, G. J., Benjamin, S., & Silman, A. J. (2001). Features of somatization predict the onset of chronic widespread pain: Results of a large population-based study. *Arthritis & Rheumatism., 44*, 940–946.

McNair, D. M., & Lorr, M. (1971). *EITS manual for the Profile of Mood States* (4th ed.). San Diego: Educational and Industrial Testing Service.

Melzack, R. (1975). The McGill Pain Questionnaire: Major properties and scoring methods. *Pain, 1*, 277–299.

Melzack, R. (1987). The short-form McGill Pain Questionnaire. *Pain, 30*, 191–197.

Metsahonkala, L., Sillanpaa, M., & Tuominen, J. (1997). Headache diary in the diagnosis of childhood migraine. *Headache, 37*, 240–244.

Nitschke, J. E., Nattrass, C. L., Disler, P. B., Chou, M. J., & Ooi, K. T. (1999). Reliability of the American Medical Association Guides' model for measuring spinal range of motion. *Spine, 24*, 262–268.

Perquin, C. W., Hazebroek-Kampscheur, A. A., Hunfeld, J. A., Bohnen, A. M., van Suijlekom-Smit, L. W., Passchier, J., et al. (2000). Pain in children and adolescents: A common experience. *Pain, 87*, 51–58.

Ricci, J. A., Stewart, W. F., Chee, E., Leotta, C., Foley, K., & Hochberg, M. C. (2006). Back pain exacerbations and lost productive time costs in United States workers. *Spine, 31*, 3052–3060.

Robbins, M. S., & Lipton, R. B. (2010). The epidemiology of primary headache disorders. *Seminars in Neurology, 30*, 107–119.

Roland, M., & Morris, R. (1983). A study of the natural history of back pain. Part I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine, 8*, 141–144.

Rusu, A., Boersma, K., & Turk, D. C. (2012). Subgroups of pain patients—The potential of customizing treatments. In M. Hasenbring, A. Rusu, & D. C. Turk (Eds.), *From acute to chronic back pain: Risk factors, mechanisms, and clinical implications* (pp. 485–511). London: Oxford University Press.

Salaffi, F., Sarzi-Puttini, P., Ciapetti, A., & Atzeni, F. (2009). Assessment instruments for patients with fibromyalgia: Properties, applications and interpretation. *Clinical & Experimental Rheumatology., 27*(5 Suppl 56), S92–S105.

Sarzi-Puttini, P., Vellucci, R., Zuccaro, S. M., Cherubino, P., Labianca, R., & Fornasari, D. (2012). The appropriate treatment of chronic pain. *Clinical Drug Investigation, 32*, 21–33.

Shanfield, S. B., Heiman, E. M., Cope, D. N., & Jones, J. R. (1979). Pain and the marital relationship: Psychiatric distress. *Pain, 7*(3), 343–351.

Staud, R., Bovee, C. E., Robinson, M. E., & Price, D. D. (2008). Cutaneous C-fiber pain abnormalities of fibromyalgia patients are specifically related to temporal summation. *Pain, 139*, 315–323.

Staud, R., Cannon, R. C., Mauderli, A. P., Robinson, M. E., Price, D. D., & Vierck, C. J. (2003). Temporal summation of pain from mechanical stimulation of muscle tissue in normal controls and subjects with fibromyalgia syndrome. *Pain, 102*, 87–95.

Staud, R., Nagel, S., Robinson, M. E., & Price, D. D. (2009). Enhanced central pain processing of fibromyalgia patients is maintained by muscle afferent input: A randomized, double-blind, placebo-controlled study. *Pain, 145*, 96–104.

Stewart, W. F., Ricci, J. A., Chee, E., Morganstein, D., & Lipton, R. (2003). Lost productive time and cost due to common pain conditions in the US workforce.

Journal of the American Medical Association, 290, 2443–2454.

Thieme, K., Turk, D. C., & Flor, H. (2007). Responder criteria for operant and cognitive-behavioral treatment of fibromyalgia syndrome. *Arthritis Care Research., 57*, 830–836.

Tota-Faucette, M. E., Gil, K. M., Williams, F. J., & Goli, V. (1993). Predictors of response to pain management treatment. The role of family environment and changes in cognitive processes. *Clinical Journal of Pain, 9*, 115–123.

Tracey, I. (2008). Imaging pain. *British Journal of Anaesthesia, 101*, 32–39.

Tracey, I., & Bushnell, M. C. (2009). How neuroimaging studies have challenged us to rethink: Is chronic pain a disease? *The Journal of Pain, 10*, 1113–1120.

Tsang, A., Von Korff, M., Lee, S., Alonso, J., Karam, E., Angermeyer, M. C., et al. (2008). Common chronic pain conditions in developed and developing countries: Gender and age differences and comorbidity with depression-anxiety disorders. *Journal of Pain., 9*, 883–891.

Turk, D. C. (1990). Customizing treatment for chronic pain patients: Who, what, and why. *Clinical Journal of Pain, 6*, 255–270.

Turk, D. C. (1997). Psychological aspects of pain. In P. Bakule (Ed.), *Expert pain management* (pp. 124–178). Springhouse, PA: Springhouse.

Turk, D. C., Burwinkle, T., & Showlund, M. (2007). Assessing the impact of chronic pain in real-time. In A. Stone, S. Shiffman, A. Atienza, & L. Nebeling (Eds.), *The science of real-time data capture: Self-reports in health research* (pp. 204–228). New York: Oxford University Press.

Turk, D. C., Dworkin, R. H., Allen, R. R., Bellamy, N., Brandenburg, N., Carr, D. B., et al. (2003). Core outcome domains for chronic pain clinical trials: IMMPACT recommendations. *Pain, 106*, 337–345.

Turk, D. C., Dworkin, R. H., Revicki, D., Harding, G., Burke, L. B., Cella, D., et al. (2008). Identifying important outcome domains for chronic pain clinical trials: An IMMPACT survey of people with pain. *Pain, 137*, 276–285.

Turk, D. C., Meichenbaum, D., & Genest, M. (1983). *Pain and behavioral medicine: A cognitive-behavioral perspective*. New York: Guilford Press.

Turk, D. C., & Melzack, R. (2011). *Handbook of pain assessment* (3rd ed.). New York: Guilford Press.

Turk, D. C., & Okifuji, A. (1994). Detecting depression in chronic pain patients: The adequacy of self-reports. *Behavior Research & Therapy., 32*, 9–16.

Turk, D. C., & Okifuji, A. (1997). What factors affect physicians' decisions to prescribe opioids for chronic noncancer pain patients? *Clinical Journal of Pain, 13*, 330–336.

Turk, D. C., & Okifuji, A. (1998a). Efficacy of multidisciplinary pain centers: An antidote for anecdotes. *Balliere's Clinical Anesthesiology., 12*, 103–119.

Turk, D. C., & Okifuji, A. (1998b). Treatment of chronic pain patients: Clinical outcomes, cost-effectiveness and cost-benefits of multidisciplinary pain centers. *Critical Reviews in Physical Medicine & Rehabilitation., 10*, 181–208.

Turk, D. C., & Okifuji, A. (1999). A cognitive-behavioral approach to pain management. In P. D. Wall & R. Melzack (Eds.), *Textbook of pain* (4th ed., pp. 1431–1445). New York: Churchill-Livingstone.

Turk, D. C., Okifuji, A., Sinclair, J. D., & Starz, T. W. (1996). Pain, disability, and physical functioning in subgroups of fibromyalgia patients. *Journal of Rheumatology, 23*, 1255–1262.

Turk, D. C., & Robinson, J. P. (2010). Multidimensional assessment of patients with chronic pain. In J. Ballantyne, J. Rathmell, & S. Fishman (Eds.), *Bonica's management of pain* (4th ed., pp. 288–301). Philadelphia: Lippincott, Williams & Wilkins.

Turk, D. C., Swanson, K. S., & Wilson, H. D. (2011). The biopsychosocial model of pain and pain management. In M. Ebert & R. D. Kerns (Eds.), *Behavioral and pharmacological pain management* (pp. 16–43). New York: Cambridge University Press.

Turk, D. C., Wack, J. T., & Kerns, R. D. (1985). An empirical examination of the "pain behavior" construct. *Journal of Behavioral Medicine, 9*, 119–130.

Turk, D. C., Wilson, H. D., & Cahana, A. (2011). Treatment of chronic non-cancer pain. *Lancet, 377*, 2226–2235.

Turner, J. A., Jensen, M. P., & Romano, J. M. (2000). Do beliefs, coping, and catastrophizing independently predict functioning in patients with chronic pain? *Pain, 85*, 115–125.

van den Berg-Emons, R. J., Schasfoort, F. C., de Vos, L. A., Bussmann, J. B., & Stam, H. J. (2007). Impact of chronic pain on everyday physical activity. *European Journal of Pain, 11*, 587–593.

Vernon, H., & Mior, S. (1991). The Neck Disability Index: A study of reliability and validity. *Journal of Manipulative and Physiological Therapy., 14*, 409–415.

Vlaeyen, J. W., & Linton, S. J. (2012). Fear-avoidance model of chronic musculoskeletal pain: 12 years on. *Pain, 153*(6), 1144–1147.

Waddell, G., Newton, M., Henderson, I., Somerville, D., & Main, C. J. (1993). A Fear Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain, 52*, 157–168.

Ware, J. E., Jr., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Medical Care, 30*, 473–483.

Wolfe, F. (2003). Pain extent and diagnosis: Development and validation of the regional pain scale in 12,799 patients with rheumatic disease. *Journal of Rheumatology, 30*, 369–378.

Woolf, C. J. (2011). Central sensitization: Implications for the diagnosis and treatment of pain. *Pain, 152*, S2–S15.

Yunus, M. B. (2007). Fibromyalgia and overlapping disorders: The unifying concept of central sensitivity syndromes. *Seminars in Arthritis and Rheumatism, 36*, 339–356.

The Interdisciplinary Treatment Approach for Chronic Pain Management: The Key Components for Success

20

Ben Lippe and Peter B. Polatin

Overview

Interdisciplinary treatment is an empirically-validated approach to managing chronic pain conditions (Gatchel & Okifuji, 2006; Oslund et al., 2009) and is based upon a biopsychosocial conceptualization of the patient's pain experience. This chapter will describe the basic rationale behind an interdisciplinary approach, the interdisciplinary program framework, and the role that this approach plays when considering disability in the workplace. Indeed, musculoskeletal and neuropathic pain are an all-too-common chief complaint with which patients present to pain treatment facilities (Gatchel & Mayer, 2008). The focus of this chapter will be on the treatment of nonmalignant pain (as opposed to chronic malignant pain). Musculoskeletal pain affects the muscles, ligaments, tendons, bones, and nerves. Low back pain is one form of musculoskeletal pain. Up to 80 % of medical costs for back pain can be accounted for by the 5–10 % of acute back pain conditions that develop into chronic pain conditions (Gatchel & Mayer, 2000). Chronic spinal disorders also represent a significant proportion of nearly 1.9 million injuries and illnesses in the US industry, with direct-cost expenses of approximately $418 billion, and indirect costs of about $837 billion (Brady et al., 1997; Melhorn, 2003). Neuropathic pain is another form of chronic nonmalignant pain, and it includes peripheral neuropathy, complex regional pain syndrome (e.g., reflex sympathetic dystrophy), neuralgia, carpal tunnel syndrome, cubital tunnel syndrome, and other neuropathic pain conditions.

Prior to the biopsychosocial model of pain, medical models of pain included the bioreductionist model in which pain was viewed as the direct result of tissue damage. Unfortunately, traditional biomedical treatment approaches based on this overly simplistic model have been found to be therapeutically limited (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). Tissue damage alone does not fully explain the experience of pain. One example of the shortcomings of a simple biomedical approach may be found in phantom limb pain, where the patient experiences pain sensations in bodily locations that are no longer even present. Clearly, this pain cannot be solely attributed to pain-site tissue damage, as there literally exists no tissue from which to ascribe the pain. Instead, nerve endings at the

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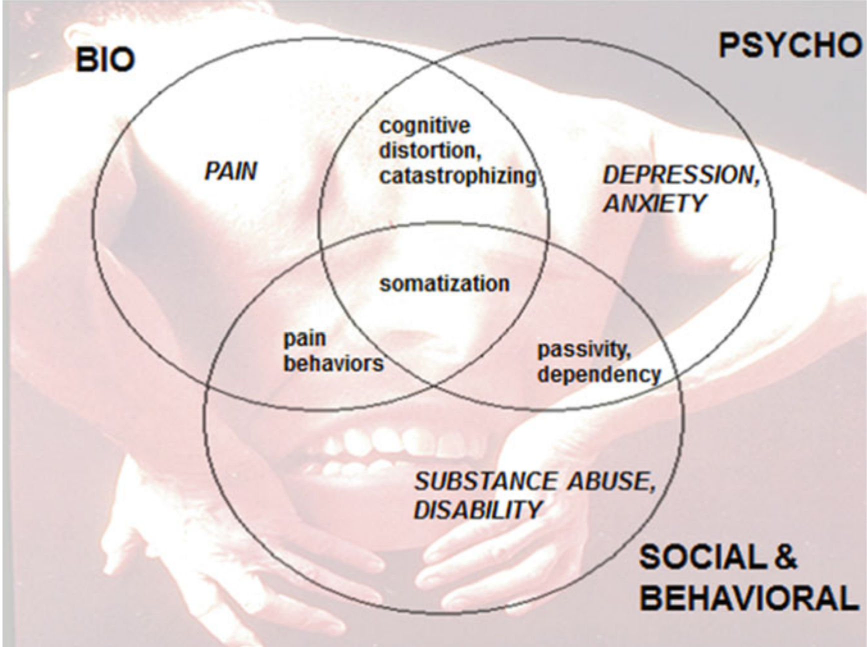

Fig. 20.1 The biopsychosocial model of pain

amputation site may continue to send pain signals to the brain as if the limb itself were still present. There is not a one-to-one correlation of tissue damage to pain.

Another example of the shortcomings of a purely biomedical approach exists in comparing pain experiences across different individuals. Patients who suffer a similar injury do not perceive the pain in an identical fashion. There is a wide range of pain tolerances and pain-related behaviors, and even the same individual may describe a different pain experience for an identical injury at different points in time. An example would be a young children scraping their knee and crying from the pain. When these same individuals scrape their knee as an adult, they might face the injury without tears or the solace seeking from a caregiver. Despite the exact same amount of direct tissue damage to the knee, this individual's reaction to, and perception of, pain are different.

The biopsychosocial model of pain and disability is regarded as the most heuristic approach to conceptualizing chronic pain problems (Turk & Monarch, 2002). According to this framework, there are multiple domains that cause, influence, and contribute to the overall pain experience. Pain may be described as a "complex phenomenon with inputs from biological nociceptive and hypothalamic-pituitary-adrenal axis activity, as well as psychosocial and socioeconomic factors such as emotional disposition, cognition and attention, functional and subjective disability, and system-of-care issues." (Gatchel, McGeary, McGeary, & Lippe, 2014). As the name suggests, biological, psychological, and psychosocial elements of pain must all be taken into account and effectively addressed to achieve the most comprehensive form of pain management. A schematic of the biopsychosocial model and its application to chronic pain is provided in Fig. 20.1.

Given that there are multiple factors at play, it is not surprising that treatment in only one domain (e.g., opioid medications for the "biological" domain) may not consistently provide full relief for patients. Rather, an approach that incorporates professional interventions across the full range of potential factors is better suited to address the often complex experience of pain. It is from this perspective that interdisciplinary chronic pain management programs were developed. Consideration of traditional pain factors is still relevant, but previously neglected aspects of pain may be incorporated into treatment considerations.

Interdisciplinary Chronic Pain Management

Program Framework

The primary components for interdisciplinary care include a common philosophy of rehabilitation shared by providers, coordinated communication among on-site healthcare professionals, integration of services between providers, and active patient involvement in the program. Collett, Cordle, and Stewart (2000) highlight the importance of having the team of providers working together in a common location in order to facilitate communication and collaboration. Most important is the integration of healthcare professionals from sufficiently diverse disciplines to cover each aspect of the biopsychosocial model of pain. It should be noted that there has been some confusion in the literature regarding the distinction between "interdisciplinary" and "multidisciplinary" pain management. Multidisciplinary approaches feature the involvement of several healthcare providers, but there is no communication or collaboration between providers within multidisciplinary treatment, and they are unlikely to be located in the same facility. Even when they are co-located, there remains a disconnected perception of patient goals and treatment directions. By contrast, interdisciplinary care requires frequent communication between healthcare providers and highlights the importance of having them all work at the same location. The International Association for the Study of Pain (IASP) developed a task force to help establish a uniform guideline for interdisciplinary pain centers (Loeser, Boureay, & Brooks, 1990).

The model of interdisciplinary pain management described in this chapter should be considered a general guide, which may be tailored to fit the individual demands of a particular clinic. There are essential features of interdisciplinary care, with room for some flexibility in the form and function of the programs. Some components of interdisciplinary care are essential. For instance, the healthcare professionals on the treatment team must include one or more physicians, a clinical psychologist, and a physical therapist. Nurses, vocational specialists, occupational therapists, and other healthcare providers are determined by the particular needs of pain populations served by a center, and other support personnel may be included as well. Support personnel may include outcome database managers, nutritionists, chaplain services, and case managers (Noe & Williams, 2012). This collective group of healthcare providers, housed in one location and working collaboratively with a common philosophy of patient rehabilitation, provides the nucleus of the interdisciplinary approach to pain management.

It is important that the support personnel communicate their roles or interventions, as well as a patient's response or performance, to the rest of the interdisciplinary team. For example, patients may interact with nutritional specialists in order to evaluate and establish a proper nutritional regimen that should be communicated to the other interdisciplinary providers. A vocational rehabilitation counselor should provide the patient's identified occupational challenges, progress, and areas of limitations or strengths. Chaplain services may highlight the role of spiritual and religious beliefs or practices that are relevant to the patient's pain condition. There are clear implications here for patients with belief systems that are not fully compatible with effective interdisciplinary care. Take, for example, a patient who was referred to an interdisciplinary program but believes that meditation alone should be sufficient to eliminate the pain problem. This person is less likely to fully adhere to all of the interdisciplinary program's components, and the chaplain service can be useful in helping other providers consider the impact of the person's spiritual beliefs on their current treatment.

In terms of other support staff, database managers can provide information regarding health and functional outcomes of the interdisciplinary program participants. These data uncover trends within a particular clinic's interdisciplinary program and inform clinic directors about areas that need to be improved. Clinical data collection provides the evidence of positive outcomes. Tracking patient progress, reporting these data to the interdisciplinary team, and contributing to the literature on treatment efficacy will empirically strengthen evidence-based care and document

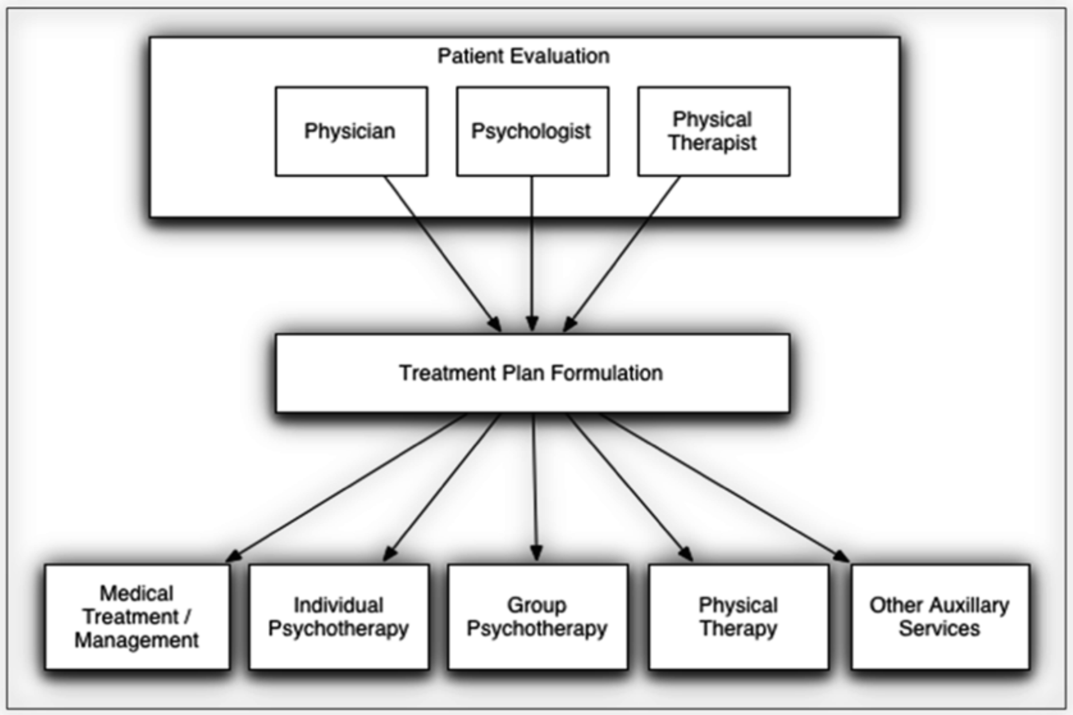

Fig. 20.2 Outline of interdisciplinary pain management program

the clinical effectiveness of the particular treatment facility. Occupational therapists are yet another provider type that may be included in the interdisciplinary program. These therapists serve the function of evaluating and treating patient concerns in the area of independent activities of daily living. As a discipline related to physiotherapy, these therapists convey important functional disability data, which is useful to the physical therapist (as well as the other treatment-team providers). Additionally, they implement the task-related treatment of upper extremity disorders.

As shown in Fig. 20.2, each type of provider plays a unique but interrelated role in the interdisciplinary team. Physicians provide the core evaluative and diagnostic formulation of the particular pathophysiological mechanisms of pain, just as they do in their more traditional role in pain management. Additionally, they are responsible for medication management of the patient. This sometimes, but not always, includes narcotic treatment considerations. Physicians constitute the most familiar form of pain treatment (i.e., biomedical interventions) and typically represent the primary referral source, as well as entry point, into interdisciplinary chronic pain management programs. While physicians within interdisciplinary pain management clinics may also specialize in biomedical interventions for pain management, they must promote the conceptualization of patient pain experience and treatment using the biopsychosocial model.

Clinical psychologists are adept at exploring how psychosocial factors influence the exacerbation and maintenance of chronic pain. They perform this function by means of diagnostic interviews and testing prior to interdisciplinary treatment. It is critical to assess previous and current functional abilities and limitations so as to determine the overall impact of chronic pain on the patient’s life. Occupational limitations are particularly relevant: Does the pain limit the patient’s ability to perform the physical functions of his or her job position? Has the depression associated with chronic pain affected motivation, attendance, and productivity at work? These are some of the types of questions that a psychologist consider when conducting their comprehensive evaluations.

Another function of psychologists in the interdisciplinary approach is to provide therapy. There are a broad range of therapeutic interventions and orientations, but cognitive-behavioral therapy strategies have been found to be the most efficacious in confronting the myriad of problems experienced by chronic pain patients (Gatchel & Turk, 1999). In particular, multimodal cognitive-behavioral methods of pain management have been demonstrated to be effective in helping to manage chronic pain. This includes such things as relaxation training, biofeedback, stress management, and positively enforced coping skills.

The physical therapist is crucial in conducting the pretreatment evaluation of physical functioning. This typically includes assessment of gross motor skills, coordination, range of motion, and muscle strength. Proper pretreatment evaluation of a patient's physical functioning helps to inform treatment goals and establish a baseline of functional ability. Additionally, it provides the physical therapist with an opportunity to provide some initial information to the patient regarding the interconnected nature of physical functioning and pain-related disability. In the context of workplace disability, physical therapists can help the patient address pain-related physical limitations in work-site performance. The overall physical therapy goals are to help guide the physical rehabilitation and to encourage patients to reassert control over their physical abilities and handle pain in a more effective manner.

Finally, within interdisciplinary rehabilitation, patients themselves have an important role by investing time and energy in active participation in their therapy, as a part of the treatment team. Decision making is collaborative, and patients are encouraged to actively participate in each treatment modality, communicate openly with treatment providers, and mutually support other patients in the interdisciplinary program within group therapy. Patients are encouraged to communicate their treatment goals to the various providers on the team, which facilitates discussion and formulation of an individualized plan within which some disciplines may be utilized more than others. For example, if a patient demonstrates a minimal need for nutritional consultation, this component may be altered or eliminated, although other program participants may choose nutritional intervention as part of their treatment plan.

Interdisciplinary Program Structure

Prior to admission, interdisciplinary pain program patients must go through a pretreatment screening process. The patient will initially meet with a staff physician, who will evaluate the patient's presenting pain complaints. Additional assessments by a psychologist and physical therapist may be recommended to determine appropriateness for program inclusion. It is important to assess all relevant biopsychosocial factors that may be relevant to the patient's clinical presentation. Formal assessment instruments may include the Minnesota Multiphasic Personality Inventory II, the Beck Depression Inventory II, the Pain Disability Questionnaire, the Roland-Morris Disability Questionnaire, and the Oswestry Disability Index. Appropriate evaluation facilitates a more systematic conceptualization of factors that need to be addressed in therapy and ensures success in overcoming specific patient barriers to functional recovery.

An individualized treatment plan that considers the individual needs of the patient is derived from the intake assessment, and it includes the specific goals identified by the patient. If vocational abilities are disrupted, for example, functional restoration may be the interdisciplinary treatment of choice. Any significant barriers to treatment, within the context of the biopsychosocial model, should be identified, and methods for managing these issues incorporated into the treatment plan (Gatchel et al., 2002). Physicians, psychologists, and physical therapists each have a role in identifying and evaluating potential barriers and then communicating them to other members of the interdisciplinary team. Vocational counselors must assess return-to-work barriers. Most injured workers who present for interdisciplinary rehabilitation are temporarily or totally disabled from work. Those who are still working, but having difficulty performing their job tasks, may be required to request time off from work in order to complete the interdisciplinary program.

Not all patients may be good candidates for an ID program. Exclusionary criteria may include severe mobility problems, psychotic disorders that have not been stabilized, or the patient's unwillingness to commit to the requirements of the program. In some cases, other treatment modalities may be indicated to address the specific treatment needs of the patient. If an interdisciplinary program is recommended, the patient is presented with a proposed program-start date. Some clinics offer "rolling" start dates, while others prefer to have specifically circumscribed start and end dates, with a consistent program cohort across the duration of the program. Most interdisciplinary programs last a minimum of 4 weeks. Sanders, Harden, and Vicente (2005) suggest a time-limited model that is capped at 20 session days. Once the program begins, research data collection may continue during the program, as well as for a period of time after it has been completed.

Central to most interdisciplinary programs are physician visits, individual cognitive-behavioral therapy, group therapy, and physical therapy. Physician visits focus on medical evaluation, monitoring, medication management, and medically based pain-relieving procedures, such as injections (e.g., lumbar epidural steroid injections), spinal cord stimulation, radiofrequency ablation, and transcutaneous electrical nerve stimulation (Harrington, Dopf, & Chalgren, 2001). Pain-relieving transdermal patches, as well as topical solutions like pain relief creams, may also be prescribed. Medication management may include opiates, anticonvulsants (Jensen, 2012), and antidepressants. There is a high comorbidity of chronic pain with psychiatric disorders, particularly depression. If there is a staff psychiatrist, he/she will offer psychiatric evaluation and psychotropic medication prescriptions to interdisciplinary program patients. Of course, the availability of these interventions varies by clinic and physician specialty and training.

At the conclusion of the interdisciplinary program, the patient's final scheduled appointment is with the staff physician. This is a "checkout" to review progress achieved, answer remaining patient questions, and establish a plan for follow-up. If the patient has not attended sufficient sessions to complete the program, the patient and physician will meet to discuss the problems that led to limited compliance. A new plan might then be formulated to include alternative treatment options or program completion. Otherwise, the patient may be discharged as "noncompliant."

Returning to the program itself, in addition to physician visits, patients are also scheduled to participate in individual cognitive-behavioral therapy, provided by the program psychologist, at regular intervals during the program. While not every patient in an interdisciplinary program necessarily has a comorbid psychiatric "disorder," the interplay between a patient's chronic pain and psychosocial functioning is critical to recognize and address, using cognitive-behavioral therapy and/or medication. The pretreatment psychosocial evaluation will help to inform individual treatment goals. Psychosocial distress (with particular emphasis on the impact of the patient's pain) will be discussed between the patient and therapist in order to collaboratively establish goals and expectations for treatment. Psychologists must be mindful of the time-limited model of interdisciplinary programs and subsequently confirm that the proposed goals can be accomplished within the established time frame, or whether treatment may be continued with the same psychologist following the conclusion of the program. Again, a cognitive-behavioral treatment (CBT) approach is most effective, and the goals that are established should be consistent with the overall philosophy of interdisciplinary treatment.

Typically, CBT sessions last between 50 min and 1 h, adjusted to fit the needs of the patient and to accommodate the daily schedule of the program. Some programs include daily individual CBT sessions, while others limit them to one to two times per week. Most interdisciplinary programs contain between 10 and 16 total individual sessions (Gatchel & Turk, 1999). Although the timing and structure may demonstrate some variation, the essential components of CBT interventions are to encourage patients to develop better coping strategies in dealing with chronic pain (McCracken & Turk, 2002). Relaxation training, guided imagery, diaphragmatic breathing techniques, and biofeedback are used to help the patient cope with pain-related processes more effectively. CBT helps the patient to identify problematic thinking patterns such as catastrophizing that contribute to emotional distress or functional impairment.

Group therapy sessions are scheduled at least one to two times per week. Each group session is led by a clinician, usually a psychologist, and lasts between 1.5 and 2 h. The timing and duration depends on the particular clinic's established program schedule. Group therapy includes a psycho-educational component (i.e., informational material regarding cognitive, emotional, and behavioral aspects of the pain experience). An interactive "pain school" curriculum is also often used. The group leader educates participants about pain issues such as coping, pacing, and stress. The patients may be presented with material outlining and describing the biopsychosocial model to facilitate awareness of these factors. Using the didactic opportunities presented in group therapy, group members may then discuss the information with each other and with the group leader. Members of the group are encouraged to share personal experiences and apply them to the provided psycho-educational material. This serves to reinforce the educational lessons by personalizing the material and facilitating consideration of the impact of pain on each participant's own quality of life.

Group therapy also allows patients the opportunity to interact with others experiencing pain-related conditions. Appropriate feedback from group members can be a powerful tool in helping patients identify and address concerns about pain, function, treatment, and psychosocial issues, such as sex, childcare, or return to work. Mutual problem solving is facilitated by the group leader. Practical solutions elucidated during group therapy often provide participants with new ideas with which to address problems or open up discussion of previously unconsidered problems.

Within an interdisciplinary program, both group and individual therapy may facilitate other program-based treatments. For instance, patients may express notable fears about particular medical procedures recommended by the staff physician. By recognizing and exploring this fear in therapy, the patient's hesitation to participate in the recommended treatment can be addressed. Group therapy serves a similar purpose, in that other group members may offer practical and creative solutions that have been helpful for them. It offers a chance for group members to acknowledge their treatment-related concerns, as well as a forum for stress reduction and problem solving.

The fourth core component of interdisciplinary pain programs is physiotherapy. To clarify, the term "physiotherapy" may be used synonymously with physical therapy. On average, interdisciplinary programs allot 6–12 sessions of physiotherapy across the duration of the program. Pretreatment evaluation by the physiotherapist provides the rationale for the selection of specific goals and interventions consistent with the needs of the individual patient (Sanders et al., 2005). Following surgery for carpal tunnel syndrome, for example, a patient is not likely to require knee strengthening, but the athlete with the torn anterior cruciate ligament does. Physical therapists communicate with the provider team and develop goals consistent with the shared philosophy of patient rehabilitation. If return to work is a primary goal, the physiotherapist will obtain a detailed job description from the vocational specialist and then construct a regimen for the patient that facilitates regaining the physical capacity to perform those job tasks. A systematic review by George (2008) concluded that the literature strongly supports the use of biopsychosocial approaches applied by physiotherapists.

In physiotherapy sessions, the emphasis is on general reconditioning, range-of-motion exercises, and targeted muscle strengthening. Some "passive" interventions are used, such as hot packs or joint manipulation. Other techniques involve more exertion on the part of the patient. Supervised progressive weight training uses weight machines or free weights. A patient may be taught range-of-motion exercises that are to be practiced at home in between program sessions (Timm, 1994). In a recent randomized controlled trial, Chao et al. (2011) found that both active physiotherapy and passive physiotherapy (including biofeedback) resulted in improvements in work-related neck and shoulder pain. Physiotherapy clearly plays a fundamental role in the interdisciplinary approach to chronic pain management and has proven to be particularly useful when addressing occupational pain-related concerns.

Further Elements of Success

Direct and open communication between the treatment-team providers helps coordinate care in an efficient way. With clearly communicated treatment goals, physicians, clinical psychologists, and physical therapists all remain on the "same page," despite the differences inherent in their respective specialty training. The patient benefits from such communication by receiving a consistent message from all of the providers. There is less likelihood of presenting contrasting or contradictory information to the patient (Dagenais & Haldeman, 2011). This serves to reduce any confusion, and it improves treatment compliance. The timing for introducing specific components of the intervention will be optimized as a result of appropriate communication across providers. A special emphasis is placed on the patient as an active participant in interdisciplinary program treatment. Communication between patient and providers also bolsters a patient's health literacy. With clear understanding of provider expectations, the purpose of a prescribed medication regimen, and the importance of full program participation, patients obtain an improved ability to successfully complete treatment goals.

The process for conducting these provider communications varies from site to site. The most common vehicle is regularly scheduled staff meetings, at which all team members (physician, clinical psychologist, physical therapist, etc.) are present. Similar to hospital rounding teams, these meetings allow for face-to-face communication from multiple providers about each patient. Meeting rooms are optimally set up in a manner that facilitates open communication among providers, as opposed to a didactically oriented room arrangement. Examples of poorly designed meeting spaces for the purposes of interdisciplinary treatment are rooms with all chairs facing a podium or presentation screen at the front of the room. Although primed for presenting information from one speaker to the larger group, this type of room setup constricts the abilities of various providers to communicate as easily as if they were able to face each other. A better setup is one in which the team sits in a circle, which facilitates face-to-face communication.

For most clinics, it makes the most sense to identify and select a regularly scheduled meeting time for each day. Examples may include a set time prior to the first patient(s) of the day or perhaps a lunchtime meeting for particularly busy clinics. It would not be advisable to select a meeting time in which one discipline could not regularly attend, because the interactive component of the meeting would be lost. Providers across domains benefit from both providing and receiving information from their colleagues about the full gamut of patient care issues. Occasional missed meetings, although at times unavoidable, should be strictly limited. What the providers communicate to each other includes treatment goals and progress toward those goals, the different conceptualizations of the patient by the different disciplines on the team, and problem areas that may arise during the course of treatment. Ongoing data collection can serve as a roadmap to document patient progress or lack thereof.

Conceptualization of the patient influences treatment formulation. Many physicians place a greater emphasis on biological insult or injury than do clinical psychologists. Psychologists, due to the nature of their training, are more likely to focus on the impact of cognitions and psychosocial factors on the patient's pain experiences. Physiotherapists may be biomechanical in their orientation, but many are aware of the impact of psychosocial factors on the presentation of their patients. Vocational specialists may introduce behavioral determinants, such as secondary and tertiary gain, into the formulation of a biopsychosocial perspective toward understanding all aspects of the patient's presentation. The common denominator in all of this is patient wellness, which requires that providers incorporate the various biopsychosocial domains into a collaborative clinical practice. If the patient's pain involves intense fear and resulting avoidant behavior, treatment of psychosocial factors should be prominently featured. Alternatively, when physical rehabilitation requirements are paramount, physical therapy becomes the core consideration when implementing and monitoring a treatment plan. Improved patient conceptualization is achieved through collaborative efforts to recognize the factors that lead to maintain, exacerbate, and remedy a patient's pain.

Challenges in the Implementation of an Interdisciplinary Program Approach

Despite the clear evidence of cost- and treatment effectiveness, there have been challenges in the more widespread implementation of the interdisciplinary approach to chronic pain management. At present, there is a lack of availability of such programs. When workers are injured or develop chronic pain problems, informed treatment decisions depend on understanding the treatment resources available. In some cases, patients must travel long distances in order to participate in an appropriate interdisciplinary program. These problems may result from structural variations within interdisciplinary programs, causing inconsistencies in how the programs are implemented. Recent media focus on pain clinics has portrayed them as narcotic-medication distribution center, or expensive "shooting galleries" in which the emphasis is on interventional procedures. It is critical to differentiate interdisciplinary programs from this stereotype, so as to facilitate a more accurate public perception of this empirically effective model of pain management. While structural variations within the framework of programs are acceptable, programs that only vaguely mirror "true" interdisciplinary care are not. The inconsistencies in interdisciplinary program implementation are reflected in variable treatment outcomes in the literature (Thurnberg & Hallberg, 2002). The differences in question include inadequately defined clinical procedures, poor communication across providers, and an unclear sense of a common clinical philosophy of treatment. The biopsychosocial model as a guiding philosophy of patient conceptualization enables providers across treatment domains to share a common basis for the formulation of patient treatment goals. They can then communicate more effectively with their provider colleagues. Without the biopsychosocial model in place, competing conceptualizations contributed to relatively poor treatment outcomes.

Another challenge in the implementation of interdisciplinary programs is due to terminological differences in the literature. Historically, the distinction between multidisciplinary approaches and interdisciplinary approaches has been poorly defined. Although some programs were advertised as providing interdisciplinary care, the actual application of the program more closely resembled multidisciplinary care. Again, the primary distinction between these terms is that the interdisciplinary approach features a common philosophy of patient treatment, co-located providers engaged in coordinated communication, and integrated services across healthcare providers. The IASP guideline for interdisciplinary pain programs has helped to shed light and unify operational definitions (Loeser et al., 1990).

Implementation of interdisciplinary programs has also been stunted by disinclination of some third-party payers to cover such comprehensive treatment. This is unfortunate because such programs have been demonstrated to be cost-effective across the literature (e.g., Turk & Swanson, 2007), particularly over time. When healthcare costs are compared over time between interdisciplinary programs versus standard (i.e., unidimensional) care, interdisciplinary programs emerge as clearly superior (Cunningham, Rome, Kerkvliet, & Townsend, 2009). Still, many third-party insurance payers balk at the upfront costs and identify their cost-containment strategies as barriers to their willingness to compensate for these programs. There exists a lack of recognition by third-party payers of the long-term cost savings of interdisciplinary programs. Also, some managed-care companies have instituted policies of piecemeal care in which patients must fragment the comprehensive care offered by interdisciplinary programs by having to select aspects of treatment to be received from other contracted providers. This serves to disrupt the core elements of the interdisciplinary program and to dilute the proven treatment benefits of this interdisciplinary approach (Robbins et al., 2003).

The net effect of these challenges to program implementation has been to limit the proliferation of a clearly established method of treating chronic pain. Employers naturally want their injured or ill workers to functionally improve so that work or performance losses are minimized. Despite the challenges inherent in establishing and maintaining interdisciplinary programs in the current managed-health environment, the empirical literature regarding both the treatment and cost-effectiveness of these programs continues to build. It is hoped that this will contribute to an emergence of interdisciplinary pain management programs.

Role of Interdisciplinary Programs in Workplace/Disability

Interdisciplinary chronic pain management programs can play a valuable role in addressing workplace and disability concerns (Norlund, Ropponen, & Alexanderson, 2009). Keeping in mind the underlying model behind the interdisciplinary approach, the consequences of chronic pain in the workplace are known to be extensive and far-reaching across biopsychosocial domains. Lost wages, lost production, disability payments, decreased performance, and low morale represent just some of the potential impacts of chronic pain in the workplace. Interpersonal concerns may arise as job responsibilities shift from the employee with chronic pain to other coworkers. Anger, frustration, and feelings of guilt regarding decreases or limitations in work performance are common. Pain-related distraction and loss of focus are also frequently cited problems at work for chronic pain sufferers, particularly in job positions requiring repetitive use of vulnerable anatomical areas, such as the wrists, elbows, and spine.

Stanos and Houle (2006) highlight the concepts of *secondary loss* and *secondary gain*. Examples of secondary loss include the social stigma of being disabled, economic loss, reductions in social support, guilt over disability, and diminished interpersonal relationships at work. Secondary gain may involve internal gain (e.g., ability to withdraw from unpleasant commitments or life roles), external gain (e.g., disability-based financial reward), and even tertiary gain [such as family or professional caretaker benefits (e.g., social sympathy/respect for ongoing caretaking duties)]. Many of these considerations may be particularly relevant for patients currently receiving or seeking disability payments.

Despite all of the complex and interrelated challenges of chronic pain sufferers whose conditions limit or exclude them from being able to work, there exist empirically based treatments available to them. Of particular relevance in this area are *functional restoration* programs.

Functional restoration programs, a type of interdisciplinary approach, have emerged as empirically supported methods of socio-professional reintegration into the work environment (Poulain et al., 2010). This type of program was originally developed by Mayer and Gatchel (1988) and focused specifically on chronic occupationally induced chronic back pain and disability. They focus on functional, psychological, social, and professional rehabilitation. As such, they are uniquely suited to address the myriad of needs faced by the chronic pain sufferer hoping to return to work or recently returned to the workplace on modified duty. Similar to other interdisciplinary programs, *functional restoration* programs rely on a biopsychosocial conceptualization of the patient's pain and disability experience. In addition, *functional restoration* programs feature interventions specifically aimed at helping the patient identify and address pain-related obstacles to occupational functionality.

There have been a number of studies evaluating health- and work-related outcomes for chronic pain sufferers following *functional restoration* programs. For example, Mayer, Gatchel, Polatin, and Evans (1999) explored the relationship between a functional restoration program and socioeconomic outcomes for patients with chronic disabling work-related upper extremity disorders. They discovered that the program was associated with improved health and socioeconomic outcomes across neuropathic and non-neuropathic subgroups. Health and socioeconomic outcomes following the functional restoration program for upper extremity disorders mirrored the previously documented successful outcomes of functional restoration for spinal disorders (Gatchel & Okifuji, 2006). Research has indicated that, compared with standard treatment, *functional restoration* programs improved pain-related disability and health-related quality of life (Huge et al., 2006). In a randomized controlled trial, Jousett et al. (2004) found that the mean number of sick-leave days was significantly reduced following a *functional restoration* program, as compared with a physical therapy program alone. Additionally, Roche-Leboucher et al. (2011) revealed that at 1 year following participation in a *functional restoration* program, patients reported less intense pain, improved flexibility, improved work and leisure functioning, and a reduced number of sick-leave days. Overall, the evidence-based outcomes research in the scientific literature strongly supports the use of functional restoration programs.

A clinical example is a patient with reflex sympathetic dystrophy, who experiences edema around the right upper extremity, as well as marked stiffness of both proximal and distal joints. Any process which requires heavy lifting or reaching for an overhead object is extremely painful. This functional disability makes it impossible for this patient to participate in required occupational activities, which involve shipping and receiving of electronics equipment. As a result of this limitation, the patient has become increasingly depressed over time and no longer has confidence in being able to physically do any aspect of the job. The patient's primary care physician refers this individual to an interdisciplinary program, whose multi-domain approach supports immediate relief of acute pain, rehabilitation of physical functioning via physiotherapy, and treatment of depression and dysfunctional pain-related coping. The confluence of treatments is eventually successful in returning this patient to work and enhancing the patient's quality of life.

Conclusions

Chronic musculoskeletal pain represents a significant and costly problem, at both a societal and an individual level. Utilizing the biopsychosocial model to conceptualize the domains affected by chronic pain, the interdisciplinary approach to its management has emerged as the "gold standard" in terms of both treatment and cost-effectiveness (Gatchel & Okifuji, 2006). The essential ingredients include a common philosophy of rehabilitation shared by providers, coordinated daily communication among on-site healthcare professionals, integration of services across providers, and active patient involvement in the interdisciplinary program. Each treatment-team member, including physicians, psychologists, physiotherapists, and other supportive personnel, shares a unique and vital role in the collaborative intervention process. Despite challenges in establishing and maintaining interdisciplinary chronic pain management programs, these programs greatly enhance the treatment effectiveness for patients suffering from chronic pain and address a wide range of workplace disability concerns. Functional restoration programs have especially demonstrated effectiveness with occupationally injured musculoskeletal pain patients and highlight the need for specific interventions aimed at addressing occupational challenges for the chronic pain sufferer. Taken collectively, the key elements of success for the interdisciplinary approach contribute to treatment practices that are cost-effective in managing a wide range of chronic pain conditions, including those conditions caused by, or interfering with, workplace functioning.

References

Brady, W., Bass, J., Moser, R., Jr., Anstadt, G. W., Loeppke, R. R., & Leopold, R. (1997). Defining total corporate health and safety costs significance and impact: Review and recommendations. *Journal of Occupational and Environmental Medicine, 39*(3), 224.

Chao, M., Szeto, G. P., Yan, T., Wu, S., Lin, C., & Li, L. (2011). Comparing biofeedback with active exercise and passive treatment for the management of work-related neck and shoulder pain: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation, 92*, 849–858.

Collett, B. J., Cordle, C., & Stewart, C. (2000). Setting up a multidisciplinary clinic. *Baillière's Clinical Obstetrics and Gynaecology, 14*, 541–556.

Cunningham, J., Rome, J. D., Kerkvliet, J. L., & Townsend, C. O. (2009). Reduction in medication costs for patients with chronic nonmalignant pain completing a pain rehabilitation program: A prospective analysis of admission, discharge, and 6-month follow-up medication costs. *Pain Medicine, 10*, 787–796.

Dagenais, S., & Haldeman, S. (2011). *Evidence-based management of low back pain*. St. Louis, MO: Mosby.

Gatchel, R. J., & Mayer, T. G. (2000). Occupational musculoskeletal disorders: Introduction and overview of the problem. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders: Function, outcomes and evidence*. Philadelphia: Lippincott Williams & Wilkins.

Gatchel, R. J., & Mayer, T. G. (2008). Evidence-based review of the effectiveness of functional restoration for the management of chronic low back pain. *The Spine Journal, 8*, 65–69.

Gatchel, R. J., McGeary, D. D., McGeary, C. A., & Lippe, B. (2014). Interdisciplinary chronic pain management: Past, present, and future. *American Psychologist, 69*(2), 83–88.

Gatchel, R. J., Noe, C. E., Pulliam, C., Robbins, H., Deschner, M., Gajraj, N. M., et al. (2002). A preliminary study of multidimensional pain inventory profile differences in predicting treatment outcome in a heterogeneous cohort of patients with chronic pain. *Clinical Journal of Pain, 18*(3), 139–143.

Gatchel, R. J., & Okifuji, A. (2006). Evidence-based scientific data documenting the treatment and cost-effectiveness of comprehensive pain programs for chronic nonmalignant pain (Peer Reviewed Journal). *The Journal of Pain, 7*(11), 779–793. doi: http://dx.doi.org/10.1016/j.jpain.2006.08.005.

Gatchel, R. J., Peng, Y., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin, 133*, 581–624.

Gatchel, R. J., & Turk, D. C. (1999). Interdisciplinary treatment of chronic pain patients. In R. J. Gatchel & D. C. Turk (Eds.), *Psychosocial factors in pain* (pp. 435–444). New York: The Guilford Press.

George, S. I. (2008). What is the effectiveness of a biopsychosocial approach to individual physiotherapy care for chronic low back pain? *The Internet Journal of Allied Health Sciences and Practice, 6*(1), 1–10.

Harrington, J. T., Dopf, C. A., & Chalgren, C. S. (2001). Implementing guidelines for interdisciplinary care of low back pain: A critical role for pre-appointment management of specialty referrals. *The Joint Commission Journal on Quality Improvement, 27*(12), 651–663.

Huge, V., Schloderer, U., Steinberger, M., Wuenschmann, B., Schöps, P., Beyer, A., et al. (2006). Impact of a functional restoration program on pain and health related quality of life in patients with chronic low back pain. *Pain Medicine, 7*(6), 501–508.

Jensen, T. S. (2012). Anticonvulsants in neuropathic pain: Rationale and clinical evidence. *European Journal of Pain, 6*(Suppl. A), 61–68.

Jousett, N., Fanello, S., Bontoux, L., Dubus, V., Billabert, C., Vielle, B., et al. (2004). Effects of functional restoration versus 3 hours per week physical therapy: A randomized controlled study. *Spine, 29*(5), 487–494.

Loeser, J. D., Boureay, F., & Brooks, P. (1990). *Desirable characteristics for pain treatment facilities*. Seattle, WA: International Association for the Study of Pain (IASP).

Mayer, T. G., & Gatchel, R. J. (1988). *Functional restoration for spinal disorders: The sports medicine approach*. Philadelphia: Lea & Febiger.

Mayer, T. G., Gatchel, R. J., Polatin, P. B., & Evans, T. H. (1999). Outcomes comparison of treatment for chronic disabling work-related upper-extremity disorders and spinal disorders. *Journal of Occupational and Environmental Medicine, 41*(9), 761–770.

McCracken, L. M., & Turk, D. C. (2002). Behavioral and cognitive-behavioral treatment for chronic pain: Outcome, predictors of outcome, and treatment. *Spine, 27*(22), 2564–2573.

Melhorn, J. M. (2003). Work-related musculoskeletal back pain: The many facets. *The Spine Journal, 3*(6), 411–416.

Noe, C., & Williams, C. F. (2012). The benefits of interdisciplinary pain management. *The Journal of Family Practice, 61*(4), S12–S16.

Norlund, A., Ropponen, A., & Alexanderson, K. (2009). Multidisciplinary interventions: Review of studies of return to work after rehabilitation for low back pain. *Journal of Rehabilitation Medicine, 41*(3), 115–121.

Oslund, S., Robinson, R. C., Clark, T. C., Garofalo, J. P., Behnk, P., Walker, B., et al. (2009). Long-term effectiveness of a comprehensive pain management program: Strengthening the case for interdisciplinary care. *Proceedings (Baylor University Medical Center), 22*(3), 211–214.

Poulain, C., Kernéis, S., Rozenberg, S., Fautrel, B., Bourgeois, P., & Foltz, V. (2010). Long-term return to work after a functional restoration program for chronic low-back pain patients: A prospective study. *European Spine Journal, 19*(7), 1153–1161.

Robbins, H., Gatchel, R. J., Noe, C., Gajraj, N., Polatin, P. B., Deschner, M., et al. (2003). A prospective one-year outcome study of interdisciplinary chronic pain management: Compromising its efficacy by managed care policies. *Anesthesia and Analgesia, 97*, 156–162.

Roche-Leboucher, G., Petit-Lemanac'h, A., Bontoux, L., Dubus-Bausière, V., Parot-Shinkel, E., Fanello, S., et al. (2011). Multidisciplinary intensive functional restoration versus outpatient active physiotherapy in chronic low back pain: A randomized controlled trial. *Spine, 36*(26), 2235–2242.

Sanders, S. H., Harden, R. N., & Vicente, P. J. (2005). Evidence-based clinical practice guidelines for interdisciplinary rehabilitation of chronic nonmalignant pain syndrome patients. *Pain Practice, 5*(4), 303–315.

Stanos, S., & Houle, T. T. (2006). Multidisciplinary and interdisciplinary management of chronic pain. *Physical Medicine and Rehabilitation Clinics of North America, 17*(2), 435–450.

Thurnberg, K. A., & Hallberg, L. R. M. (2002). The need for organizational development in pain clinics: A case study. *Disability and Rehabilitation, 24*, 755–762.

Timm, K. E. (1994). A randomized-control study of active and passive treatments for chronic low back pain following L5 laminectomy. *The Journal of Orthopaedic and Sports Physical Therapy, 20*(6), 276–286.

Turk, D. C., & Monarch, E. S. (2002). Biopsychosocial perspective on chronic pain. In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed.). New York: The Guilford Press.

Turk, D. C., & Swanson, K. (2007). Efficacy and cost-effectiveness treatment of chronic pain: An analysis and evidence-based synthesis. In M. E. Schatman & A. Campbell (Eds.), *Chronic pain management: Guidelines for multidisciplinary program development*. New York: Informa Healthcare.

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Early Intervention to Prevent the Development of Chronic Musculoskeletal Pain Disorders and Disability

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Overview

As highlighted in the first chapter of this handbook, musculoskeletal disorders are the single largest category of work-related illnesses in industrialized countries today. Moreover, the recent and highly influential Institute of Medicine Report, "Relieving Pain in America," has emphasized the urgent need for better methods of pain management because the ever-increasing costs associated with current treatment approaches are unsustainable. The report also highlighted musculoskeletal pain as the most common single type of chronic pain; within this category, chronic low back pain is the most prevalent. Supporting these high prevalence findings, chronic lower back pain (LBP), followed by temporomandibular joint and muscle disorders (TMJMD), ranks as the most frequently occurring musculoskeletal conditions that result in disability and pain (National Institute of Dental and Craniofacial Research, 2008). The critical nature of occupational musculoskeletal disorders was also earlier highlighted by the fact that, in 1998, the *National Institutes of Health* requested the National Academy of Sciences/National Research Council to convene a panel of experts to carefully evaluate some of the questions raised by the US Congress concerning occupational musculoskeletal disorders (National Research Council, 2001). One important issue was: "Does the research literature reveal any specific guidelines to prevent the development of chronic conditions?"

Preventing costly chronic pain conditions through early intervention is further evidenced by epidemiological studies; here, musculoskeletal disorders, such as low back pain, are reinforced as serious problems that result in immeasurable emotional suffering, work loss, and high economic cost (e.g., Crombie, Croft, Linton, LeResche, & Von Korff, 1999; Garofalo, Gatchel, Kishino, & Strizak, 2005). A continued call for early intervention methods to prevent acute and subacute musculoskeletal disorders, such as low back pain, from becoming chronic pain and disability problems exists (Garofalo et al., 2005; Linton, 2002b). As noted by Garofalo et al. (2005),

> There are benefits and disadvantages in the various earlier predictive models that have empirically examined risk factors to disability. Accurate and convincing risk assessments may motivate acutely

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> and subacutely injured patients to participate in risk management and prevention programs (Krause, Frank, Dasinger, Sullivan, & Sinclair, 2001; Linton & Hallden, 1998; Mondloch, Cole, & Frank, 2001). Evaluation of risk is intended to promote aggressive intervention on those at greatest risk, and is a necessary condition for major intervention. It is likely that many of these same variables affect life quality and this has fueled the growing investigation to identify potential patient characteristics and other variables that contribute to increased vulnerability to disability and to overall quality of life in patients with back pain. While research has begun to catch up with these trends, early interventions remain an understudies approach and the investigation of their efficacy is important in several aspects of public health. The predictive models of disabling chronic LBP developed in the past have generally justified their development as representing the blueprints for an aggressive intervention tailored to the salient factors of the model. (Frymoyer, 1992, p. 490)

In this chapter, a series of studies showing significant promise in the early identification of patients at greater risk for developing chronic pain and disability will be reviewed, followed by relevant early intervention approaches. Two major forms of musculoskeletal disorders will be addressed: low back pain and TMJMD.

Low Back Pain

The economic burden of LBP is quite large and continues to grow in the USA. Estimations for the total healthcare costs for LBP, combining direct and indirect costs, amount to about $100 billion annually (Katz, 2006). Parsing this further, general acceptance exists for the "20/80 rule"; that is, 20 % of all cases of LBP (the chronic cases) account for 80 % of the total costs of LBP in general.

Luo, Pietrobon, Sun, Liu, and Hey (2003) reported that approximately 80 % of Americans will experience at least one back pain episode during their lifetimes and 15–20 % will report back pain at some time in a 1-year period. Nonspecific LBP, defined by the absence of anatomical source, serious pathology, or substantial neurological involvement, is the most common type (Dagenais, Tricco, & Haldeman, 2010). Estimates of nonspecific LBP range from 85 to 93–95 % (Australian Acute Musculoskeletal Pain Guidelines, 2003; Gozna, 2001; Hall & McIntosh, 2008). Not surprisingly, given these staggering data, the US federal government and National Institutes of Health now call for more cost-effective research addressing musculoskeletal disorders, including LBP (Lauer & Collins, 2010; Manchikanti, Falco, Boswell, & Hirsch, 2010; Sox, 2010).

Initial Studies on the Early Identification of "High-Risk" Acute Low Back Pain Patients

Most recently, Gatchel (2010b) provided an overview of studies conducted by his clinical research team identifying potential predictors of acute low back pain (ALBP) occurrences likely to develop into more chronic disability problems. These studies were all supported by research grants from the National Institutes of Health. In the first project, Gatchel, Polatin, and Mayer (1995) administered a comprehensive assessment battery of physical and psychosocial factors (i.e., a biopsychosocial evaluation) to a large cohort of 421 ALBP patients within 6 weeks of their initial occupational injury (no previous history of LBP). These patients were followed during the next year; at the end, a structured telephone interview was conducted, evaluating return-to-work status.

Logistic regression analyses were conducted to differentiate between patients who returned to work at 1-year and those who did not. The model generated correctly identified 90.7 % of the cases. Of note, no differences between the two groups on physician-rated severity of the initial injury or the physical demands of the patients' jobs. Rather, a "psychosocial disability factor" emerged, reflecting issues such as poor coping skills and symptom magnification tendencies. Subsequently, a receiver-operator characteristic (ROC) curve analysis, based on the probabilities estimated from the above logistic regression model developed for the cohort, was applied. A statistical algorithm was generated from this ROC analysis, identifying a cutoff point from a patient self-report assessment test. This short measure required less than 15 min to complete and could identify "high-risk" ALBP patients (i.e. patients who were prime candidates for early intervention in order to prevent chronicity). It was hypothesized that "low-risk" ALBP patients would not require any extra early intervention other than standard medical care.

As a natural extension of these above important findings, the second NIH-funded study in this series involved assessing and identifying a large cohort of 700 ALBP patients, individuals at "high risk" for developing chronicity (using the above reviewed algorithm) (Gatchel et al., 2003). Random assignment of this "high-risk" patient group to one of two groups occurred next: an early intervention or a nonintervention group (which simply received whatever standard care they would routinely receive). Patients identified as "low risk" also received any standard care usually received. During the next year, routine 3-month follow-up evaluations were then conducted to assess important long-term socioeconomic outcomes such as return-to-work, healthcare utilization rates, medication use rates, etc. Two major hypotheses were struck:

1. Early intervention at the acute stage would prevent the development of chronic disability. Again, as a replication of the previous grant project results, the nonintervention group was compared to a demographically matched cohort of initially assessed ALBP patients with an absence of the "high-risk" profile (i.e., the "low-risk" group).
2. The "high-risk," nonintervention group would demonstrate higher rates of chronic disability at 1-year relative to the "high-risk" intervention and the "low-risk" groups.

Under the study design, "high-risk" patients were randomly assigned to one of two groups: an early intervention group or a nonintervention group. The early intervention program used consisted of an abbreviated form of interdisciplinary functional restoration, which included physical therapy, occupational therapy, psychology, and case management. The program, guided by a supervising nurse-physician team, consisted of a maximum of the following: three physician evaluations, one physical therapy evaluation, nine active physical therapy sessions, nine biofeedback (BFB)/pain management sessions, nine group didactic sessions, nine case manager/occupational therapy sessions, and three interdisciplinary team conferences. This early intervention approach was based on multiple recommendations from leading field experts; they argued the critical importance of better identifying suitable patients at the acute phase in order to decrease the high cost of chronic musculoskeletal pain and disability (e.g. Hazard, 1995; Linton, 2002a; Linton & Bradley, 1996). Patients in the nonintervention group, in addition to those classified as "low risk," continued to receive their standard care routine.

Clearly, the study's results revealed a significant reduction in the prevalence of chronic pain and disability for "high-risk," early intervention group compared to the "high-risk," nonintervention group (Gatchel et al., 2003). Table 21.1 summarizes the outcome data that displayed significant differences among groups in the anticipated directions. As can be seen, the major hypotheses of this study were confirmed. The "high-risk" ALBP patients who received early intervention (the HR-I group) demonstrated significantly fewer indices of chronic pain disability on a wide range of work, healthcare utilization, medication use, and self-reported pain variables. Additionally, this group was much more likely to return to work (odds ratio = 4.55), less likely to be currently taking narcotic analgesics (odds ratio = 0.44), and less likely to be taking psychotropic medication (odds ratio = 0.24). These results are relative to the "high-risk" ALBP patients who did not receive the early intervention (the HR-NI group).

Calculating cost-comparisons between groups yielded quite impressive results. Using unit cost multipliers obtained from the Bureau of Labor Statistics for compensation costs due to disability days (2002), from the *Medical Fees in the United States 2002* (Practice Management Information Corporation [PMIC], 2002) for healthcare costs, and the *Drug Topics Red Book 2002* (2002) for medication costs, we were able to calculate the average costs per patient associated with healthcare visits related to LBP, narcotic analgesic and psychotropic medications, and work disability days/lost wages. Table 21.2 lists these costs

Table 21.1 Long-term outcome results at 12-month follow-up (from Gatchel et al., 2003)

Outcome measure	HR-I ($n=22$)	HR-NI ($n=48$)	LR ($n=54$)	p Value
% Return-to-work at follow-up	91 %	69 %	87 %	0.027
Average # healthcare visits regardless of reason	25.6	28.8	12.4	0.004
Average # healthcare visits related to LBP	17.0	27.3	9.3	0.004
Average # of disability days due to back pain	38.2	102.4	20.8	0.001
Average of self-rated most "intense pain" at 12-month follow-up (0–100 scale)	46.4	67.3	44.8	0.001
Average of self-rated pain over last 3 months (0–100 scale)	26.8	43.1	25.7	0.001
% Currently taking narcotic analgesics	27.3 %	43.8 %	18.5 %	0.020
% Currently taking psychotropic medication	4.5 %	16.7 %	1.9 %	0.019

Table 21.2 Cost-comparison results (average cost per patient/year) (from Gatchel et al., 2003)

Cost variable	HR-I ($n=22$)	HR-NI ($n=48$)
Healthcare visits related to LBP	$1,670	$2,677
Narcotic analgesic medication	$70	$160
Psychotropic medication	$24	$55
Work disability days/lost wages	$7,072	$18,951
Early intervention program	$3,885	NA
Totals	$12,721	$21,843

associated with the HR-I and HR-NI groups. As can be seen, the average overall costs per patient over the 1-year follow-up period (even taking into account the $3,885/patient cost of the early intervention for the HR-I group) were significantly higher for the HR-NI group. The differences were statistically significant. Thus, these results, obviously, have major implications in terms of decreasing emotional distress and producing socioeconomic cost-savings for this prevalent LBP and disability problem.

Obstacles to Return to Work

Another interesting finding from this above investigation was that even in the early intervention group, problems were encountered by some patients returning to work. Preliminary evaluations indicated that workplace factors presented significant obstacles for some patients to immediately return to work when ready. This result supports a significant body of literature highlighting workplace issues as a potential obstacle in the return-to-work process (e.g. Hagen, Svensen, & Eriksen, 2005; Schultz, Crook, & Winter, 2005; Shaw et al., 2010). Adding a financial angle, early interventions including a workplace component likely have a financial benefit (Carroll, Rick, Pilgrim, Cameron, & Hillage, 2010).

For these preliminary evaluations, two patient assessments were administered via structured telephone interviews: the Linton Obstacles to Return-to-Work Questionnaire (ORQ; (Marhold, Linton, & Melin, 2002) and the Liberty Mutual Disability Risk Questionnaire (Shaw, Pransky, Fitzgerald, Patterson, & Winters, 2002). The results of this pilot study indicated that many of the early intervention patients reported a willingness to return to work earlier if they had not encountered some significant workplace obstacles to return to work. For example, from the Liberty Mutual Disability Risk Questionnaire, a patient who did not return to work immediately after he or she was ready, but instead was delayed and initiated vocational retraining, reported to be *not* satisfied. Relative to those who did promptly return, she reported the impactful workplace variables were as follows: the employer's lack of attempts to communicate with her after the injury, the perception that her boss blamed her for the injury, and the absence of job accommodations to support recovery despite her physician ordering some work changes. Interestingly this patient reported complete job satisfaction *before* her injury on the "Work Satisfaction" scale of the ORQ, contrasting to her post-injury, lowered satisfaction. Even though these pilot, retrospective evaluations were not collected for all patients, such results provided additional important preliminary data suggesting the need to modify potential obstacles for return-to-work return to (1) maximize the early intervention program for "high-risk" patients and, subsequently, (2) further prevent the development of chronic disability. Such data aligns with study results from Marhold et al. (2002) further suggesting the importance of patients' perceptions of workplace variables representative of potentially formidable obstacles to expeditious work return.

Not surprisingly, these preliminary results became a major evaluation focus in our third study in this series of NIH-supported investigations. Here, we systematically evaluated potential return-to-work obstacles within the context of our already developed and successful biopsychosocial assessment-treatment protocol (based on the past two reviewed studies) for "high-risk" ALBP patients. This revised protocol represented a three-component, biopsychosocial model of early intervention:

1. The identification of "high-risk" status using the developed empirically supported statistical algorithm
2. The administration of our empirically supported, successful, early intervention program for these "high-risk" patients
3. The introduction of a back-to-work transition component in order to directly modify potential work force obstacles that may prevent an expeditious return to work

The inclusion of the latter work-transition component was hypothesized to the "final puzzle piece" in this biopsychosocial model of early intervention, maximizing early work return and the prevention of chronicity in "high-risk" ALBP patients.

In this study by Whitfill et al. (2010), "high-risk" ALBP patients were randomly assigned to one of four groups: early intervention alone (EI), early intervention *plus* work transition (EI/WT), work transition alone (WT), or standard care (SC). The work-transition component, consisting of up to six individual sessions, provided guidance in the transition back to work and helped address current work conditions that might aggravate the injury. Modifications related to schedules, tasks, and ergonomics are examples of areas that might benefit from adjustment. Results of this study again clearly demonstrated the effectiveness of the EI program. However, the WT component did not significantly add anything to these positive outcomes. This lack of effect could be due to patients viewing WT as a "complicating" factor in the return-to-work process with concerns around the potentially negative impact of their "suggestions" to their employers. Thus, the success of the EI supports the position that additional work-specific interventions may be unnecessary, due to the added costs and compliance issues, in an acute population. They may be better suited for a more chronic population. This is consistent by current research indicating that workplace interventions are indicated for the subacute population (e.g. Anema et al., 2007; Loisel et al., 2001; Schultz, Crook, & Winter, 2005). Additionally, Frank et al. (2000) argues that the subacute stage, when compared to the acute stage, is more amenable to treatment to reduce subsequent disability.

Finally, Rogerson, Gatchel, and Bierner (2010) conducted a cost utility analysis of this early intervention program, versus standard treatment, for the high-risk ALBP patients. Results revealed that the early intervention group again reported fewer healthcare visits and missed workdays, relative to the standard treatment group. Moreover, the early intervention was more effective and less costly from a societal perspective, as well as being the preferred option in over 85 % of the cases. Such findings support the utilization of an early intervention program, both in its cost effectiveness and in patient satisfaction. This concurs with the research conducted by Palmer et al. (2012) who advocates the use of expensive interventions only with "rigorous cost benefit evaluation planned from the outset" (p. 230).

Other LBP Early Intervention Programs

It should be noted that other similar clinical research programs have demonstrated efficacy. This is not surprising; Schultz, Crook, and Winter (2005) has noted that in their review of early intervention literature, one of the key elements include multidisciplinary, multimodal programs.

For example, Loisel and Durand (2005) provided a detailed account of the *Sherbrooke Model*. This well-researched multidisciplinary approach involves both the worker and the workplace using a progressive and graded schedule. They have noted that

> The interventions included in this model of management had as a principle aim the early identification of workers at risk of prolonged disability (four weeks of absence from regular work). A work rehabilitation process, graded to match the improvement of the worker's capacities with a progressive augmentation of work demands, was utilized. Additionally, a simultaneous ergonomic intervention was undertaken to permanently reduce excessive work demand. (pp. 480–481)

The efficacy of this model was evaluated by a randomized control trial, which compared it with usual care, as well as with other traditional rehabilitation approaches. Results of this study clearly demonstrated that the *Sherbrooke Model* approach was significantly more efficacious at returning workers to their regular jobs faster, reducing the duration of absence from work, and self-report measures of pain and disability were reported as further reduced when compared to usual care treatment or partial interventions (Loisel & Durand, 2005). Finally, on a financial note, this model was reported to be more cost-beneficial for the Quebec workers compensation board and to have saved benefit days when compared with partial interventions or usual care (Loisel et al., 2002).

Another example of a successful, multidisciplinary early intervention program with demonstrated efficacy for preventing prolonged disability is within the vocational and rehabilitation medicine realm (Nastasia, Tcaciuc, & Coutu, 2011). Here, Taylor, Simpson, Gow, and McNaughton (2001) developed a 6-week program that utilizes an interdisciplinary rehabilitation team and a cognitive-behavioral model for a population of individuals with disabling musculoskeletal pain (in particular LBP). Cognitive-behavioral therapy has been indicated as a best practice in early intervention treatment (Schultz, Crook, & Winter, 2005). The program's focus includes teaching adaptive beliefs and attitudes (including addressing fear avoidance beliefs), development of personal control, and self-management skills; vocational rehabilitation, psychological pain management, and reconditioning strategies are also major focuses. Results demonstrated a significant impact on returning clients to work; three-quarters of the cohort had a successful outcome (Taylor et al., 2001).

An important subset of the LBP population is injured workers; for workers under 45, LBP forms the leading disability cause and for all workers this issue is considered to be reoccurring (Koes, van Tulder, & Thomas, 2006). Surprisingly, this group is underrepresented in intervention research with focus primarily on workers generally, not on "at-risk" workers (Loisel et al., 1997). However, addressing this gap, Schultz, Crook, Berkowitz, Milner, and Lewis (2008) designed a study involving integrated clinical, occupation, and case management intervention "at-risk" workers in the subacute injury phase in the workers' compensation system. A conventional worker's compensation case management approach was controlled for and compared to an integrated, multidisciplinary, and multimodal early intervention. In this latter intervention, key approaches included a multisystem and multi-method approach (providing a coordinated effort between the worker and the treatment team, barrier reduction, and encouragement), a support network of service and education for workers, and resource coordination. Workers identified as those at risk for disability (high to moderate risk) using the Disability Risk Questionnaire, which was developed and validated in an earlier study (Schultz, Crook, Berkowitz, Milner, & Meloche, 2005), were provided with one-to-one motivational interviewing session and follow-up with the occupational health nurse employed by the workers' compensation system (WorkSafeBC, Canada), case planning and coordination by a case, workplace visit to address barriers to return to work, as well as a telephone communication between a workers' compensation physician and a family physician. Results showed that this early intervention approach was effective with respect to time loss reduction (87 days for the intervention group versus 120 days for the control group). In addition, statistically significant differences were recorded at 6 months post-intervention for workers at the highest risk of protracted disability. As studies on other medical conditions show, the effect of early intervention might not be observed immediately, but rather becomes more prominent in longer-term outcome studies. Moreover, interestingly, the study results showed that this intervention was unnecessary and redundant for injured workers who were not identified as "at high risk," including workers at moderate and low risk. Thus, early intervention should not be applied indiscriminately.

In a subsequent randomized control study, this early intervention (EI) approach was applied in two intervention groups: the first experimental group, which offered protocol-driven "fixed" EI with high-risk injured workers, and the second group, whereby the same intervention component was not protocol driven, but rather offered in a "flexible" and clinically customized individualized manner by the members of the workers' compensation team. The "flexible" approach to early intervention led to superior results as compared to fixed, protocol-driven intervention (Schultz et al., 2009).

In a randomized trial comparing a multidisciplinary to a brief intervention with patients in the workers compensation environment with LBP, Stapelfeldt et al. (2011) examined the effectiveness of treatment for patient subgroups. This follows previous research that argued that specific subgroups of patients should be offered specific treatment (e.g., Shaw, Linton, & Pransky, 2006; Steenstra et al., 2009). In this study, the multidisciplinary intervention involved patients on sick leave from 3 to 16 weeks participating in a primarily occupationally and socially focused treatment. Results reported that the multidisciplinary intervention was more effective with worker populations with low job satisfaction, feeling at risk of losing their jobs, and experiencing no influence on work planning (when compared to groups of high job satisfaction, no perceived risk at losing their job, and having an influence over their work plan). Findings were confirmed with an additional subset of patients.

Finally, addressing general risk factors contributing to disability, Sullivan and colleagues developed the now popular program, the Progressive Goal Attainment Program (PGAP), for individuals with pain conditions. A cognitive-behavioral focus, this 10-week course is focused on developing a structured activity program within a strong therapeutic relationship, establishing goals, addressing return-to-work obstacles, and facilitating a return to work. It integrates psychosocial and behavioral interventions to achieve optimal rehabilitation outcomes in LBP patients (Sullivan, 2012; Sullivan et al., 2005). Researchers have demonstrated PGAP to be effective in addressing psychological barriers, including reducing fear of movement, perceived injustice, and catastrophic thinking for patients with LBP. They were able to identify potential risk factors and then tailor the rehabilitation program accordingly. The researchers studied "at-risk" injured workers with LBP in the acute and subacute stages with PGAP. In addition to the above named psychological changes, results showed a success rate of 60 % (i.e., 45 % return to work and 15 % readiness to return to work) (Sullivan & Adams, 2012; Sullivan & Stanish, 2003). These results revealed that a psychologically focused program might play a meaningful role in early intervention in order to prevent the development of chronic pain and disability and in the return-to-work process.

On a final note, Wickizer et al. (2011) conducted a population-based intervention study examining the role of financial incentives to providers all focused on reducing disability time from work for individuals in the workers compensation environment. Incentives were geared to develop enhanced health information technology, improve adherence to best practices, and provide organizational support. Results showed that the individuals with LBP, the reduction of days from work, was 29.5 % ($P = 0.003$) when compared to a non-equivalent comparison group. For all compensation claims, including those involving TMJMD and LBP, medical costs were reduced by $510USD ($P < 0.01$) per claim and had a reduction of disability days of 19.7 % ($P = 0.005$).

Temporomandibular Joint and Muscle Disorder (TMJMD)

Similar to our work on LBP, the authors of this chapter developed a parallel line of research on TMJMD. Temporomandibular joint (TMJ) pain is part of the larger diagnostic category called TMJMDs. The majority of cases of TMJMD involve either disc displacements, muscle disorders, internal derangements or degenerative changes of the TMJ, or combined muscle-joint disorders. The American Academy of Orofacial Pain (2004) estimates that 75 % of the US population experiences symptoms of TMJMD during their lifetime and that 5–10 % require professional treatment. Although the prevalence of TMJMD varies widely among studies, researchers surveying the prevalence literature estimated that in any given year, 10 % of women and 6 % of men have TMJMD-related pain, which translates to some 20 million adults (Drangsholt & LeResche, 1999). These researchers also estimated that within a 6–12-month period, more than 5.3 million US residents would seek treatment for TMJMD; a conservative estimate for only direct treatment costs is $2 billion. Although studies measuring indirect costs are presently lacking, researchers have found that 28 % of TMJMD patients report disability and limitations, in addition to unemployment (Von Korff, Ormel, Keefe, & Dworkin, 1992). National Institute of Dental and Craniofacial Research (2008) report that total estimated temporomandibular disorders (TMD) costs exceed $4 billion annually.

Indeed, with healthcare costs an issue for many patients and healthcare providers, researchers have found that some biobehavioral treatments offer a significant medical cost-offset effect (e.g. Chiles, Lambert, & Hatch, 1999). Annual managed care treatment costs for orofacial pain individually can range from $12,000 to $20,000 (Brotman, 1997). Von Korff, Lin, Fenton, and Saunders (2007) observed 372 TMJMD patients over a 3-year period and found that this pain population made more doctor visits than controls. Thus, in addition to the dental and psychosocial benefits in preventing patients from progressing from acute to chronic TMJMD, a great cost benefit is also identified. Additionally, traditional TMJMD treatment is considered more physical and reactive in nature and known to be unresponsive for this pain population. Predominately, treatment has been invasive and includes TMJ surgery, occlusional adjustments, and a wide array of pharmocotherapeutic approaches. Other nonsurgical treatments, such as interocclusal appliances, physical therapy, and nocturnal alarms, also have been used. Unfortunately, research clearly establishes that as the duration of pain increases, patients become more refractory to intervention (Gatchel, 2002).

Clearly, TMJMD is a common, complex, and costly disorder. High costs in addition to the treatment non-responsiveness have resulted in a trend toward more conservative treatment. Stohler and Zarb (1999), in their seminal article on this issue, made a plea for a "low-tech, high-prudence therapeutic approach (p. 258)." In response to this plea, a number of effective behavioral medicine approaches have been developed to better assess and treat TMJMD disorders. However, as Dworkin (1995) began to highlight, a more comprehensive biopsychosocial approach was needed to address both the physical and psychosocial factors involved in TMJMDs. Nearly two decades later, this assertion is affirmed by Palla (2011); further, he notes that the majority of treatment outcomes research conducted continue to address only physical and not psychosocial issues. On a hopeful note, Orlando, Manfredini, Salvetti, and Bosco (2007) performed an exhaustive search on current psychosocial treatments and recommended its inclusion in the management of TMD. Additionally, the International RDC-TMD Consortium (2012) announced that more expansive diagnostic criteria for TMD, expected to include nonphysical factors, would be available late 2012.

Our clinical research team became interested in TMJMD because, as originally noted by Dworkin (1995), TMJMD and LBP are disabilities with a number of similarities: both have typically recurrent and often chronic course and the severity of pain and related behavioral disability is highly variable, both over time as well as between patients. Furthermore, as also pointed out by Von Korff (1995), similar to LBP, TMJMD pain may be viewed as an "illness in search of a disease (p. 227)." The majority of cases of LBP and TMJMD are rarely associated with a well-defined disease. Moreover, traditional interventional approaches have not proven to be as therapeutic or cost-effective as desired. Because of these similarities, our clinical research program on LBP was paralleled by a similar research program on TMJMD.

Initial Studies on the Early Identification of "High-Risk" Acute TMJMD Patients

Examining the trend for more comprehensive, manual-driven treatment approaches that are biopsychosocial in nature, in our initial intervention study, Mishra, Gatchel, and Gardea (2000) utilized a more biopsychosocial approach as identified by Dworkin (1995). Four different treatment modalities for the treatment of TMJMD were compared: BFB, cognitive behavioral therapy (CBT), comprehensive combined BFB/CBT, and treatment as usual. It was found that the three active treatment groups (BFB, CBT, and BFB'CBT) had significantly reduced pain scores from pre- to posttreatment and significantly improved mood scores, relative to the treatment-as-usual group. In addition, among the treatment groups, the BFB group alone showed the greatest improvement.

Gardea, Gatchel, and Mishra (2001) completed a 1-year outcome evaluation on the original study. Results showed that all treatment groups maintained their therapeutic gains from pretreatment to 1-year follow-up, relative to the treatment-as-usual group. At 1 year, the largest treatment gains were associated with the comprehensive BFB/CBT group, relative to the BFB alone group. Short-range positive outcomes afforded by the BFB intervention, combined with longer-range gains provided by the CBT intervention, were thought to explain the increased gains in terms of physical and emotional functioning of the combined group at 1-year.

More specifically, with both the BFB and the BFB/CBT groups, both experienced immediate benefits of the BFB treatment. Treatment was more obviously and directly linked to the patients' physical pain complaint; this may have increased the patients' motivation to comply both in-session and with home practice. However, with the comprehensive BFB/CBT group, the gains over the BFB group may reflect a combination of immediate benefits of BFB treatment in conjunction with longer-term benefits realized after a lifestyle change. Such change may develop following CBT, which requires more time to fully embrace and implement.

NIH-Supported Clinical Research Studies

The continuation of the recent trend of developing a comprehensive, manual-driven, biopsychosocial, treatment approach is illustrated above. This "low-tech, high-prudence therapeutic approach" to TMJMD is now employed with acute patients (complaints of pain for less than 6 months by most standards). For our research team, initially led by Epker, Gatchel, and Ellis (1999), the question of whether the progression from acute to chronic TMJMD-related pain may be avoided by early intervention (with patients deemed "at risk" for developing chronic pain) was the first issue addressed. They formulated a statistical algorithm, based on a logistic regression model, relying upon self-reported pain intensity ratings (as assessed by the Characteristic Pain Intensity index and used in the research

Table 21.3 Long-term outcome results at 1-year follow-up

Outcome measures
Self-reported pain as measured by the characteristic pain intensity (CPI); effect size = 0.872 ("large")
Self-reported symptoms of depression as measured by the BDI; effect size = 0.44 ("medium")
Adaptive and maladaptive coping styles; effect size for "self-blame" = 0.40 ("medium")
Psychopathology (affective disorders, anxiety disorders, and somatoform disorders)
Healthcare utilization related to jaw pain (dentists, orthodontists, oral surgeons, chiropractors, etc.) outside of the study

diagnostic criteria [RDC]/TMD), and the presence or absence of myofascial pain to palpation (again, as measured by RDC/TMD criteria) in acute TMJMD patients. At 1-year follow-up, results found that this model correctly classified 91 % of patients at "high risk" for developing chronic TMJMD problems. In subsequent studies to be reviewed next, the hypothesis from our LBP studies that early intervention would result in lower levels of pain at 1-year follow-up (relative to nonintervention patients) was repeated here. It was further hypothesized that these early intervention patients would demonstrate improved levels of coping and decreased emotional distress at 1-year follow-up. As will be reviewed next, both hypotheses were confirmed.

Results from the first major study in this series clearly revealed that early intervention at the acute stage of TMJMD significantly reduced the prevalence of chronic pain and emotional distress, relative to the "high-risk," nonintervention TMJMD patients (Gatchel, Stowell, Wildenstein, Riggs, & Ellis, 2006). Table 21.3 summarizes the outcome data that displayed significant differences in the anticipated directions between the "high-risk" early intervention and the "high-risk," nonintervention groups at 1-year post-intervention follow-up. The major hypotheses of this study were confirmed. The "high-risk" acute TMJMD patients who received early intervention displayed significantly fewer indices of chronicity on measures of pain, healthcare utilization related to jaw pain, and emotional distress (as reflected by symptoms of depression, maladaptive coping styles, and major psychopathology), relative to the "high-risk" acute TMJMD patients in the nonintervention group. Such results, obviously, have major implications in decreasing emotional distress and for potentially producing cost-savings for this prevalent pain problem. Interestingly, nonintervention patients had significantly more healthcare visits jaw-pain treatment compared to the early intervention patients. As important were the types of providers seen. Many visits were to more costly providers that could, over time, result in greater overall expense, especially if complex chronicity developed.

In terms of cost savings, a more comprehensive cost-effectiveness analysis was conducted on differences between the intervention and nonintervention groups (Stowell, Gatchel, & Wildenstein, 2007). Healthcare costs associated with jaw pain were collected from all patients from the initial pain onset to study intake and for the study's duration (1-year). Data included costs for healthcare visits and related appliances/splints, travel distance and travel time to visits, medications, etc. Results demonstrated significantly greater overall costs associated with the nonintervention group, relative to the intervention group. For example, the early intervention group spent statistically significant fewer dollars during the 1 year after initial intake, relative to the nonintervention group ($131.84 average versus $422.91 average, respectively). No differences between groups at initial intake were noted. Such therapeutic efficacious and cost-effective results are in keeping with the earlier cited plea by Stohler and Zarb (1999) for a "low-tech, high-prudence therapeutic approach" to TMJMD.

Finally, we also completed an initial analyses of even longer-term outcomes of patients used in the above two studies by Gatchel and colleagues. In this investigation, longer-term posttreatment outcomes (from approximately 2 to 6 years since initial intake) were evaluated in order to determine if the benefits achieved at 1-year were sustainable (Gatchel, 2010a). Results clearly demonstrated this sustainability, with the early intervention group displaying lower pain and depression measures at long-term follow-up, relative to the nonintervention group. Moreover, the early

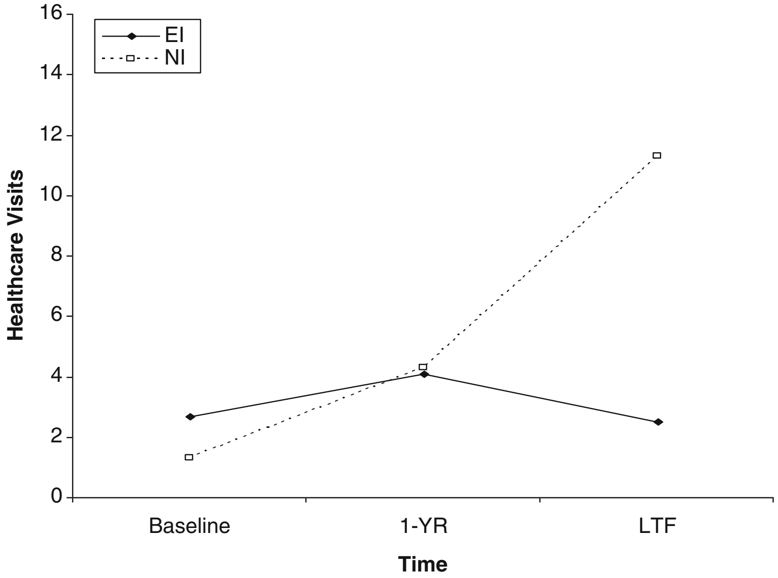

Fig. 21.1 Statistically significant linear trend for jaw-pain-related healthcare visits (from Gatchel, 2010a). *EI* Early intervention, *NI* Nonintervention, *LTF* Long-term follow-up (2–6 years posttreatment)

intervention subjects reported the continued use of the skills and techniques at this long-term period, and they perceived the intervention as very valuable, with 96 % *very likely* or *likely* to recommend the intervention to others. In addition, the early intervention group patients had significantly fewer visits to healthcare providers for jaw pain than the nonintervention subjects, as displayed in Fig. 21.1. These findings represent one of the first attempts at this type of long-term follow-up with TMJMD patients.

Notably, the success of the biopsychosocial (combined BFB/CBT) intervention used in this study was not surprising given that CBT has been shown to be very efficacious in the treatment of pain as initially reviewed in a meta-analysis by Morley, Eccleston, and Williams (1999) and more recently Orlando et al. (2007). Such treatment also appears effective irrespective of medical diagnoses (Gatchel & Oordt, 2003; Morley & Vlaeyen, 2005). For example, a double-blind, randomized control trial on the treatment of chronic primary insomnia, often seen in a variety of medical disorders, has been shown to be efficacious (Edinger, Wohlgemuth, Radtke, Marsh, & Quillian, 2001). Earlier randomized control trials of the efficacy of CBT for TMJMD clinic patients by Truelove, Huggins, Mancl, and Dworkin (2006), Dworkin et al. (2002), and Turner, Mancl, and Aaron (2006) further support the clinical robustness of this treatment modality.

The above results have major implications on effective early intervention and significant healthcare cost savings for this prevalent TMJMD pain and disability problem. We are now currently conducting a third NIH-supported project that implements this treatment program in order to evaluate its effectiveness in actual community-based dental practices. For this project, all of the TMJMD patients are assessed and treated in actual community-based dental practices. This shift responds to the National Institutes of Health's request for the implementation of evidence-based treatment approaches, developed in controlled clinical research settings, to the "real world" of diverse community practice settings. It addresses priorities delineated in a number of federal reports, such as "Translating Behavioral Science into Action: A Report of the National Advisory Mental Health Council's Behavioral Science Workshop (National Advisory Mental

Health Council Behavioral Science Workgroup)" and "From Clinical Trials to Community: The Science of Translating Diabetes and Obesity Research" (2004). One unique aspect of this ongoing project is its focus on acute, recently diagnosed TMJMD patients in an effort to prevent these patients from developing more costly and complex chronic disorders. Results to date are quite encouraging in again demonstrating clinical effectiveness of our early intervention.

Summary

We have reviewed the growing evidence-based support for the treatment and cost-effectiveness of early identification and intervention methods for "high-risk" patients with musculoskeletal disorders. Two very prevalent and costly examples of such disorders—LBP and TMJMD—were used to demonstrate such effectiveness. The clinical research conducted and reviewed was stimulated by repeated calls for such an approach. For example, as succinctly noted by Linton (2005),

> While identifying patients at risk for developing persistent… pain and disability is important, providing an effective intervention is crucial. Indeed, the central question after identification is "How do we prevent this problem from becoming chronic?" Without effective remedies, early identification is relatively meaningless. Thus, early identification has little inherent worth if it is not tied to action. However, developing early interventions has been a difficult challenge that has received too little attention. Still, some progress has been made and various researchers have developed programs and scientifically tested them. (p. 463)

Indeed, a significant amount of progress has been made in response to this clear challenge for "action." For example, substantial gains have been made in solving the puzzle for the most therapeutic and cost-effective method to prevent chronic LBP and TMJMD. However, another important challenge now faces us: how can we "bridge the gap" between such evidence-based approaches and the "push" for healthcare insurance companies to utilize such approaches as a treatment of choice in the larger public marketplace arena? Importance rests on conducting systematic clinical research for other prevalent musculoskeletal pain disorders. It is an empirical question, whether and under what circumstances, evidence-supported and protocol-driven early intervention approaches increase or lose effectiveness while transitioning to practice. One study (Schultz et al., 2009) suggests that flexible adaptation of manualized interventions in real-life context might produce much improved clinical and occupational results, while allowing for customization, patient matching, and clinical decision making, as compared to fixed "by the book" approach. However, the research in this complex area of knowledge exchange is just emerging.

Our hope is that similar lines of research can be extended to other prevalent and costly conditions such as upper and lower extremity pain and disability syndromes and factors responsible for effective knowledge and practice in the area of early intervention with high-risk patients will further develop.

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References

American Academy of Orofacial Pain. (2004). *TMD symptoms*. Retrieved December 16, 2004, 2004, from http://www.aaop.org/index.asp?Type=SEC&SEC={1387ACCB-B805-48F6-BB7F-0031808FDEAB}&DE={79C1954A-AA74-44C9-A517-4FF98FB17183}

Anema, J. R., Steenstra, I. A., Bongers, P. M., de Vet, H. C. W., Knol, D. L., Loisel, P., et al. (2007). Multidisciplinary rehabilitation for subacute low back pain: Graded activity or workplace intervention or both? A randomized controlled trial. *Spine, 32*(3), 291–298.

Australian Acute Musculoskeletal Pain Guidelines. (2003). *Evidence-based management of acute musculoskeletal pain*. Brisbane, Australia: Australian Academic Press.

Brotman, S. (1997). Managed health care and orofacial pain. *Orofacial Pain and Related Disorders, 41*(2), 297–307.

Bureau of Labor Statistics. (2002). Retrieved 2002, from http://data.bls.gov/surveymost

Carroll, C., Rick, J., Pilgrim, H., Cameron, J., & Hillage, J. (2010). Workplace involvement improves work return rates among employees with back pain on long-term sick leave: A systematic review of the effectiveness an cost-effectiveness of interventions. *Disability and Rehabilitation, 32*(8), 607–621.

Chiles, J. A., Lambert, M. J., & Hatch, A. L. (1999). The impact of psychological interventions on medical cost offset: A meta-analytic review. *Clinical Psychology: Science and Practice, 6*(N2), 204–220.

Crombie, I. K., Croft, P. R., Linton, S. J., LeResche, L., & Von Korff, M. (1999). *Epidemiology of pain* (Vol. 1). Seattle, WA: IASP Press.

Dagenais, S., Tricco, A. C., & Haldeman, S. (2010). Synthesis of recommendations for the assessment and management of low back pain from recent clinical practice guidelines. *Spine, 10*(6), 514–529.

Drangsholt, M., & LeResche, L. (1999). Temporomandibular disorder pain. In Task Force on Epidemiology of the International Association for the Study of Pain (IASP) (Ed.), *Epidemiology of pain* (pp. 203–233). Seattle, WA: International Association for the Study of Pain.

Drug Topics Redbook 2000. Montvale, MJ: Thompson Medical Economics, 2002.

Dworkin, S. (1995). Behavioral characteristics of chronic temporomandibular disorders: Diagnosis and assessment. In B. J. Sessle, P. S. Bryant, & R. A. Dionne (Eds.), *Temporomandibular disorders and related pain conditions*. Seattle, WA: IASP Press.

Dworkin, S. F., Turner, J. A., Mancl, L., Wilson, L., Massoth, D., Huggins, K. H., et al. (2002). A randomized clinical trial of a tailored comprehensive care treatment program for temporomandibular disorders. *Journal of Orofacial Pain, 16*(4), 259–276.

Edinger, J. D., Wohlgemuth, W. K., Radtke, R. A., Marsh, G. R., & Quillian, R. E. (2001). Cognitive behavioral therapy for treatment of chronic primary insomnia: A randomized controlled trial. *JAMA, 285*(14), 1856–1864.

Epker, J. T., Gatchel, R. J., & Ellis, E. (1999). An accurate model for predicting TMD chronicity: Practical applications in clinical settings. *Journal of the American Dental Association, 130*, 1470–1475.

Frank, J., Yassi, A., Stock, S., Guzmán, J., Clarke, J., Friesen, M., et al. (Eds.). (2000). *Work-ready: Return-to-work approaches for people with soft-tissue injuries*. Toronto, ON: Institute for Work & Health.

Frymoyer, J. W. (1992). Predicting disability from low back pain. *Clinical Orthopaedics and Related Research, 279*, 101–109.

Gardea, M. A., Gatchel, R. J., & Mishra, K. D. (2001). Long-term efficacy of biobehavioral treatment of temporomandibular disorders. *Journal of Behavioral Medicine, 24*, 341–359.

Garofalo, J. P., Gatchel, R. J., Kishino, N. D., & Strizak, A. M. (2005). An early screening and intervention approach for acute low back pain disability. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention*. New York: Springer.

Gatchel, R. J. (2002). Treatment of patients with temporomandibular disorders. In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed.). New York: Guilford.

Gatchel, R. J. (2010a). Behavioral medicine treatment approaches to temporomandibular joint and muscle disorders. In D. Manfredini (Ed.), *Current concepts in temporomandibular disorders*. Berlin: Quintessence Publishers.

Gatchel, R. J. (2010b). Early, simple and low-cost methods for improving outcomes in high-risk musculoskeletal pain disorder cases. *International Association of Industrial Accident Boards and Commissioners Journal, 47*, 23–56.

Gatchel, R. J., & Oordt, M. S. (2003). *Clinical health psychology and primary care: Practical advice and clinical guidance for successful collaboration*. Washington, DC: American Psychological Association.

Gatchel, R. J., Polatin, P., & Mayer, T. (1995). The dominant role of psychosocial risk factors in the development of chronic low back pain disability. *Spine, 20*(24), 2702–2709.

Gatchel, R. J., Polatin, P. B., Noe, C., Gardea, M., Pulliam, C., & Thompson, J. (2003). Treatment- and cost-effectiveness of early intervention for acute low-back pain patients: A one-year prospective study. *Journal of Occupational Rehabilitation, 13*(1), 1–9.

Gatchel, R. J., Stowell, A. W., Wildenstein, L., Riggs, R., & Ellis, E. (2006). Efficacy of an early intervention for patients with acute TMD-related pain: A one-year outcome study. *Journal of the American Dental Association, 137*, 339–347.

Gozna, E. (2001). *For the workplace health safety and compensation commission of New Brunswick. Guidelines for the daignosis and tratment of low back pain*. New Brunswick, WC: WHSCC of New Brunswick.

Hagen, E. M., Svensen, E., & Eriksen, H. R. (2005). Predictors and modifiers of treatment effect influencing sick leave in subacute low back pain patients. *Spine, 30*(24), 2717–2723.

Hall, H., & McIntosh, G. (2008). Low back pain (chronic). *Clinical Evidence (Online), 2008*, 1116.

Hazard, R. G. (1995). Spine update: Functional restoration. *Spine, 20*, 2345–2348.

International RDC-TMD Consortium. (2012). *RDC/TMD announcement*. Retrieved October 9, 2012, from http://www.rdc-tmdinternational.org/TMDAssessmentDiagnosis/DCTMDannouncement.aspx

Katz, J. N. (2006). Lumbar disc disorders and low-back pain: Socioeconomic factors and consequences. *Journal of Bone and Joint Surgery (American), 88* (Suppl. 2), 21–24.

Koes, B. W., van Tulder, M. W., & Thomas, S. (2006). Diagnosis and treatment of low back pain. *British Medical Journal, 332*, 1430–1434.

Krause, N., Frank, J. W., Dasinger, L. K., Sullivan, T., & Sinclair, S. J. (2001). Determinants of duration of disability and return to work after work-related injury and illness: Challenges for future research. *American Journal of Industrial Medicine, 40*, 464–484.

Lauer, M. S., & Collins, F. S. (2010). using science to improve the nation's health system. *JAMA: The Journal of the American Medical Association, 303*(21), 2182–2183.

Linton, S. J., & Hallden, K. (1998). Can we screen for problematic back pain? A screening questionnaire for predicting outcome in acute and subacute back pain. *Clinical Journal of Pain, 14*, 209–215.

Linton, S. J. (2002a). A cognitive-behavioral approach to the prevention of chronic back pain. In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed.). New York: Guilford.

Linton, S. J. (Ed.). (2002b). *New avenues for the prevention of chronic musculoskeletal pain and disability*. Amsterdam: Elsevier.

Linton, S. J. (2005). Early interventions for "at risk" patients with spinal pain. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention*. New York: Springer.

Linton, S. J., & Bradley, L. A. (1996). Strategies for the prevention of chronic pain. In R. J. Gatchel & D. C. Turk (Eds.), *Psychological approaches to pain management: A practitioner's handbook*. New York: Guilford Publications.

Loisel, P., Abenhaim, L., Durand, P., Esdaile, J. M., Suissa, S., Gosselin, L., et al. (1997). A population-based, randomized clinical trial on back pain management. *Spine, 22*, 2911–2918.

Loisel, P., & Durand, M. J. (2005). Working with the employer: The Sherbrooke model. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention, and prevention*. New York: Springer.

Loisel, P., Durand, M., Berthelette, D., Vézina, N., Baril, R., Gagnon, D., et al. (2001). Disability prevention: New paradigm for the management of occupational back pain. *Disability Management and Health Outcomes, 9*, 351–360.

Loisel, P., Lemaire, J., Poitras, S., Durand, M., Champagne, F., Stock, S., et al. (2002). Cost-benefit and cost-effectiveness analysis of a disability prevention model for back pain management: A six year follow up study. *Occupational and Environmental Medicine, 59*(12), 807–815.

Luo, X., Pietrobon, R., Sun, S. X., Liu, G. G., & Hey, L. (2003). Estimates and patterns of direct health care expenditures among individuals with back pain in the United States. *Spine, 29*(1), 79–86.

Manchikanti, L., Falco, F. J., Boswell, M. V., & Hirsch, J. A. (2010). Facts, fallacies, and politics of comparative effectiveness research: Part I. Basic considerations. *Pain Physician, 13*(1), E23–E54.

Marhold, C., Linton, S. J., & Melin, L. (2002). Identification of obstacles for chronic pain patients to return to work: Evaluation of a questionnaire. *Journal of Occupational Rehabilitation, 12*, 65–76.

Mishra, K. D., Gatchel, R. J., & Gardea, M. A. (2000). The relative efficacy of three cognitive-behavioral treatment approaches to temporomandibular disorders. *Journal of Behavioral Medicine, 23*, 293–309.

Mondloch, M. V., Cole, D. C., & Frank, J. W. (2001). Does how you do depend on how you think you'll do? A systematic review of the evidence for a relation between patients' recovery expectations and health outcomes. *Canadian Medical Association Journal, 165*(10), 174–179.

Morley, S., Eccleston, C., & Williams, A. (1999). Systematic review and meta-analysis of randomized controlled trials of cognitive behavior therapy and behavior therapy for chronic pain in adults, excluding headache. *Pain, 80*, 1–13.

Morley, S., & Vlaeyen, J. W. S. (2005). Epilogue to the special topics series. *Clinical Journal of Pain, 21*(1), 69–72.

Nastasia, I., Tcaciuc, R., & Coutu, M.-F. (2011). *Strategies for preventing prolonged disability in workers compensated for work related musculoskeletal disorders: A systematic and comprehensive literature review* (Research report R-719). Retrieved from the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) website: www.irsst.qc.ca

National Advisory Mental Health Council Behavioral Science Workgroup. *Translating behavioral science into action*. Available from http://www.nimh.nih.gov/publicat/nimhtranslating.pdf

National Institute of Dental and Craniofacial Research. (2008). *Facial pain*. Bethesda, MD: National Institutes of Health [updated December 20, 2008; cited September 13, 2009]. Retrieved from http://www.nidcr.nih.gov/DataStatistics/FindDataByTopic/FacialPain/

National Institutes of Health. (2004). *From clinical trials to community: The science of translating diabetes and obesity research.* Paper presented at the from clinical trials to community: The science of translating diabetes and obesity research, Bethesda, MD.

National Research Council. (2001). *Musculoskeletal disorders and the workplace: Low back and upper extremities*. Washington, DC: National Academy Press.

Orlando, B., Manfredini, D., Salvetti, G., & Bosco, M. (2007). Evaluation of the effectiveness of biobehavioral therapy in the treatment of temporomandibular disorders: A literature review. *Behavioral Medicine, 33*, 101–118.

Palla, S. (2011). Biopsychosocial pain model crippled? *Journal of Orofacial Pain, 25*(4), 289–290.

Palmer, K. T., Harris, E. C., Linaker, C., Barker, M., Lawrence, W., Cooper, C., et al. (2012). Effectiveness of community- and workplace-based interventions to manage musculoskeletal-related sickness absence and job loss: A systematic review. *Rheumatology (Oxford), 51*(2), 230–242.

Practice Management Information Corporation (PMIC). (2002). *Medical fees in the United States 2000*. Los Angeles: Author.

Robinson, K. (2007). *Efficacy of an early biopsychosocial intervention for patients with acute TMD-related pain: A long-term follow-up study*. Dissertation, The University of Texas Southwestern Medical Center at Dallas, Dallas, TX. Retrieved from http://hdl.handle.net/2152.5/750

Rogerson, M. D., Gatchel, R. J., & Bierner, S. M. (2010). Cost utility analysis of interdisciplinary early intervention versus treatment as usual for high risk acute low back pain patients. *Pain Practice, 10*, 382–395.

Schultz, I. Z., Crook, J., Berkowitz, J., Milner, R., & Lewis, M. L. (2008). A prospective study of the effectiveness of early intervention with high-risk back-injured workers: A pilot study. *Journal of Occupational Rehabilitation, 18*, 140–151.

Schultz, I. Z., Crook, J., Berkowitz, J., Milner, R., & Meloche, G. R. (2005). Predicting return to work after low back pain injuryusing the psychosocial risk for occupational disability instrument: A validation study. *Journal of Occupational Rehabilitation, 15*(3), 365–376.

Schultz, I. Z., Crook, J., Berkowitz, J., Milner, R., Meloche, G. R., & Prkachin, K. (2009). *Early intervention with low back injured workers who are at risk for work disability*. Unpublished study report for WorkSafeBC, Canada.

Schultz, I. Z., Crook, J., & Winter, A. (2005). Evidence-informed best practices for injured workers at risk for disability at the subacute stage. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention, and prevention*. New York: Springer.

Shaw, W. S., Linton, S. J., & Pransky, G. (2006). Reducing sickness absence from work due to low back pain: How well do intervention strategies match modifiable risk factors? *Journal of Occupational Rehabilitation, 16*(4), 591–605.

Shaw, W. S., Pransky, G. S., Fitzgerald, T. E., Patterson, W., & Winters, T. (2002). *Returning to work after acute occupational low back pain: A multiple site study of prognosis*. Montreal, Canada: Montreal International Forum V for Primary Care Research on Low Back Pain.

Shaw, W. S., van der Windt, D. A., Main, C. J., Loisel, P., Linton, S. J., & Decade of the Flags Working Group. (2010). Early patient screening and intervention to address individual-level occupational factors ("Blue Flags") in back disability. *Journal of Occupational Rehabilitation, 19*, 64–80.

Sox, H. C. (2010). Comparative effectiveness research: A progress report. *Annals of Internal Medicine, 153*, 469–472.

Stapelfeldt, C. M., Christiansen, D. H., Jensen, O. K., Nielsen, C. V., Peterson, K. D., & Jensen, C. (2011). Subgroup analyses on return to work in sick-listed employees with low back pain in a randomized trial comparing brief and multidisciplinary intervention. *BMC Musculoskeletal Disorders, 12*(112), 1–13.

Steenstra, I. A., Knol, D. L., Bongers, P. M., Anema, J. R., van Mechelen, W., & de Vet, H. C. (2009). What works best for whom? An exploratory, subgroup analysis in a randomized, controlled trial on the effectiveness of a workplace intervention in low back pain patients on return to work. *Spine, 34*, 1243–1249.

Stohler, C. S., & Zarb, G. A. (1999). On the management of temporomandibular disorders: A plea for a low-tech, high-prudence therapeutic approach. *Journal of Orofacial Pain, 13*(4), 255–261.

Stowell, A. W., Gatchel, R. J., & Wildenstein, L. (2007). Cost analysis of temporomandibular disorders: Biopsychosocial intervention versus treatment as usual. *Journal of the American Dental Association, 138*, 202–208.

Sullivan, M. J. L. (2012). Cognitive-behavioral approaches in return to work. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of return work*. New York: Springer.

Sullivan, M. J. L., & Adams, H. (2012). Psychosocial techniques to augment the impact of physical therapy interventions for low back pain. *Physiotherapy Canada, 62*(3), 180–189.

Sullivan, M. J. L., & Stanish, W. D. (2003). Psychologically based occupational rehabilitation: The Pain-Disability Prevention Program. *The Clinical Journal of Pain, 19*, 97–104.

Sullivan, M. J. L., Ward, L. C., Tripp, D., French, D. J., Adams, H., & Stanish, W. D. (2005). Secondary prevention of work disability: Community-based psychosocial intervention for musculoskeletal disorders. *Journal of Occupational Rehabilitation, 15*(3), 377–392.

Taylor, W., Simpson, R., Gow, D., & McNaughton, H. (2001). Rehabilitation that works: Vocational outcomes following rehabilitation for occupational musculoskeletal pain. *New Zealand Medical Journal, 114*(1130), 185–187.

Truelove, E., Huggins, K. H., Mancl, L., & Dworkin, S. F. (2006). The efficacy of traditional, low cost, and non-splint therapies for temporomandibular disorder: A randomized controlled trial. *JAMA, 137*, 1099–1107.

Turner, J. A., Mancl, L., & Aaron, L. A. (2006). Short- and long-term efficacy of brief cognitive-behavioral therapy for patients with chronic temporomandibular disorder pain: A randomized, controlled trial. *Pain, 121*, 181–194.

Von Korff, M. (1995). Health services research and temporomandibular pain. In B. J. Sessle, P. S. Bryant, & R. A. Dionne (Eds.), *Temporomandibular disorders and related pain conditions* (pp. 227–236). Seattle, WA: IASP Press.

Von Korff, M., Lin, E. H., Fenton, J. J., & Saunders, K. (2007). Frequency and priority of pain patients' health care use. *Clinical Journal of Pain, 23*, 400–408.

Von Korff, M., Ormel, J., Keefe, F. J., & Dworkin, S. F. (1992). Grading the severity of chronic pain. *Pain, 50*, 133–149.

Whitfill, T., Haggard, R., Bierner, S. M., Pransky, G., Hassett, R. G., & Gatchel, R. J. (2010). Early intervention options for acute low back pain patients: A randomized clinical trial with one-year follow-up outcomes. *Journal of Occupational Rehabilitation, 20*, 256–263.

Wickizer, T. M., Franklin, G., Fulton-Kehoe, D., Gluck, J., Mootz, R., Smith-Weller, T., et al. (2011). Improving quality, preventing disability, and reducing costs in worker's compensation healthcare: A population-based intervention study. *Medical Care, 49*(12), 1105–1111.

22

A Review of Self-Management Support for (Work-Related) Musculoskeletal Pain Disorders

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Overview

The concepts of self-management (SM; what the patient does) and self-management support (SMS; what the health professional, caregivers and the system do) have origins in the chronic disease and medical rehabilitation field (Sterling, von Esenwein, Tucker, Fricks, & Druss, 2010). Chronic condition SM is a process that includes a broad set of attitudes, behaviours and skills. It is directed towards managing the impact of the disease or condition on all aspects of living by the patient with a chronic condition. It includes, but is not limited to, self-care, and it may also encompass prevention. An operational definition is that an individual with a chronic condition self-manages by:

- Having knowledge of the condition and/or its management
- Adopting an SM care plan agreed and negotiated in partnership with health professionals, significant others and/or caregivers and other supporters
- Actively sharing in decision-making with health professionals, significant others and/or caregivers and other supporters
- Monitoring and managing signs and symptoms of the condition
- Managing the impact of the condition on physical, emotional, occupational and social functioning
- Adopting lifestyles that address risk factors and promote health by focusing on prevention and early intervention
- Having access to, and confidence in, the ability to use support services

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SMS, on the other hand, is what health professionals, caregivers and health systems do to assist patients to self-manage their conditions. This chapter focuses on SMS.

Chronic disorders have a longer and more complex recovery trajectory (by definition) than acute disorders, and outcomes are more varied in terms of recovery of function. They are a logical target for SMS education by health professionals with patients who have chronic or long-term conditions (the UK and NZ term). The modern concept of SM has a clear basis in early social and behavioural learning theories, particularly those that focus on self-efficacy (Lorig & Holman, 2003). In the context of behaviour change, Bandura defines self-efficacy as 'people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives' (Bandura, 1994). Current day SM programmes have a strong emphasis on self-efficacy and the provision of tools that can facilitate recovery, health and well-being. In other words, the skills and resources inherent in SMS provide an increase in self-belief that enable individuals to actively participate in the rehabilitation process and ongoing maintenance of health and well-being (Lorig & Holman, 2003; Sterling et al., 2010). This concept of empowerment, and the patient playing a more active role in recovery, has relevance in a society in which there is a strong desire to be (passively) cured. The recognition of the limitations of this culture, as well as the high level of burden stemming from chronic disease and the ageing society and workforce in developed nations, has seen a recent and significant shift in health policy towards patient-centred care (Jordan & Osborne, 2007; South Australian Department of Human Services, 2003), including SMS. For example, in the UK and the USA, attempts have already been made to widely implement SMS, including SM education programmes. However, trials have had limited success thus far (Kennedy et al., 2004). In addition, the Australian Government budget for the 2006–2007 financial year included an unprecedented funding allocation to allow for the implementation of chronic disease SMS education for health professionals over the subsequent 5-year period (National Health Priority Action Council (NHPAC), 2006).

SMS for patients has been found to enable people with chronic disabling conditions to minimise pain and reduce healthcare patronage, share in decision-making about treatment, gain a sense of control over their lives (Barlow, Williams, & Wright, 1999; Lorig, Mazonson, & Holman, 1993) and also reduce the frequency of visits to doctors and generally enjoy a better quality of life (Barlow & Ellard, 2007; Lorig, Gonzalez, Laurent, Morgan, & Laris, 1998). It has been shown to be effective in improving self-efficacy, clinical outcomes in certain contexts and in reducing disability (Lorig & Holman, 1989; Lorig et al., 1993; Lorig, Sobel, Ritter, Laurent, & Hobbs, 2001; Warsi, Wang, LaValley, Avorn, & Solomon, 2004), but has not yet been applied to any great extent in a vocational rehabilitation (VR) setting for those with chronic *compensated* musculoskeletal conditions.

Research suggests that the expectations and beliefs of the injured worker with respect to success of treatment, as well as the time of readiness to return to work (RTW), play a significant role in influencing the success of an RTW attempt (Cameron, 2011; Heymans et al., 2006). It follows that if self-efficacy is targeted for injured workers during the occupational rehabilitation and RTW process by introducing self-management training, then this should improve functional outcomes for these individuals, including RTW success/maintenance and general quality of life. Theoretically, SMS has the potential to make a difference in recovery outcomes for those with chronic compensated musculoskeletal disorders (MSDs), including RTW. Many have recognised its potential, and a few have even tried to implement it, but most have found the barriers to disability management in the compensation system too overwhelming. This chapter aims to present the current state of knowledge of the use of SMS techniques for work-related MSDs by:

- Providing an overview of the practice of SMS and theory relevant to the above context
- Providing an overview of the evidence of effectiveness of SMS:
  - For chronic conditions in general
  - Specific to MSDs
  - Specific to MSDs in the workers' compensation context

- Considering whether the practice of vocational rehabilitation already includes SMS

The chapter concludes with a hypothesis of the characteristics of SMS for work-related MSDs that are most likely to be effective.

Overview of the Practice of Self-Management Support and Relevant Theory

For the purpose of this review, SMS is defined as education and support provided by health professionals and/or lay leaders to increase patients' ability and self-confidence in managing their health and well-being, typically in the context of living with a chronic condition (Lawn & Battersby, 2008). Generally, SMS programmes are designed to facilitate behaviour change that is required to achieve better health outcomes (Lawn & Schoo, 2010). SMS will typically include the provision of relevant and useful resources; education around how to identify current problems and barriers to self-management; and associated goal setting and problem-solving guidance, with an emphasis on the importance of forming a patient–healthcare provider *partnership*. The programmes also generally reinforce the idea of continued monitoring of progress, paired with active follow-up (Lawn & Schoo, 2010; Sterling et al., 2010). Self-efficacy, which can be defined in a basic sense as the confidence to carry out a behaviour that is necessary to reach a desired goal (Bandura, 1994), is a concept that is central to SM. Self-efficacy is enhanced when individuals succeed in solving problems that they themselves have identified, which is the aim of SM.

Approaches to Self-Management Support

SMS programmes can be delivered effectively in a wide variety of ways, including facilitated groups, individual programmes, telephone counselling programmes, online programmes and even self-instruction (e.g. web based). There are three major modes or approaches to SMS currently available:

1. Group programmes that directly involve those with chronic disease (and sometimes also their caregivers). These programmes are either generic (for any chronic disease) or disease specific. They are typically facilitated by a health professional or lay leader with a chronic condition. This approach requires weekly sessions of approximately 2–2.5 h duration, typically for 4–6 weeks [e.g. the Chronic Disease Self-Management Program (CDSMP) involves two leaders, at least one lay leader with a chronic condition].
2. A care-planning process that is coordinated or administered by the healthcare professional who forms a partnership with the patient, collaboratively identifies current problems to do with their chronic condition and facilitates the management of their chronic condition. An example of this is the *Flinders Program* (Battersby et al., 2007) that is a patient-centred care approach that requires detailed assessment and care planning using standardised tools; identification of high-priority problems; and the subsequent development of specific, viable and action-oriented goals and the effective monitoring of health-related issues.
3. Health coaching or the provision of tools that facilitate the *partnership* between the health professional and the patient. This approach typically involves SMS training for health professionals in order to allow them to relinquish their traditional role of caregiver in order to better facilitate necessary patient health-related behaviour change. An example would be motivational interviewing, which is a patient-centred method that aims to improve intrinsic motivation to change (Lawn & Schoo, 2010). As in the above modes of SMS delivery, this approach emphasises collaborative relationships, the provision of empathy, exploring and minimising resistance to change and increasing self-efficacy (Lawn & Schoo, 2010).

In terms of specific programmes currently available, the CDSMP is a group programme developed by Kate Lorig of Stanford University and is currently the most widely accepted and used SMS tool (Foster, Taylor, Eldridge, Ramsay, & Griffiths, 2007; Lorig, 1996). The CDSMP and the *Expert Patients Programme* or EPP (equivalent programme used in the UK) typically consist of a structured course of six weekly group sessions (with 10–15 participants), each lasting around 2.5 h. Each session is usually facilitated by two trained lay facilitators and/or healthcare professionals. The lay facilitator importantly acts as a role model who is able to empathise with each attendee with a chronic disease. The leaders introduce key topics and provide basic knowledge, resources and skills, but the interaction and participation of the attendees are highly valued and thought of as fundamental to the success of each session and the overall programme. Topics introduced by the leaders include goal setting; problem-solving; positive health-promoting lifestyle changes; symptom, pain and emotional management; communication with health professionals; and the identification of resources (Foster et al., 2007). In addition to the generic CDSMP, there have since been disease-specific versions of the programme developed, such as those for arthritis (Lorig, Ritter, & Plant, 2005), diabetes (Glasgow et al., 2002; Lorig et al., 2010), chronic obstructive pulmonary disease (Bourbeau et al., 2003) and heart failure (Glasgow et al., 2002).

Overview of Relevant Models and Theories

One of the most consistent findings to emerge from the literature is that SMS improves patient self-efficacy (to be reviewed later in this chapter). The original *self-efficacy theory* (Bandura, 1977) was formulated around two types of expectancy beliefs that are believed to be the major determinants of behaviour (goal setting, activity choice, willingness to expend effort, etc.). *Outcome expectancies* are beliefs that certain behaviours result in certain outcomes, and *self-efficacy* entails beliefs that behaviours can be performed effectively in order to give rise to the outcome. Models of health behaviour change (HBC), largely developed to assist in primary prevention, share some important similarities with Bandura's *self-efficacy theory* (Bandura, 1994). The next section will outline models of HBC in the context of recovery and health behaviour for those with chronic conditions, including chronic MSDs. The subsequent section will then introduce the relevant concept of behavioural economics and also provide a brief overview of intrinsic motivation theories as other potential frameworks for understanding health-related behaviour in the context of RTW with chronic conditions.

Models of Health Behaviour Change

Models of HBC, originally put forward to explain behaviours such as overeating, problem drinking and smoking that lead to chronic health conditions (Ajzen, 1991; Dijkstra, Vlaeyen, Rijnen, & Nielson, 2001; Prochaska & DiClemente, 1983; Schwarzer & Luszczynska, 2008), are also very relevant to understanding the processes underlying behaviour change relevant to recovery and health maintenance for those with chronic conditions. For instance, they allow us to understand the processes required to inhibit condition-compromising behaviours in favour of behaviours that are more likely to facilitate recovery and rehabilitation. It is important, however, to realise that behaviour theories have their critics, including among the authors of this chapter! Indeed, there are countless clinician- and patient-related variables that have the potential to influence the health behaviour of a patient with a chronic condition. HBC model critics consider that the complex psychosocial processes that underlie HBC are impossible to be able to comprehensively capture in any one theory. Indeed, the HBC models are probably best thought of as process models. They are atheoretical in that they do not contribute to a better understanding of the psychosocial processes necessary for a person to reach a certain 'stage', nor the individual factors underlying the decisions to change their behaviour.

With these limitations in mind, models of HBC include those that propose that individuals may be placed on a continuum of the 'likelihood of action' based on their intentions. An example includes the *Theory of Planned Behaviour*, which suggests that an individual's attitude towards behaviour, subjective norms and ‘perceived behavioural control’ together shape their behavioural intentions and behaviours (Ajzen, 1991). Importantly, the notion of ‘perceived behavioural control’ originates from *self-efficacy theory*.

Current models of HBC have recently overcome a major criticism of the original continuum models by taking into account the different stages that an individual passes through that give rise to a better prediction of the adoption of a behaviour, actual behaviour change and maintenance of change (Schwarzer & Luszczynska, 2008). The most popular and commonly cited stage model, the *Transtheoretical Model* (TTM) of change, implies that different behavioural interventions should be introduced at appropriate stages of HBC. The TTM, originally described by Prochaska and DiClemente (1983), was initially put forward to describe the behaviour change required to overcome nicotine addiction. However, the general framework and concepts are easily applied more broadly to general HBC (Prochaska & Velicer, 1997). According to the TTM, there are several stages through which individuals need to move to reach a point where they would have sufficient belief in their control over their recovery (akin, once more, to the notion of self-efficacy). Individuals typically begin with showing no intention or motivation to change their behaviour at the first ‘precontemplation stage’, followed by moving to the ‘contemplation stage’, which is followed by the internalisation of the new behaviour at the final two ‘action’ and ‘maintenance’ stages, at which point individuals execute the behaviour change and exert effort to prevent relapse (Dijkstra et al., 2001). According to the recent and relevant adaptation of the TTM specific to MSDs, the *Motivational Readiness for Pain Self-Management* (MRPSM; Jensen, Nielson, & Kerns, 2003), individuals move from the ‘precontemplation stage’ where they have yet to take on any responsibility for pain control and recovery and have no interest in making any behavioural changes to the intermediate ‘contemplation stage’ where there is some consideration of behavioural change associated with a recognition of *personal responsibility* for controlling pain. The final ‘maintenance stage’ is reached when an individual accepts personal responsibility for the management of their condition (Jensen et al., 2003).

The concepts underlying the MRPSM model also quite clearly share many similarities with those of Bandura’s self-efficacy theory. When MRPSM is applied directly to chronic MSDs’ recovery and rehabilitation, it predicts that those with low self-efficacy are unlikely to make much progress in terms of recovery while they believe that they do not have responsibility or control over the recovery process. The TTM model has also been applied recently to the development of a questionnaire to identify readiness for behaviour change for those with chronic pain conditions. The *Pain Stages of Change Questionnaire* (PSOCQ; Kerns, Rosenberg, Jamison, Caudill, & Haythornthwaite, 1997) has been used to determine behaviour change ‘scores’ and, more recently, to predict intervention programme engagement and completion, with promising results (Burns, Glenn, Lofland, Bruehl, & Harden, 2005; Carr, Moffett, Sharp, & Haines, 2006; Habib, Morrissey, & Helmes, 2005; Kerns, Wagner, Rosenberg, Haythornthwaite, & Caudill-Slosberg, 2005). The recent identification of subgroups with distinct ‘readiness’ profiles (e.g. ‘Participation’ and ‘Ambivalent’ groups) using the PSOCQ should enable quite accurate predictions of treatment outcomes, as well as engagement (Fors, Damsgård, Røe, & Anke, 2010). Preliminary support for the validity and reliability of another similar measure, the *Multidimensional Pain Readiness to Change Questionnaire Version 2* (MPRCQ2), has also recently reported (Nielson, Jensen, Ehde, Kerns, & Molton, 2008).

Very recently, the *Health Action Process Approach* (HAPA; Schwarzer & Luszczynska, 2008) emerged in response to a general criticism of the stages of change model that it failed to acknowledge the complexity of an individual’s perspective on behaviour change (Lawn & Schoo, 2010). The HAPA instead views motivation for change as being quite distinct from action and is also better able to account for the period between intentions and action. It proposes two major processes or stages: a pre-intentional motivation process that culminates in the development of behavioural intention and a post-intentional (volitional) process during which the individual gradually adopts, and ultimately maintains, the desired health behaviour (Schwarzer & Luszczynska, 2008). Once a 'good intention' has been developed, it is not automatically transformed into a plan for action. There are many obstacles and barriers that can disrupt this translation and prevent the action from being carried out. In order to bridge this 'intention-behaviour gap', the HAPA proposes the existence of certain volitional factors (such as action planning and volitional self-efficacy) that mediate behavioural outcomes. Of all of the models discussed above, the HAPA stands out as the most relevant framework to apply to recovery from chronic disorders, especially in the specific context of recovery from work-related compensable MSDs. Not only does the model incorporate various forms of self-efficacy that contribute to the recovery process, but it also incorporates potential barriers to implementation of action plans.

Behavioural Economics and Intrinsic Motivation Theories

It is clear that the characteristics of the patient (i.e. attitudes, beliefs, motivation, self-efficacy) have a significant potential influence on functional outcomes, including RTW, for those with chronic work-related disorders, but it is also important to consider the potential influence of context, settings and physical environment on the *extent* of health-related behaviour change (Adams, 2010). For instance, the use of rewards and incentives to increase compliance has the potential to improve outcomes by allowing participants to grasp the concept that decisions in the short term can improve long-term prospects (Thaler & Sunstein, 2008). The general concept of behavioural economics fits with another category of theory relevant to the motivation to, and likelihood of, performing certain behaviours—*intrinsic motivation theories*. This class of theory generally distinguishes intrinsic (personal interest, enjoyment) and extrinsic (other incentives, such as rewards) motivation. An example is *Self-Determination Theory* (SDT; Deci & Ryan, 1985). This theory is based on the notion that we, as humans, are motivated to maintain an optimal level of stimulation, but that we also strive towards competence and self-determination. SDT purports that self-determination occurs when the reasons for engaging in a particular behaviour are fully internalised. There are sequential stages or levels through which an individual must work in order to attain internalisation of behaviour and self-determination (Ryan & Deci, 2001). As individuals move from unmotivated to more motivated states, the regulation of their behaviour changes from being externally motivated to internally regulated and more self-determined. External regulation is the least autonomous form of motivation. At this stage, individuals engage in behaviour for external reasons and are controlled by rewards or threats. In contrast, internally motivated individuals perform an activity more out of interest or fulfilment (Ryan & Deci, 2001). In the context of work-related MSD recovery, when a patient attends a rehabilitation session as a means to improve function and reduce pain, this represents higher levels of internalisation and self-determination. Identifying the particular state of regulation for those with chronic, compensated work-related disorders could potentially allow us to determine the type of intervention that individuals are likely to be responsive to when HBC is required. However, the theory is less directly applicable to predicting the potential effects of SMS than the models of HBC discussed above. Nevertheless, it may become more useful in the future as workers' compensation systems and workplaces become more adept at creating effective incentives and disincentives for RTW, as must inevitably happen.

What Do We Know About Recovery from Chronic Conditions, Including Work-Related Musculoskeletal Disorders?

The biopsychosocial model (Engel, 1977) is acknowledged by many in the general field of illnesses as the best suited to explain the long-term disability process experienced by those with chronic conditions. The biological aspects of a chronic disease or injury are insufficient to explain the long-term, complex and variable recovery process in this group. It is essential to take into account the psychological and social dimensions relevant to living with chronic pain and a long-term condition (Weinstein, 1968). Chronic illness is challenging to treat because, by definition, it has a prolonged course and requirement for ongoing management, with often complex causal factors and bouts of serious functional impairment. The majority of current medical approaches are better at treating acute, transient conditions than chronic disabling conditions (Holman & Lorig, 2004). Indeed, current clinical guidelines regarding chronic pain conditions, such as low back pain, strongly suggest that healthcare should be kept to a minimum and self-care encouraged (Snook, 2004). As more research is carried out into forms of treatment interventions for individuals with chronic conditions,[1] it is starting to emerge that multidisciplinary treatment programmes are more effective than interventions that only address a single aspect of chronic injury and pain (Battersby et al., 2010; Wagner et al., 2001). It is also being recognised that the provision of relevant information and ongoing support is an essential component of treatment for those with chronic conditions if patients are to be encouraged to become effective managers of their own health and well-being (Wagner et al., 2001). Indeed, as recognised by Bodenheimer, Lorig, Holman, and Grumbach (2002), healthcare professionals should really be thought of as facilitators and consultants who support the chronically unwell person in their role as the principal caregiver. Therefore, it seems quite intuitive that SMS should be useful in facilitating and empowering individuals with chronic conditions to take on the role as the principal manager of their condition which should, in turn, result in improved functional outcomes.

Similar to the research showing the benefit of multidisciplinary rehabilitation programmes for those with chronic conditions generally, it has also become evident that multidisciplinary programmes are better at improving functional status and increasing the likelihood of returning to productive work for individuals with chronic MSDs and pain conditions (Gatchel & Okifuji, 2006; Sullivan, Adams, Rhodenizer, & Stanish, 2006). Of considerable importance, however, is the recognition of substantial psychosocial barriers for those with chronic conditions attempting to return to a functional life, including returning to work. Perhaps it is not surprising, then, that we see high rates of treatment refusal and dropout, poor adherence and frequent relapse following treatment for those with chronic pain conditions (Turk & Rudy, 1991). The psychosocial issues may be further elevated in those who have been injured in the workplace and receiving compensation. For these individuals, there can be the overlay of associated stigma, frustration, feelings of low self-worth and powerlessness, for example, that come along with living with a work-related compensated condition. After workplace injury, injured workers are forced to deal with a complex and difficult reality, involving loss of income, reduction in general functional ability and quality of life, as well as secondary psychosocial issues such as lowered self-efficacy and depressed mood (Franche et al., 2009). Moreover, injury compensation systems have a tendency to distort and complicate the recovery and RTW process (Eggert, 2010). For instance, evidence suggests that injured workers on compensation (i.e. those who are being paid as a result of their disability) will behave differently to those with equivalent injuries who are not compensated (Mayer & Polatin, 2000) and will have slower recovery (Cameron, 2011). Research has shown that it is unlikely that individuals who have been off-work due to chronic pain for 2 years post-injury will RTW (Watson, Booker, Moores, & Main, 2004). Indeed, there is increasing consensus that the poor health and vocational outcomes of workers with long-term workers' compensation claims

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[1] For more details, see the Chronic Care Model proposed to improve standards for chronic illness care from a healthcare systems perspective: Wagner, E. H., Austin, B. T., Davis, C., Hindmarsh, M., Schaefer, J., & Bonomi, A. (2001). Improving Chronic Illness Care: Translating Evidence Into Action: Interventions that encourage people to acquire self-management skills are essential in chronic illness care *Medicine and Chronic Illness* (Vol. 6, pp. 64–78).

are, to some extent, explained by barriers to RTW created by policies and procedures of the workers' compensation systems (MacEachen, Kosny, Ferrier, & Chambers, 2010).

From the point of view of SMS, an important but neglected vulnerability of this particular group is to depression. A recent, large-scale prospective study, of over 400 workers following sustaining a work-related MSD, reported that depressive symptoms were pervasive in this group. However, they were rarely diagnosed or treated (Franche et al., 2009). As was found by Franche et al. (2009), 27 % of their injured-worker sample showed high depressive symptom levels at 1 month post-injury and, of those, nearly 50 % showed symptom persistence at 6 months. In addition, approximately 40 % of workers who had not returned to work at 6 months post-injury had high self-reported depressive symptom levels. It follows that the inertia, lowered self-efficacy and apathy associated with depression have a high probability of compounding the situation and further retarding functional recovery and RTW, and probably participation and engagement in SMS programmes.

How Effective Is SMS in the Context of Chronic Conditions Including MSDs?[2]

There is a long history of the use of self-management in the general context of chronic conditions. Systematic reviews of quantitative controlled trials of self-management education programmes for chronic conditions, including arthritis, asthma, hypertension, diabetes and other conditions, have found small-to-moderate clinical effects for people with diabetes, hypertension and asthma, but not for arthritis (Chodosh et al., 2005; Warsi et al., 2004). However, results of a more recent systematic review suggested that SMS programmes may have a small-to-moderate effect in improving pain and disability for those with arthritis in the *long term* that is not significant in the medium term (Du et al., 2011). The recently conducted Cochrane systematic review of lay-led SMS intervention programmes (based on a meta-analysis of 17 randomised controlled trials) found a significant, yet modest, improvement in self-efficacy in managing symptoms, improvements in perceptions of health and increased regularity of aerobic exercise as a result of lay-led SMS intervention programmes (Foster et al., 2007). Also reported were (apparently clinically unimportant) improvements in pain, disability, fatigue and depression (Foster et al., 2007). Specific to MSDs, recent systematic reviews of the effectiveness of SMS for those with chronic *low back pain and osteoarthritis* (highly prevalent MSDs) showed consistent but small (moderate at best) treatment effects, with improvements in areas such as pain levels and general function and, also quite often, in health behaviours, psychosocial well-being and overall affect (Du et al., 2011; May, 2010; Warsi, LaValley, Wang, Avorn, & Solomon, 2003; Warsi et al., 2004).

SMS programmes, using a variety of delivery methods, have resulted in functional improvements such as decreased pain severity, pain interference and general disability, and improved psychosocial well-being, such as lower stress, depression and anxiety (Chiauzzi et al., 2010; Nicholas et al., 2012; Ruehlman, Karoly, & Enders, 2012) for those with chronic pain conditions and MSDs. We also see evidence of the adoption of SM strategies for those with chronic MSDs/pain after SMS education, such as increased use of positive self-talk, greater use of social support, increased time spent in physical activity and improvements in self-efficacy (Chiauzzi et al., 2010; Damush et al., 2003; Von Korff et al., 1998). These results are very similar to those shown by the mixed chronic condition groups (Kellett et al., 2011; Lorig et al., 2001, 2005, 2010; Swerissen et al., 2006), although there is some evidence that the condition-specific programmes (such as the ASMP for those with arthritis) have slightly better outcomes early on (Lorig et al., 2005; Warsi et al., 2004). Importantly, systematic reviews and meta-analyses show that knowledge alone is not enough. Successful intervention programmes need to

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[2] See Appendix for details regarding the literature review methodology.

include skills and to encourage behaviours, as well as provide knowledge (Battersby et al., 2010).

There has been a recent movement away from the more traditional group-based SMS interventions to the more convenient/less labour- and resource-intensive, interactive web-based and telephone-based SMS interventions. Although there is some preliminary emerging evidence of the potential effectiveness of these novel modes of delivery of SMS (Chiauzzi et al., 2010; Jerant, Moore, Lorig, & Franks, 2008; Ruehlman et al., 2012; Solomon, Wagner, & Goes, 2012), further evidence of relative effectiveness is required. Yet another mode of delivery that is convenient for participants, but far more resource and labour intensive, is the home-based delivery method such as the *Homing in on Health* programme (Jerant et al., 2008). There has been some success with this latter mode of delivery in the form of improved secondary health outcomes (found to be superior to delivery by telephone). However, evidence to date suggests it is still inferior to group-based delivery of SM principles (Jerant et al., 2008). Of the recently reported SMS intervention programmes that were group based, most involved an additional non-group-based component. An example of this novel multimodal delivery involved three group sessions and a subsequent telephone follow-up that delivered additional SMS (Damush et al., 2003). Another involved a four-session group-based intervention that also provided self-help material in the form of a book and a video (Von Korff et al., 1998). Interestingly, the latter study showed evidence of sustained effects (lower levels of disability, less worry about pain and more confidence in self-care) for the intervention group at the 12-month follow-up period. Finally, yet another emerging mode of delivery is the staged approach, such as the SCAMP intervention (Damush, Wu, Bair, Sutherland, & Kroenke, 2008), which combines the treatment of any current problematic clinical symptoms (in this case, the optimization of antidepressant medication) at Stage 1, with the standard group SMS programme (Stage 2). The importance of minimising the effects of depression was illustrated by a recent systematic review (Miles et al., 2011) that reported consistent evidence that depression (and self-efficacy), at baseline, predicts SMS outcomes. Although still early in development, it seems that SCAMP offers some promise in terms of its efficacy for those with chronic conditions and depression symptoms.

A clear message that came from the qualitative studies in the area of SMS and chronic pain conditions, including MSDs, was that not all aspects of self-management programmes suit all individuals and that there may be some promise in the idea of tailoring SMS programmes to the affected person, setting or context (Hamnes, Hauge, Kjeken, & Hagen, 2011; Johnston, Irving, Mill, Rowan, & Liddy, 2012; Matthias, Miech, Myers, Sargent, & Bair, 2012). The nature of chronic pain conditions, especially chronic lower back pain (CLBP), is such that participants have generally tried a variety of ways to manage their pain (e.g. medication, exercise and the use of heat), with limited success. There is also a potential lack of awareness in patients of the full range of self-management strategies that can be useful in ongoing management of chronic MSDs (Crowe, Whitehead, Jo Gagan, Baxter, & Panckhurst, 2010). Matching SMS techniques to individuals is in its early stages. Interestingly, the recognition that patients' responsiveness may vary over time is an area of potential benefit which has been neglected. In fact, no studies of SMS for MSDs were identified that considered the most appropriate *time* point post-injury to deliver the programme effectively, yet the authors' experience with an RCT suggests this is likely to be an important determining factor in terms of the potential success of the intervention (Ellis et al., in preparation).

Because there are so many varieties of SMS education programmes, it is difficult to determine from the literature to date which programme elements are essential, or the extent to which process variables (e.g. differences in leader training, communication style and knowledge, programme format and content) affect outcomes (Bodenheimer et al., 2002; Chodosh et al., 2005). The potential for leader characteristics to affect outcomes was recently investigated by a Cochrane systematic review of the effectiveness of lay-led SMS interventions, which found that (based on limited available evidence) lay-led programmes are just as effective as health practitioner-led programmes in the context of chronic conditions in general (Foster et al., 2007). Also of consideration, patient attributes (such as education level, health literacy, condition severity and duration, current treatments, social support and self-efficacy) are rarely reported and have not been controlled for within studies (Warsi et al., 2004). Recent discussions on healthcare reform have highlighted the importance of taking *health literacy* into account as a potential mediator of outcomes for any healthcare intervention with an educational component (Adams, 2010). *Health literacy* may be defined as an individual's ability to source, comprehend and utilise health information. Findings suggest that health literacy can indeed influence SM practices and skills (Institute of Medicine, 2004; Williams, Baker, Parker, & Nurss, 1998) and also that functional health literacy predicts self-efficacy in certain chronic conditions (Ishikawa & Yano, 2008; Wolf et al., 2007). Clearly, health literacy is a factor that deserves consideration when evaluating the efficacy of SMS intervention programmes. Greater tailoring of SMS programmes to individual needs may improve engagement. In SMS, this may take the form of basic facilitation, such as the provision of transportation, to more effortful modifications of programmes that enable tailoring to specific subpopulations, such as tailoring to persons with low health literacy or to those at a particular stage of recovery. Indeed, the extent to which patients with chronic conditions accept responsibility for the maintenance of health and management of their condition has been shown to vary (Larsson, Nordholm, & Ohrn, 2009). Without a more tailored approach, attrition is likely to remain high and effect sizes small.

Overall, one of the most consistent positive outcomes of SMS is improvements of self-efficacy in symptom management (Adams, 2010; Foster et al., 2007). Other than changes in self-efficacy, evidence suggests that SMS programmes for chronic conditions, including MSDs, are more effective than providing resources and information alone to patients in terms of improving *selected* clinical and functional outcomes (Chiauzzi et al., 2010). The extent and variety of outcomes that change after exposure to SMS is likely determined by various patient group and intervention characteristics. It is difficult to determine characteristics of success of SMS for chronic conditions, including MSDs, from the current evidence base, and only time will tell whether the novel multimodal interventions are more successful than traditional group-based programmes with their small-moderate effect sizes. Recent studies suggest that future directions lie in tailoring SMS more to individual readiness and needs. Evolving models of HBC suggest there is potential value in classifying patients in terms of their level of readiness to take responsibility for the ongoing management of their conditions (Burns et al., 2005; Kerns et al., 1997; Kerns & Rosenberg, 2000), and there has been some success in developing instruments to do this (Kerns et al., 1997). Evidence on cost-effectiveness of SMS interventions is limited (Battersby et al., 2010). However, Bodenheimer et al. (2002) found that SMS programmes for patients with a variety of chronic conditions improved both outcomes and reduced costs.

How Effective Is Self-Management Support in the Context of Chronic, Compensated Work-Related MSD?

Despite the importance of work in today's society (and, therefore, as a functional outcome of recovery or rehabilitation from chronic conditions), there is a paucity of controlled trials in the literature examining the effectiveness of SMS interventions for those with chronic pain and MSD conditions in terms of work capacity and RTW outcomes. Of the few that have been conducted which specifically target functioning in the workplace, it has been found that SMS programmes conducted within the occupational setting are effective for chronic MSD conditions (May, 2010). A systematic review found that vocational rehabilitation interventions, based on empowerment and aimed at job retention, are also effective (Varekamp, Verbeek, & van Dijk, 2006). However, despite it seems intuitively logical, very few studies to date have directly assessed the potential benefit of adding SMS to vocational rehabilitation for those with work-related MSDs. Of relevance, one particular recent study (Barlow & Ellard, 2007) reported on the EPP, a lay-led self-management intervention that was already widely used and accepted as a community-delivered programme in the UK for those with chronic medical conditions (not specific to MSDs). This study carried out a qualitative examination into the effectiveness of the EPP in the *workplace* setting. Results were not conclusive due to a small sample size and their qualitative nature, but suggested that employees working with chronic conditions were generally poor at managing their condition in the workplace and that there was a potential benefit from the introduction of SMS. Another study combined cognitive behavioural therapy (CBT) and SM reconditioning for a group of accident-compensation claimants (not specific to occupational) with disabling musculoskeletal pain (Taylor, Simpson, Gow, & McNaughton, 2001). The programme was reported to result in a 75 % vocational success (including 59 % RTW F/T or P/T and 16 % actively looking for work). However, there was no control group or usual care comparison, and these results are consistent with the normal progression to RTW experienced by accident-compensation schemes. Finally, another RCT showed no benefit in RTW from the inclusion of SMS for patients with schizophrenia (Vauth et al., 2005).

Extending the literature search to include studies that have looked at introducing SMS to *prevent* work disability, a few more studies emerge. An important proof-of-principle study (Lacaille et al., 2008) evaluated a pilot SMS programme aimed at preventing work disability and improving current work productivity in workers with inflammatory arthritis. This demonstrated that the modified SMS programme was feasible to conduct external to the workplace and was also well received by participants. Participants reported increased self-efficacy in managing problems in the workplace, reduced fatigue and increased productivity. Following up from this preliminary study, another study systematically evaluated whether SMS principles may be useful for adults in the workplace who have persistent or recurrent pain and injuries in order to sustain employment and prevent (further) work disability (Shaw et al., 2012). The study outlined a preliminary hypothetical SMS programme that deals specifically with workplace pain concerns. However, a number of individual- and workplace-based barriers were noted. Despite these viability issues, there were several potentially beneficial outcomes described for both employers and employees that make the concept worthy of further exploration (Shaw et al., 2012). Similar to the notion of self-management, Samoocha et al. (2011) recently raised the idea of ‘empowerment’ being key to the rehabilitation process for those with long-term disabilities; an outcome that is central to SMS. The idea is to stimulate a shift of care responsibility to individuals and allow a person to be the designer of his/her own route back to work. A recently reported randomised controlled trial of one such ‘empowerment’ training programme, which was implemented to enhance the knowledge base, self-awareness and problem-solving in the workplace for individuals with chronic physical disease (Varekamp, Krol, & van Dijk, 2011), showed that self-efficacy, mental quality of life and fatigue levels improved in the intervention group. The workers themselves also reported that they felt an improvement in their work function and satisfaction levels.

A discussion of the potential efficacy of SMS for those with chronic work-related MSDs would not be complete without consideration of the potential barriers to implementation, which are many. Individual psychosocial factors, including frustration, depression and discrimination, are highly prevalent in those with compensated work-related MSDs and are likely to affect both engagement in and outcomes of SMS programmes (to be discussed in the next section). There is also the issue of general diversity and heterogeneity of individuals with chronic work-related disorders. The idea of adapting SMS to specific workplaces and tailoring to meet the needs of different cultures and groups has not yet been thoroughly explored (Griffiths et al., 2005; Shaw et al., 2012). External barriers within the healthcare system are also relevant to the potential success of SMS in the context of work-related compensable MSDs. A review of the implementation of the EPP into the National Health Service (NHS) has suggested that the lack of engagement and promotion by healthcare professionals contributed greatly to its limited uptake (Bury & Pink, 2005; Kennedy et al., 2004). As suggested by Jordan and Osborne (2007), healthcare professionals treating those with chronic conditions need to facilitate and promote SMS for patients with chronic conditions and injuries if we are to see a better uptake of SMS. They can also act to ensure that minority groups are especially encouraged. Vocational rehabilitation practitioners should be well placed to play such a role in the setting of work. At present, the availability of SMS is also limited, and SMS programmes that address the specific needs for those with chronic compensated MSD injuries are rare, if they exist at all. To overcome this major barrier and to provide compensated injured workers access to such programmes, the system or insurance companies first need to be convinced that SMS can make a difference to key client outcomes, including RTW. As reported by Battersby et al. (2010), however, there is little evidence at this stage as to whether SMS is cost-effective. Data on improved client outcomes and cost-effectiveness of SMS programmes tailored to the needs of people with compensated work-related MSDs will allow policymakers and funders to make informed decisions about the value of introducing SMS into vocational rehabilitation.

Current Practice of Vocational Rehabilitation: Does It Already Incorporate the Principles of SMS?

Most compensation systems or insurance agents dealing with work-related injuries have outsourced the management of rehabilitation to vocational rehabilitation (VR) providers and, in some countries, the employer shares part of the VR responsibility (such as Germany and Sweden; Chamberlain et al., 2009). VR is provided in most developed nations (Baker, Goodman, Ekelman, & Bonder, 2005), the general aim of which is to facilitate the access, maintenance or return of injured workers to productive employment (Chamberlain et al., 2009; Li, Li-Tsang, Lam, Hui, & Chan, 2006). Timeliness is key, as evidence suggests that the chances of returning to work significantly decrease with time. Despite the importance of establishing effective practices in VR in terms of improving health outcomes and minimising productivity losses and healthcare costs for injured workers, available evidence suggests that current unimodal VR programmes are not very effective. Indeed, evidence suggests that the most effective models of VR are multimodal models, or VR models that use a broad, coordinated, comprehensive rehabilitation programme, usually with a combination of medical and psychosocial approaches, such as CBT, with physical activities, training or physiotherapy (Chamberlain et al., 2009). To illustrate, one particular insurance company in Switzerland, which services 67 % of the population of workers, provides three types of services, dependent on the type of condition, prognosis and needs of the individual and, as a result, maintains remarkably high levels of client satisfaction and has seen a substantial drop in the proportion of disability pensions offered (Chamberlain et al., 2009).

There is emerging consensus, not only from the perspective of the worker but also from that of case managers, employers, workers' compensation personnel and VR providers, that there are serious problems with current vocational injury management and rehabilitation (Roberts-Yates, 2003). Although this report was specific to vocational injury management and rehabilitation processes within Australia, it is unlikely that these issues are unique to the Australian workers' compensation system. Furthermore, there is a growing understanding that the processes of workers' compensation system delay injury recovery (Cameron, 2011). The involvement of third parties (insurers, government bodies, unions, lawyers) takes away the onus of responsibility for recovery from the injured person. Despite considerable inter-system and legislation differences, the management of the RTW process tends to be highly structured, which leaves little room for injured workers to make decisions or to have a significant say in their rehabilitation (Cameron, 2011). In other words, work-related compensation systems tend to disempower already vulnerable individuals who face major issues during their injury compensation journey, such as low self-worth, financial instability, traumatic workplace relationships, feelings of disempowerment, shame, loss, anxiety and depression, general problems in emotional control and management, as well as secondary family relationship issues, among others (Eggert, 2010; Franche et al., 2009; Roberts-Yates, 2003).

The past few decades have seen the necessary shift in the VR model from the traditional medical remediation-based care to a biopsychosocial model that also incorporates an aspect of work-disability prevention (Schultz, Stowell, Feuerstein, & Gatchel, 2007; Xu et al., 2007). Quite recently, some countries have also introduced multimodal models of VR (Chamberlain et al., 2009) which seem to be more effective than unimodal models. Indeed, the definition of VR put forward by the International Labour Organization (1998) explicitly acknowledges that the psychological, social and occupational aspects of work disability, as well as the medical, all need to be addressed as part of vocational rehabilitation. In terms of whether SMS is already incorporated into current VR practices, a recently published study that examined high-level policy in a leading national provider of vocational rehabilitation (in Australia) showed that, despite a policy that encourages tripartite decision-making among the injured worker, employer and healthcare provider, the current practice of vocational rehabilitation does not incorporate self-management strategies or principles (Ellis, MacKenzie, McLeod, & Battersby, 2011). This study showed very little evidence of the active engagement of the injured workers themselves in their recovery. This is surprising given that it is common practice for regulators to recommend that VR services should focus on (at least in part) empowering individuals (Victorian WorkCover Authority, 2012). This can be contrasted with the outpatient or in-residence occupational rehabilitation programmes provided in Norway that tailor programmes to individuals and also target self-efficacy for injured workers. Their residential programme focuses on both individual- and workplace-related factors to enhance RTW, and interventions offered as standard practice focus on overcoming RTW-relevant issues identified during the assessment, building self-confidence and training in stress management (Haugli, Steen, Lærum, Nygard, & Finset, 2001). Therefore, it seems that while some current VR practices do incorporate aspects of SMS, most do not. The introduction of SMS principles to a VR-service delivery model is intuitively logical (Cameron, 2011; Ellis et al., 2011), as it has the potential to re-empower individuals who have been disempowered by the compensation system and to improve the RTW outcomes for these individuals.

Inclusion of SMS in Vocational Rehabilitation

As discussed above, individuals with chronic disorders, especially those who are off-work and on workers' compensation, feel disempowered, disenchanted with the system, frustrated, depressed and anxious about their future. They also quite often fail to take ownership of their recovery or rehabilitation. Work-related conditions are often attributed to the employer or to workplace health and safety issues and, as a result, workers with the conditions tend to believe that the system, the employer and the insurer are together responsible for their recovery, including getting them back into the workplace. Indeed, a recent study found that having a MSD, being physically inactive and taking MSD-related sick leave were all strongly associated with the most *external attitude* in the 'responsibility self-active' dimension of the Attitudes regarding Responsibility for Musculoskeletal Disorders (ARM) instrument (Larsson et al., 2009). In addition, due to the rigid structure of occupational rehabilitation for chronically injured workers in the workers' compensation system and other constraints placed on individuals from insurers, most feel as if the decisional control has been taken away from them (Ellis et al., in preparation). Taken together, those with chronic, compensated MSDs are likely to believe that the responsibility for their rehabilitation and recovery is not their own.

The HAPA (Schwarzer & Luszczynska, 2008) would suggest that once an injured worker intends to RTW (i.e. the 'good intention' has been developed), efforts should be focused on the potential obstacles and barriers that can disrupt the translation of intention into action and, in doing so, facilitate the goal-related action of RTW. Self-efficacy is a key factor during this 'intention-behaviour gap': if action self-efficacy is strong, then individuals have a much greater likelihood of succeeding in reaching their behavioural goal, in this case, RTW. SMS aims to improve self-efficacy for managing chronic conditions and developing healthy lifestyles, and one of the most consistently reported functional outcomes of SMS is improved self-efficacy. Assuming that it was possible to engage these individuals to attend and complete an SMS programme, it follows that improvements in self-efficacy and recovery outcomes, including RTW, should result.

Can We Predict the Specific Type of SMS that Is Most Likely to Be Effective?

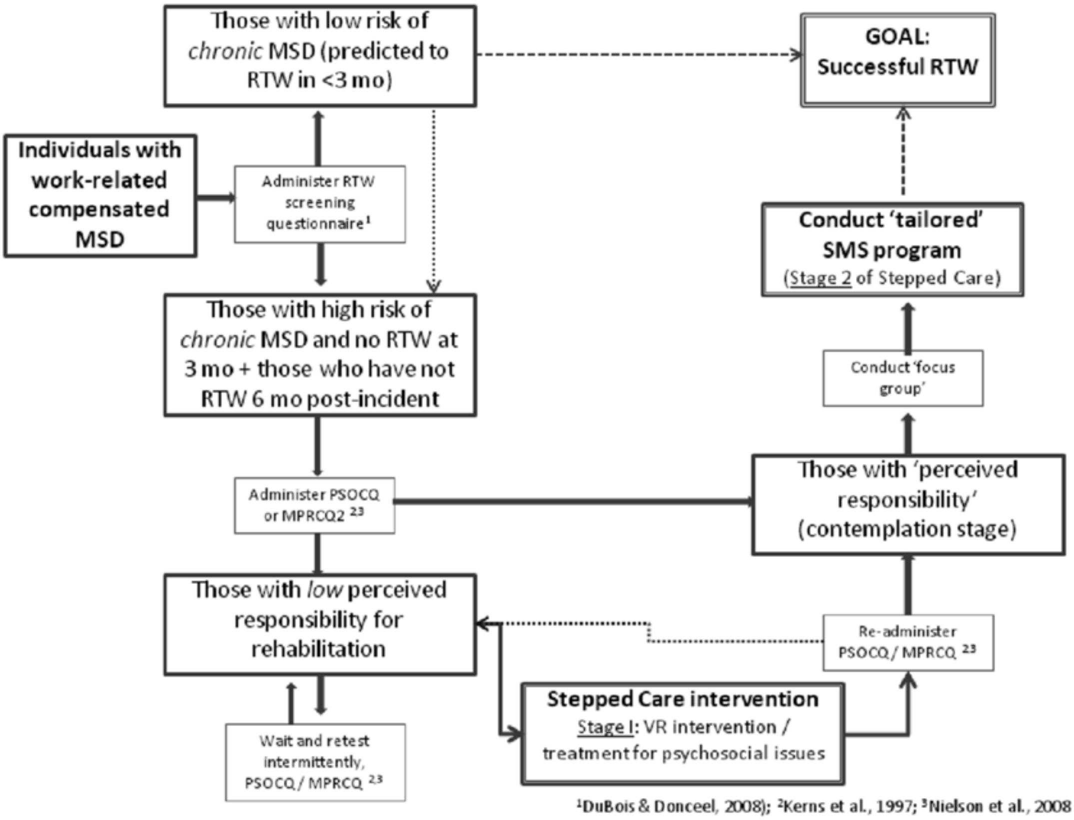
Standard SMS programmes do not include resources and problem-solving about the RTW process and the compensation system. The compensation system is an 'obstacle course' in the recovery process for these individuals, especially for those with chronic MSDs who take longer to RTW. For that reason, returning to work after being off-work due to injury and on compensation can be a daunting process (Ellis et al., in preparation). Among other things, the stigma associated with being on workers' compensation and the fear of re-injury are major obstacles to overcome (Lippel, 2007). It seems logical that if SMS were to be tailored to this group of individuals, so that it provided resources and dealt with problem-solving around issues directly related to RTW and the workers' compensation system, we would see a better engagement and lower attrition. Meeting the needs and expectations of the person with a chronic condition predicts programme completion and is also associated with improved outcomes (Wagner et al., 2001). Of the few SMS programmes that have been trialled in the workplace setting, one recently reported that a key theme noted by participants was that the (standard) self-management programme was more focused on *living with* a chronic condition, as opposed to working with one (Barlow & Ellard, 2007). It was further suggested that future programmes should incorporate more practical information about *working* with a chronic injury and how to go about seeking support when required. It stands to reason that undertaking SMS education with more directly relevant resources and problem-solving skills would improve the 'action self-efficacy' for the injured worker around these specific issues. According to the HAPA, we would be far more likely to see the good intentions of those wanting to RTW be transformed into a plan of action and then carried out, theoretically improving the likelihood of a successful RTW and its maintenance.

Overcoming other potential obstacles and barriers for injured workers to facilitate programme engagement is also another area that warrants consideration (Damush et al., 2002; Gucciardi, Demelo, Offenheim, & Stewart, 2008; Swerissen et al., 2006). Some of those can be potentially overcome by offering a more flexible mode of delivery (e.g. the development of interactive web-based SMS programmes). As noted earlier, we are starting to see more innovation in modes of delivery for SMS that will, hopefully, see an improvement in uptake of SMS education and completion of programmes. A 'stepped-care' intervention that first addresses major clinical psychosocial issues for workers with chronic compensated MSDs may also be worthy of consideration. For example, the SCAMP intervention (Damush et al., 2008) is a stepped-care approach that delivers a combined medication and SMS behavioural intervention for primary care patients with chronic musculoskeletal pain and depression. Clearly, there are barriers to adopting such a resource-intensive programme, but for those whose psychosocial issues prevent them from participating in or seeing the full benefits of SMS, this approach may be relevant. Other research, as well as the authors' own experience implementing an SMS intervention (RCT) with those with chronic, compensated work-related MSDs (Ellis et al., in preparation), suggests that the SMS needs to be offered at the appropriate 'time' post-injury. Some good research is now being conducted using appropriate models to predict the likelihood of behaviour change. For example, a very recent study used the MRPSM model (Jensen et al., 2003) with patients with chronic disorders and pain and demonstrated a clear need for interventions to address patient motivation if they are to be successful (Tkachuk, Marshall, Mercado, McMurtry, & Stockdale-Winder, 2012). A worker needs to reach the stage of acceptance of his/her disorder as a chronic condition and one that requires ongoing attention (Jensen et al., 2003). The MRPSM contends that individuals start at the 'precontemplation stage' where they have yet to take on any responsibility for pain control and recovery and have no interest in making any behavioural changes. If SMS was introduced at this early stage, then it is likely that we would see little or no benefit from SMS. Indeed, Tkachuk et al. (2012) showed that those with lower levels of perceived responsibility for pain control, and who have not yet reached the stage of 'contemplating' self-management, were more likely to fail to complete the intervention programme. More importantly, those with higher levels of perceived responsibility for pain control, and who had also reached the stage of contemplating self-management, were *more* likely to complete the intervention programme (Tkachuk et al., 2012). Conversely, if SMS were introduced at a much later stage, we may also be less likely to see a convincing benefit in terms of functional outcomes. The psychosocial complexities and very low self-efficacy of individuals who have been off-work due to occupational injury for prolonged periods are such that they are resistant to the idea that any treatment will be able to help their situation (Ellis et al., in preparation). It follows, then, that the ideal stage to implement SMS is the intermediate 'contemplation stage' where there is (importantly) some consideration of behavioural change associated with recognition of *personal responsibility* for managing their chronic MSD condition. SMS, if offered at this time, should improve self-efficacy and, theoretically, help individuals reach the final 'maintenance stage', at which they accept responsibility for the ongoing coordination and management of their condition and also show increased self-efficacy in this area.

This chapter, thus far, has integrated relevant theory, reviewed research that has explored the efficacy of SMS for chronic conditions generally, discussed the limited research that has been conducted with those with chronic compensated work-related MSDs and reviewed the experience of our current randomised controlled trial of a tailored SM programme for these individuals. The authors have concluded that, based on current knowledge of the theory, practice and effectiveness of SMS, SMS has the potential to aid in the recovery of chronic compensated MSDs. However, the complexity of systems and settings in which SMS would be offered demands greater attention to the design of such programmes. SMS programmes for chronic compensated MSDs will need to ensure that they are offered at an optimal point in the recovery pathway, are tailored to address RTW and navigating the workers' compensation system, reinforced by vocational rehabilitation practitioners and workplaces and meet best-practice criteria for delivery channels. Notwithstanding the barriers that the implementation of this type of intervention must overcome, it seems that we are not far from determining whether this sort of approach is viable and effective with this particularly complex group.

Hypothesis and Plan

The stage of 'motivational readiness' or perceived responsibility for rehabilitation is likely to be highly informative as to whether workers with chronic compensated MSDs are 'ready' to undertake training in self-management principles to facilitate their functional rehabilitation and RTW. A theoretically informed plan that takes this into consideration is presented in Fig. 22.1. As can be seen, the first step is to identify those who are likely to become chronic (i.e. who are predicted to not have returned to work in 3 months). There has recently been significant research on this subject, and various screening tools have been developed. Our ability to identify those who will not RTW within a short time frame is likely



¹DuBois & Donceel, 2008); ²Kerns et al., 1997; ³Nielson et al., 2008

Fig. 22.1 A theoretically informed plan to introduce SMS into vocational rehabilitation for those with chronic compensated musculoskeletal disorders

to continue to improve in the short to medium term. For example, Du Bois and Donceel (2008) reported preliminary evidence of the effectiveness of a screening questionnaire to predict individuals who fail to RTW within 3 months post-onset of the MSDs. The patients' own expectations surrounding RTW were highly predictive of RTW outcome at 3 months, as was their perceived severity of pain (Du Bois & Donceel 2008). By using this, or similar, validated screening tools, workers who are *unlikely to have returned to work at 3 months post-onset* would be identified and referred for consideration for SMS (along with other management as part of standard vocational rehabilitation).

The next step would be for the VR to assess the motivation for self-management. The PSOCQ (Kerns et al., 1997) or the MPRCQ2 (Nielson et al., 2008), both based on the TTM of behaviour change, could be used by the VR practitioner to periodically assess the readiness to accept responsibility for injury management. Those identified with score profiles indicative of very little or no perceived responsibility for self-management, and who are at the precontemplation stage for self-management, are unlikely to be open (as yet) to the principles of SMS. This group of individuals is likely to need more time to get their symptoms/health under control before undertaking such an intervention. A 'stepped-care approach' should be offered to this group that firstly addresses potential barriers through VR and/or treats underlying psychosocial issues (see Fig. 22.1). The ultimate aim of Step 1 is to enable the worker with a MSD to reach the contemplation stage, as per the MRPSM model (Jensen et al., 2003). The ideal time to introduce SM education is once individuals have formed the 'good intention' to RTW (i.e. those who have reached the contemplation stage and are ready to consider accepting responsibility for the management of their condition). By targeting only those people with chronic MSDs with higher levels of perceived responsibility for the management of their condition and pain control, and who are at the stage of contemplating self-management, the authors hypothesise that improvements in SM programme attendance, completion (as has been found by Tkachuk et al., 2012) and subsequent functional outcomes would be achieved. In order to further maximise the SMS engagement by these individuals, the specific characteristics of the SMS programme itself should be considered carefully. The programme should also be available in a mode of delivery that is convenient for the majority of the target population (Damush et al., 2002; Swerissen et al., 2006). Preliminary focus groups (see Fig. 22.1) with the target population would allow a well-informed decision to be made as to the ideal mode of delivery (e.g. multimodal, web-based interactive). However, it should be one that involves at least some exposure to group sessions, as evidence suggests that this is the most effective mode of delivery in terms of outcomes for those with chronic conditions. Providing content that is currently unavailable in generic SMS programmes (e.g. managing RTW and navigating the workers' compensation system) and relevant problem-solving skills would also improve the 'action self-efficacy' for the injured worker around these specific issues. Notwithstanding VR provider and compensation barriers, should the plan be introduced for workers with a chronic compensated MSD, the authors hypothesise that the addition of SMS to VR will contribute to improving the rate and sustainability of RTW.

Concluding Remarks

Given the evidence of the substantial influence of individuals' beliefs about their own abilities to effect behavioural change with regard to chronic condition management and also the influence of self-perceptions of health status on work disability, it is not surprising that self-management is on the agenda as part of the future for health reform in developed nations. SMS aims to empower patients to develop skills and techniques to enhance self-care and management of their chronic conditions. There is growing concern that the evidence base to support vocational rehabilitation interventions is still weak. We know that people with compensated conditions have slower recoveries than people with similar conditions who are not receiving compensation and that people in compensation systems feel disempowered. Theoretically, self-management should assist. We are currently on the cusp of determining whether this sort of approach is viable and effective with this particularly complex group. We have learned that there are many barriers—some that can potentially be overcome and others that we need to be aware of and work with. There are also still other questions. One is WHEN is the best time to introduce SMS? Is it best to introduce to those who are currently working with a MSD (prevention of disability/maintenance approach; e.g. Shaw et al., 2012), or is it post-onset for those who have been identified as having *chronic* MSDs and, if so, when during their injury recovery process? We also need to consider the potential modifying effects of patient group characteristics on RTW outcomes, from the individual level up to the societal level. Indeed, the literature has reported influences at the individual level (such as worker characteristics, characteristics of the condition, exposure to medical treatments and/or occupational rehabilitation programmes, level of education and health literacy, duration of job tenure, age), as well as at the job level (i.e. various work characteristics), organisational level (i.e. employer characteristics) and society level (Krause, Frank, Dasinger, Sullivan, & Sinclair, 2001). These cannot just be ignored. The other major consideration is that SMS needs an infrastructure; it needs to be tied to a system already in operation. Is SMS best offered within primary care, occupational rehabilitation or the workplace? The engagement of, and endorsement by, compensation systems, insurance providers, rehabilitation and healthcare professionals or workplaces will require more information on benefits in terms of client outcomes and cost-effectiveness.

Appendix: Literature Review Methodology

The form of the review on self-management interventions for chronic conditions and musculoskeletal disorders (MSDs) within this chapter is narrative. Individual qualitative and quantitative research studies as well as systematic reviews and other reviews of relevance were considered. Four major databases (Ovid Medline, AMED, PsycINFO, Cochrane) were searched for relevant peer-reviewed literature published in the last 10 years. Publications prior to this period were included in the review if the work was considered seminal in terms of its contribution to the self-management knowledge base within the context of interest. The following terms were used as keywords and linked using Boolean operators: self-care, self-management, chronic disease, chronic illness, patient education as topic, patient-centred care, health behaviour, low back pain and musculoskeletal disorders. As the focus of the review was on persons of working age, the limits applied included English language and adults aged 15–64 years. Relevant grey literature and references from key authors in the field were also consulted. We did not formally assess the methodological quality of included studies. The identified peer-reviewed studies were then examined for intervention components that are tightly conceptually linked with self-management and the involvement of chronic conditions, especially MSDs, and excluded otherwise.

References

Adams, R. J. (2010). Improving health outcomes with better patient understanding and education. *Risk Management and Healthcare Policy, 3*, 61–72.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

Baker, P., Goodman, G., Ekelman, B., & Bonder, B. (2005). The effectiveness of a comprehensive work hardening program as measured by lifting capacity, pain scales and depression scores. *Work, 24*, 21–31.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopaedia of human behavior* (Vol. 4, pp. 71–81). New York: Academic Press.

Barlow, J. H., & Ellard, D. R. (2007). Implementation of a self-management programme for people with long-term medical conditions in a workplace setting. *Journal of Applied Rehabilitation Counseling, 38*(2), 24–34.

Barlow, J. H., Williams, B., & Wright, C. C. (1999). 'Instilling the strength to fight the pain and get on with life': Learning to become an arthritis self-manager through an adult education programme. *Health Education Research, 14*(4), 533–544.

Battersby, M., Harvey, P., Mills, P. D., Kalucy, E., Pols, R. G., Frith, P. A., et al. (2007). SA HealthPlus: A controlled trial of a statewide application of a generic model of chronic illness care. *The Milbank Quarterly, 85*, 37–67.

Battersby, M., Von Korff, M., Schaefer, J., Davis, C., Ludman, E., Greene, S. M., et al. (2010). Twelve evidence-based principles for implementing self-management support in primary care. *Joint Commission Journal on Quality & Patient Safety, 36*(12), 561–570.

Bodenheimer, T., Lorig, K., Holman, H., & Grumbach, K. (2002). Patient self-management of chronic disease in primary care [Research Support, Non-U.S. Gov't]. *Journal of the American Medical Association, 288*(19), 2469–2475.

Bourbeau, J., Julien, M., Maltais, F., Rouleau, M., Beaupré, A., Bégin, R., et al. (2003). Reduction of hospital utilization in patients with chronic obstructive pulmonary disease: A disease-specific self-management intervention. *Archives of Internal Medicine, 163*(5), 585–591.

Burns, J. W., Glenn, B., Lofland, K., Bruehl, S., & Harden, R. N. (2005). Stages of change in readiness to adopt a self-management approach to chronic pain: The moderating role of early-treatment stage progression in predicting outcome. *Pain, 115*(3), 322–331.

Bury, M., & Pink, D. (2005). The HSJ debate. Self-management of chronic disease doesn't work. *Health Service Journal, 115*(5947), 18–19, 11.

Cameron, M. (2011). Occupational rehabilitation. In M. Cameron, S. Selig, & D. Hemphill (Eds.), *Clinical exercise: A case-based approach* (pp. 124–134). Sydney, Australia: Elsevier.

Carr, J., Moffett, J., Sharp, D., & Haines, D. (2006). Is the Pain Stages of Change Questionnaire (PSOCQ) a useful tool for predicting participation in a self-management programme? Further evidence of validity, on a sample of UK pain clinic patients. *BMC Musculoskeletal Disorders, 7*(1), 101.

Chamberlain, M. A., Fialka Moser, F. M., Schüldt Ekholm, F., O'Connor, R. J., Herceg, M., & Ekholm, J. (2009). Vocational rehabilitation: An educational review. *Journal of Rehabilitation Medicine, 41*, 856–869.

Chiauzzi, E., Pujol, L. A., Wood, M., Bond, K., Black, R., Yiu, E., et al. (2010). painACTION-back pain: A self-management website for people with chronic back pain. *Pain Medicine, 11*(7), 1044–1058.

Chodosh, J., Morton, S. C., Mojica, W., Maglione, M., Suttorp, M. J., Hilton, L., et al. (2005). Meta-analysis: Chronic disease self-management programs for older adults. *Annals of Internal Medicine, 143*(6), 427–438.

Crowe, M., Whitehead, L., Jo Gagan, M., Baxter, D., & Panckhurst, A. (2010). Self-management and chronic low back pain: A qualitative study [Research Support, Non-U.S. Gov't]. *Journal of Advanced Nursing, 66*(7), 1478–1486.

Damush, T. M., Weinberger, M., Clark, D. O., Tierney, W. M., Rao, J. K., Perkins, S. M., et al. (2002). Acute low back pain self-management intervention for urban primary care patients: Rationale, design, and predictors of participation. *Arthritis & Rheumatism, 47*(4), 372–379.

Damush, T. M., Weinberger, M., Perkins, S. M., Rao, J. K., Tierney, W. M., Qi, R., et al. (2003). Randomized trial of a self-management program for primary care patients with acute low back pain: Short-term effects. *Arthritis & Rheumatism, 49*(2), 179–186.

Damush, T. M., Wu, J., Bair, M. J., Sutherland, J. M., & Kroenke, K. (2008). Self-management practices among primary care patients with musculoskeletal pain and depression. *Journal of Behavioral Medicine, 31*(4), 301–307.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum Press.

Dijkstra, A., Vlaeyen, J. W. S., Rijnen, H., & Nielson, W. (2001). Readiness to adopt the self-management approach to cope with chronic pain in fibromyalgic patients. *Pain, 90*(1), 37–45.

Du, S., Yuan, C., Xiao, X., Chu, J., Qiu, Y., & Qian, H. (2011). Self-management programs for chronic musculoskeletal pain conditions: A systematic review and meta-analysis. *Patient Education & Counseling, 85*(3), e299–e310.

Du Bois, M., & Donceel, P. (2008). A screening questionnaire to predict no return to work within 3 months for low back pain claimants. *European Spine Journal, 17*(3), 380–385.

Eggert, S. (2010). Psychosocial factors affecting employees' abilities to return to work. *AAOHN Journal: Official Journal of the American Association of Occupational Health Nurses, 58*(2), 51–55.

Ellis, N., Jull, G., Johnston, V., Strong, J., Gargett, S., Battersby, M. W., et al. (in preparation). A self-management intervention for chronic musculo-skeletal injuries in the return to work setting. *ARC Linkage Project*.

Ellis, N., MacKenzie, A., McLeod, R., & Battersby, M. (2011). Disempowerment of workers in vocational rehabilition: Would self-management help? *Journal of Health, Safety and Environment, 27*(3), 171–184.

Engel, G. L. (1977). The need for a new medical model: A challenge for biomedical science. *Science, 196*, 126–136.

Fors, T., Damsgård, E., Røe, C., & Anke, A. (2010). Readiness to adopt a self-management approach to pain—Are profiles of subscale scores on the Pain Stages of Change Questionnaire useful? *European Journal of Pain, 14*(10), 1051–1058.

Foster, G., Taylor, S. J. C., Eldridge, S., Ramsay, J., & Griffiths, C. (2007). Self-management education programmes by lay leaders for people with chronic conditions. *Cochrane Database of Systematic Reviews* (4), CD005108.

Franche, R. L., Carnide, N., Hogg-Johnson, S., Cote, P., Breslin, F. C., Bultmann, U., et al. (2009). Course, diagnosis and treatment of depressive symptomatology in workers following a workplace injury: A prospective cohort study. *Canadian Journal of Psychiatry, 54*(8), 435–546.

Gatchel, R. J., & Okifuji, A. (2006). Evidence-based scientific data documenting the treatment and cost-effectiveness of comprehensive pain programs for chronic nonmalignant pain. *The Journal of Pain, 7*, 779–793.

Glasgow, R., Funnell, M., Bonomi, A., Davis, C., Beckham, V., & Wagner, E. (2002). Self-management aspects of the improving chronic illness care breakthrough series: Implementation with diabetes and heart failure teams. *Annals of Behavioral Medicine, 24*(2), 80–87.

Griffiths, C., Motlib, J., Azad, A., Ramsay, J., Eldridge, S., Feder, G., et al. (2005). Randomised controlled trial of a lay-led self-management programme for Bangladeshi patients with chronic disease. *British Journal of General Practice, 55*(520), 831–837.

Gucciardi, E., Demelo, M., Offenheim, A., & Stewart, D. E. (2008). Factors contributing to attrition behavior in diabetes self-management programs: A mixed method approach. *BMC Health Services Research, 8*, 33.

Habib, S., Morrissey, S., & Helmes, E. (2005). Preparing for pain management: A pilot study to enhance engagement. *The Journal of Pain, 6*(1), 48–54.

Hamnes, B., Hauge, M. I., Kjeken, I., & Hagen, K. B. (2011). 'I have come here to learn how to cope with my illness, not to be cured': A qualitative study of patient expectations prior to a one-week self-management programme [Research Support, Non--U.S. Gov't]. *Musculoskeletal Care, 9*(4), 200–210.

Haugli, L., Steen, E., Lærum, E., Nygard, R., & Finset, A. (2001). Learning to have less pain—Is it possible? A one-year follow-up study of the effects of a personal construct group learning programme on patients with chronic musculoskeletal pain. *Patient Education and Counseling, 45*(2), 111–118.

Heymans, M. W., de Vet, H. C., Knol, D. L., Bongers, P. M., Koes, B. W., & van Mechelen, W. (2006). Workers' beliefs and expectations affect return to work over 12 months. *Journal of Occupational Rehabilitation, 16*(4), 685–695.

Holman, H., & Lorig, K. (2004). Patient self-management: A key to effectiveness and efficiency in care of chronic disease. *Public Health Reports, 119*(3), 239–243.

Institute of Medicine. (2004). *Health literacy: A prescription to end confusion*. Committee on health literacy: L. Nielsen-Bohlman, A.M. Panzer, D.A. Kindig. Washington, DC: The National Academies Press.

International Labour Organization. (1998). *Vocational rehabilitation and employment of disabled persons*. Geneva, Switzerland: International Labour Organization.

Ishikawa, H., & Yano, E. (2008). Patient health literacy and participation in the health-care process. *Health Expectations, 11*(2), 113–122.

Jensen, M. P., Nielson, W. R., & Kerns, R. D. (2003). Toward the development of a motivational model of pain self-management. *The Journal of Pain, 4*(9), 477–492.

Jerant, A., Moore, M., Lorig, K., & Franks, P. (2008). Perceived control moderated the self-efficacy-enhancing effects of a chronic illness self-management intervention. *Chronic Illness, 4*(3), 173–182.

Johnston, S., Irving, H., Mill, K., Rowan, M., & Liddy, C. (2012). The patient's voice: An exploratory study of the impact of a group self-management support program. *BMC Family Practice, 13*(1), 65.

Jordan, J. E., & Osborne, R. H. (2007). Chronic disease self-management education programs: Challenges ahead. *Medical Journal of Australia, 186*, 84–87.

Kellett, S., Bickerstaffe, D., Purdie, F., Dyke, A., Filer, S., Lomax, V., et al. (2011). The clinical and occupational effectiveness of condition management for Incapacity Benefit recipients. *British Journal of Clinical Psychology, 50*(2), 164–177.

Kennedy, A. P., Nelson, E., Reeves, D., Richardson, G., Roberts, C., Robinson, A., et al. (2004). A randomised controlled trial to assess the effectiveness and cost of a patient orientated self management approach to chronic inflammatory bowel disease. *Gut, 53*, 1639–1645.

Kerns, R. D., & Rosenberg, R. (2000). Predicting responses to self-management treatments for chronic pain: Application of the pain stages of change model. *Pain, 84*(1), 49–55.

Kerns, R. D., Rosenberg, R., Jamison, R. N., Caudill, M. A., & Haythornthwaite, J. (1997). Readiness to adopt a self-management approach to chronic pain: The Pain Stages of Change Questionnaire (PSOCQ). *Pain, 72*(1–2), 227–234.

Kerns, R. D., Wagner, J., Rosenberg, R., Haythornthwaite, J., & Caudill-Slosberg, M. (2005). Identification of subgroups of persons with chronic pain based on profiles on the pain stages of change questionnaire. *Pain, 116*(3), 302–310.

Krause, N., Frank, J. W., Dasinger, L. K., Sullivan, T. J., & Sinclair, S. J. (2001). Determinants of duration of disability and return-to-work after work-related injury and illness: Challenges for future research. *American Journal of Industrial Medicine, 40*, 464–484.

Lacaille, D., White, M. A., Rogers, P. A., Backman, C. L., Gignac, M. A. M., & Esdaile, J. M. (2008). A proof-of-concept study of the "Employment and Arthritis: Making it Work" program. *Arthritis Care and Research, 59*(11), 1647–1655.

Larsson, M. E. H., Nordholm, L. A., & Ohrn, I. (2009). Patients' views on responsibility for the management of musculoskeletal disorders—A qualitative study. *BMC Musculoskeletal Disorders, 10*, 103.

Lawn, S., & Battersby, M. W. (2008). *Capabilities for supporting prevention and chronic condition self-management: A resource for educators of primary health care professionals*. Adelaide, Australia: Australian Government Department of Health and Ageing.

Lawn, S., & Schoo, A. (2010). Supporting self-management of chronic health conditions: Common approaches [Review]. *Patient Education & Counseling, 80*(2), 205–211.

Li, E. J. Q., Li-Tsang, C. W. P., Lam, C. S., Hui, K. Y. L., & Chan, C. C. H. (2006). The effect of a "training on work readiness" program for workers with musculoskeletal injuries: A randomized control trial (RCT) study. *Journal of Occupational Rehabilitation, 16*, 529–541.

Lippel, K. (2007). Workers describe the effect of the workers' compensation process on their health: A Québec study. *International Journal of Law and Psychiatry, 30*(4–5), 427–443.

Lorig, K. (1996). Chronic disease self-management. *American Behavioral Scientist, 39*(6), 676–683.

Lorig, K., Gonzalez, V. M., Laurent, D. D., Morgan, L., & Laris, B. A. (1998). Arthritis self-management program variations: Three studies. *Arthritis Care & Research, 11*(6), 448–454.

Lorig, K., & Holman, H. R. (1989). Long-term outcomes of an arthritis self-management study: Effects of reinforcement efforts. *Social Science & Medicine, 29*(2), 221–224.

Lorig, K., & Holman, H. (2003). Self-management education: History, definition, outcomes, and mechanisms. *Annals of Behavioral Medicine, 26*(1), 1–7.

Lorig, K., Mazonson, P. D., & Holman, H. R. (1993). Evidence suggesting that health education for self-management in patients with chronic arthritis has sustained health benefits while reducing health care costs. *Arthritis and Rheumatism, 36*(4), 439–446.

Lorig, K., Ritter, P. L., Laurent, D. D., Plant, K., Green, M., Jernigan, V. B. B., et al. (2010). Online diabetes self-management program: A randomized study. *Diabetes Care, 33*(6), 1275–1281.

Lorig, K., Ritter, P. L., & Plant, K. (2005). A disease-specific self-help program compared with a generalized chronic disease self-help program for arthritis patients. *Arthritis & Rheumatism, 53*(6), 950–957.

Lorig, K., Sobel, D. S., Ritter, P. L., Laurent, D., & Hobbs, M. (2001). Effect of a self-management program on patients with chronic disease. *Effective Clinical Practice, 4*(6), 256–262.

MacEachen, E., Kosny, A., Ferrier, S., & Chambers, L. (2010). The "toxic dose" of system problems: Why some injured workers don't return to work as expected. *Journal of Occupational Rehabilitation, 20*, 349–366.

Matthias, M. S., Miech, E. J., Myers, L. J., Sargent, C., & Bair, M. J. (2012). An expanded view of self-management: Patients' perceptions of education and support in an intervention for chronic musculoskeletal pain. *Pain Medicine, 13*(8), 1018–1028.

May, S. (2010). Self-management of chronic low back pain and osteoarthritis [Review]. *Nature Reviews. Rheumatology, 6*(4), 199–209.

Mayer, T. G., & Polatin, P. B. (2000). Tertiary nonoperative interdisciplinary programs: The functional restoration variant of the outpatient chronic pain management program. In T. G. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders: Function, outcomes, and evidence* (pp. 639–650). Philadelphia, PA: Lippincott, Williams & Wilkins.

Miles, C. L., Pincus, T., Carnes, D., Homer, K. E., Taylor, S. J. C., Bremner, S. A., et al. (2011). Can we identify how programmes aimed at promoting self-management in musculoskeletal pain work and who benefits? A systematic review of sub-group analysis within RCTs. *European Journal of Pain, 15*(8), e1–e11.

National Health Priority Action Council (NHPAC). (2006). *National chronic disease strategy*. Canberra, Australia: Australian Government Department of Health and Ageing.

Nicholas, M. K., Asghari, A., Corbett, M., Smeets, R. J. E. M., Wood, B. M., Overton, S., et al. (2012). Is adherence to pain self-management strategies associated with improved pain, depression and disability in those with disabling chronic pain? [Research Support, Non--U.S. Gov't]. *European Journal of Pain, 16*(1), 93–104.

Nielson, W. R., Jensen, M. P., Ehde, D. M., Kerns, R. D., & Molton, I. R. (2008). Further development of the multidimensional pain readiness to change questionnaire: The MPRCQ2. *The Journal of Pain, 9*(6), 552–565.

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 51*, 390–395.

Prochaska, J. O., & Velicer, W. F. (1997). The Transtheoretical Model of health behavior change. *American Journal of Health Promotion, 12*, 38–48.

Roberts-Yates, C. (2003). The concerns and issues of injured workers in relation to claims/injury management and rehabilitation: The need for new operational frameworks. *Disability and Rehabilitation, 25*(16), 898–907.

Ruehlman, L. S., Karoly, P., & Enders, C. (2012). A randomized controlled evaluation of an online chronic pain self management. *Pain, 153*(2), 319–330.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology, 52*, 141–166.

Samoocha, D., De Koning, J., Zaeyen, T., De Vet, H. C., Bruinvels, D. J., Nijhuis, F., et al. (2011). Empowerment of people with a long-term work disability: Development of the 'VrijBaan' questionnaire. *Disability and Rehabilitation, 33*(9), 734–742.

Schultz, I. Z., Stowell, A. W., Feuerstein, M., & Gatchel, R. J. (2007). Models of return to work for musculoskeletal disorders. *Journal of Occupational Rehabilitation, 17*, 327–352.

Schwarzer, R., & Luszczynska, A. (2008). How to overcome health-compromising behaviors. *European Psychologist, 13*(2), 141–151.

Shaw, W. S., Tveito, T. H., Geehern-Lavoie, M., Huang, Y.-H., Nicholas, M. K., Reme, S. E., et al. (2012). Adapting principles of chronic pain self-management to the workplace. *Disability & Rehabilitation, 34*(8), 694–703.

Snook, S. H. (2004). Self-care guidelines for the management of nonspecific low back pain. *Journal of Occupational Rehabilitation, 14*(4), 243–253.

Solomon, M., Wagner, S. L., & Goes, J. (2012). Effects of a web-based intervention for adults with chronic conditions on patient activation: Online randomized controlled trial. *Journal of Medical Internet Research, 14*(1).

South Australian Department of Human Services. (2003). *Final report of the generational health review*. Adelaide, Australia: South Australian Department of Human Services.

Sterling, E. W., von Esenwein, S. A., Tucker, S., Fricks, L., & Druss, B. G. (2010). Integrating wellness, recovery, and self-management for mental health consumers. *Community Mental Health Journal, 46*, 130–138.

Sullivan, M. J., Adams, H., Rhodenizer, T., & Stanish, W. D. (2006). A psychosocial risk factor—Targeted intervention for the prevention of chronic pain and disability following whiplash injury. *Physical Therapy, 86*(1), 8–18.

Swerissen, H., Belfrage, J., Weeks, A., Jordan, L., Walker, C., Furler, J., et al. (2006). A randomised control trial of a self-management program for people with a chronic illness from Vietnamese, Chinese, Italian and Greek backgrounds. *Patient Education and Counseling, 64*(1–3), 360–368.

Taylor, W., Simpson, R., Gow, D., & McNaughton, H. (2001). Rehabilitation that works—Vocational outcomes following rehabilitation for occupational musculoskeletal pain. *New Zealand Medical Journal, 114*(1130), 185–187.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press.

Tkachuk, G. A., Marshall, J. K., Mercado, A. C., McMurtry, B., & Stockdale-Winder, F. (2012). Readiness for change predicts outcomes of functional rehabilitation following motor vehicle accident. *Journal of Occupational Rehabilitation, 22*(1), 97–104.

Turk, D. C., & Rudy, T. E. (1991). Neglected topics in the treatment of chronic pain patients—Relapse, noncompliance, and adherence enhancement. *Pain, 44*(1), 5–28.

Varekamp, I., Krol, B., & van Dijk, F. J. H. (2011). Empowering employees with chronic diseases: Process evaluation of an intervention aimed at job retention [Research Support, Non-U.S. Gov't]. *International Archives of Occupational & Environmental Health, 84*(1), 35–43.

Varekamp, I., Verbeek, J. H. A. M., & van Dijk, F. J. H. (2006). How can we help employees with chronic diseases to stay at work? A review of interventions aimed at job retention and based on an empowerment perspective [Review]. *International Archives of Occupational & Environmental Health, 80*(2), 87–97.

Vauth, R., Corrigan, P. W., Clauss, M., Dietl, M., Dreher-Rudolph, M., Stieglitz, R.-D., et al. (2005). Cognitive strategies versus self-management skills as adjunct to vocational rehabilitation. *Schizophrenia Bulletin, 31*(1), 55–66.

Victorian WorkCover Authority. (2012). *Clinical framework for the delivery of Health Services Group: Transport Accident Commission and WorkSafe Victoria*.

Von Korff, M., Moore, J. E., Lorig, K., Cherkin, D. C., Saunders, K., Gonzalez, V. M., et al. (1998). A randomized trial of a lay person-led self-management group intervention for back pain patients in primary care. *Spine, 23*(23), 2608–2615.

Wagner, E. H., Austin, B. T., Davis, C., Hindmarsh, M., Schaefer, J., & Bonomi, A. (2001). Improving chronic illness care: Translating evidence into action: Interventions that encourage people to acquire self-management skills are essential in chronic illness care. Medicine and Chronic Illness. *Health Affairs, 20*(6), 64–78.

Warsi, A., LaValley, M. P., Wang, P. S., Avorn, J., & Solomon, D. H. (2003). Arthritis self-management education programs: A meta-analysis of the effect on pain and disability. *Arthritis & Rheumatism, 48*(8), 2207–2213.

Warsi, A., Wang, P. S., LaValley, M. P., Avorn, J., & Solomon, D. H. (2004). Self-management education programs in chronic disease: A systematic review and methodological critique of the literature. *Archives of Internal Medicine, 164*(15), 1641–1649.

Watson, P. J., Booker, C. K., Moores, L., & Main, C. J. (2004). Returning the chronically unemployed with low back pain to employment. *European Journal of Pain, 8*, 359–369.

Weinstein, M. R. (1968). The concept of the disability process. *Psychosomatics, 19*(2), 94–97.

Williams, M. V., Baker, D. W., Parker, R. M., & Nurss, J. R. (1998). Relationship of functional health literacy to patients' knowledge of their chronic disease: A study of patients with hypertension and diabetes. *Archives of Internal Medicine, 158*(2), 166–172.

Wolf, M. S., Williams, M. V., Parker, R. M., Parikh, N. S., Nowlan, A. W., & Baker, D. W. (2007). Patients' shame and attitudes toward discussing the results of literacy screening. *Journal of Health Communication, 12*(8), 721–732.

Xu, Y.-w., Chan, C. C. H., Lam, C. S., Li-Tsang, C. W. P., Lo-Hui, K. Y. L., & Gatchel, R. J. (2007). Rehabilitation of injured workers with chronic pain: A stage of change phenomenon. *Journal of Occupational Rehabilitation, 17*, 727–742.

23

Work Accommodation in Musculoskeletal Disorders: Current Challenges and Future Directions in Research and Practice

Hanah C. Kwan and Izabela Z. Schultz

Due to the economic, personal, and societal impact of workplace injuries, the return to work (RTW) process in occupational disability, especially in musculoskeletal disorders (MSD), has been extensively researched. It has been described as multifactorial and involving multiple stakeholders (Baril, Clarke, Friesen, Stock, & Cole, 2003; Carroll, Rick, Pilgrim, Cameron, & Hillage, 2010; Franche, Baril, Shaw, Nicholas, & Loisel, 2005; Friesen, Yassi, & Cooper, 2001; Krause, Frank, Dasinger, Sullivan, & Sinclair, 2001; Loisel, Durand, Baril, Gervais, & Falardeau, 2005; Loisel et al., 2001; Schultz, Stowell, Feuerstein, & Gatchel, 2007). This often means that, for many injured workers, the process is complicated and systems are difficult to navigate. Various systematic reviews and best evidence synthesis have been written about the existing RTW body of quantitative and qualitative studies. These reviews (Franche, Cullen, et al., 2005; Krause, Dasinger, & Neuhauser, 1998; MacEachen, Clarke, Franche, Irvin, & Workplace-based Return to Work Literature Review Group, 2006) and other studies (Arnetz, Sjögren, Rydéhn, & Meisel, 2003; Crook, Milner, Schultz, & Stringer, 2002; Loisel et al., 1997) have identified that work accommodations are critical components in enhancing RTW outcomes. However, on systematic review of best evidence-informed practices in the field of RTW, the effective implementation of workplace accommodations remains elusive (Schultz, Duplassie, Hanson, & Winter, 2012).

Work Accommodation in Current Literature: Conceptual, Research, and Practice Challenges

A wide range of RTW determinants have been identified in the research. Characteristics of the injured worker, components of particular medical and occupational rehabilitation interventions, physical and psychosocial job characteristics, workplace factors, the insurer or workers' compensation scheme, and broader societal factors such as labor market conditions and the prevailing legal framework all have been shown to have some role to play in influencing RTW outcomes independent of the underlying medical condition (Krause et al., 2001; MacEachen et al., 2006; Pransky et al., 2002). One of the major challenges is that relevant research is not only cross-disciplinary but also partly unpublished and contained in reports from various statutory authorities

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and other stakeholders in the RTW process (Krause et al., 2001). This issue has resulted in an extremely large body of literature which, at the same time, is difficult to analyze, compare, and synthesize because of the variability in the population studied, sampling procedures, the study design issues, and the way the variables, including outcome variables, are defined and measured in the research (Krause et al., 2001). This chapter includes contributions from any research discipline that addresses the intersection of RTW and accommodations. This literature review concentrates on factors affecting RTW for workplace-injured workers with musculoskeletal injuries, including the role of various stakeholders.

Work Accommodation Research: What We Know and What We Do Not Know

The terms workplace interventions, modified work, job modifications, and accommodations have been overlapping and entangled concepts in the literature (Durand et al., 2007). The accommodation research could be divided into two broad categories. The first category describes an inclusion strategy for employees with long-term disabilities from non-work-related injuries (Butterfield & Ramseur, 2004; Gates & Akabas, 2011; Habeck, Kregel, Head, & Yasuda, 2007; Moon & Baker, 2012; Schartz, Hendricks, & Blanck, 2006). The second category encompasses an intervention to facilitate RTW of injured workers temporarily or recurring and, henceforth, referenced as *RTW accommodations and RTW accommodations process*. This body of research is multidisciplinary, involving disability studies, human resource and management, occupational disability, and physical and occupational therapy. Accommodations as an inclusion strategy may be more extensive including transportation access, personal assistance, assistive technology such as voice recognition software and applications. This category often has a greater focus on macrosystem interventions aimed at changing societal attitudes such as duty to accommodate, reasonable accommodations, human rights legislation, and legislative policies for inclusion. Some researchers have postulated the need to distinguish between permanent and temporary modifications to the work situation in order to advance the accommodation research (Durand et al., 2007). The terms "recurring" versus "one-time requests" for accommodations have also been used (Baldridge & Veiga, 2006). In addition, much of the research to date does not distinguish accommodations for work- or non-work-related injuries. There are indications of possible differences in the processes for these two types of accommodation requests. Interestingly, Schartz and associates found that current employees who become disabled are more likely to receive workplace accommodations as compared to job applicants with disabilities entering the workforce and requesting accommodations (Burkhauser, Schmeiser, Weathers & Robert, 2011; Schartz et al., 2006).

Injury and Disability Type

The injury-related conditions studied have varied in the RTW literature (Burton, Kendall, Pearce, Birrell & Bainbridge, 2009; Waddell & Burton, 2001). Much of the conceptual models of RTW have been derived from research on MSD and have been applied to RTW processes for all types of work disability (van Oostrom et al., 2009). As such, there is a large body of research on MSD (e.g., Arnetz et al., 2003; Bültmann et al., 2009; Franche et al., 2007; McCluskey, Burton, & Main, 2006) and a specific focus on back pain (e.g., Karjalainen et al., 2003; Loisel et al., 1997; Soeker, Wegner, & Pretorius, 2008; Steenstra, Verbeek, Heymans, & Bongers, 2005; Yassi et al., 1995) and upper extremity disorders (e.g., Williams, Westmorland, Schmuck, & MacDermid, 2004). However, in a review of workplace accommodations, Butterfield and Ramseur (2004) noted that 19 of the 30 articles were single-subject case studies describing specific accommodations made for specific individuals. The other 11 multi-subject studies mostly looked at accommodations for people with musculoskeletal limitations and visual impairments.

The question of the cross-validity, generalizability, and application of these studies for differing conditions is an unanswered question in the research literature. Few published studies have described and compared the types of accommodations used by people within and across user groups (Sanford & Milchus, 2006). Furthermore, van Oostrom and associates' review of workplace interventions found that there were insufficient numbers of studies to determine whether workplace intervention outcomes differ by condition type for MSD, mental health problems, and other health conditions (van Oostrom et al., 2009).

Key Accommodations by Type

Descriptive studies of the prevalence of various types of accommodations and outcome studies of the efficacy and effectiveness of accommodations for specific populations are generally lacking (Sanford & Milchus, 2006). Although the importance of work accommodation in RTW is recognized, little is known about the impact of specific ergonomic, work organization, and schedule components on outcomes (Franche, Baril, et al., 2005). Research in modified work has identified the need for tools to (1) provide a link between measures of physical function and specific work tasks, (2) improve concordance between ergonomic exposure categories and usual methods of accommodation, and (3) provide a structured process for including employee and employer preferences (Lincoln, Feuerstein, Shaw & Miller, 2002; Franche, Baril, et al., 2005). However, valid and reliable assessment methods and studies that identify information needs for making decisions, including evidence of functional limitations, about appropriate accommodations are also lacking (Sanford & Milchus, 2006). Sanford and Milchus (2006) put forth that:

> The absence of empirical evidence base in workplace accommodations has often resulted in unnecessary reinventing of wheels and perhaps over reliance on unproven or ineffective ones in the practice of workplace accommodations (p. 329).

Butterfield and Ramseur (2004) also reviewed the types of assistive technologies used in the workplace for work-related or non-work-related and broadly classified disabilities. They found that short-term accommodations were commonly implemented, such as adjusting work schedules, adopting flexible leave policies, and restructuring jobs, which they referred to as supported employment and adaptive strategies. The authors reported that computer technologies were the most prevalent workplace accommodation in the literature. Their review also looked at environment access accommodations (i.e., tool operation, seating, and positioning). Other modified work studies have found that the most common type of modified work or accommodations was light duty, followed by flexible schedule and reduced hours (Brooker, Cole, Hogg-Johnson, Smith, & Frank, 2001; Krause et al., 1998). Additionally, Yeager and associates found that employee requests for assistive technology were often granted, but many others had to pay for their own workplace assistive technology (Yeager, Kaye, Reed, & Doe, 2006). Williams, Sabata, and Zolna (2006) also found that among a sample largely of individuals with motor limitations, a significant number of participants indicated that they did not receive any workplace accommodations, despite functional limitations. As well, the researchers showed that older employees who have disabling conditions were less likely to receive workplace accommodations.

Workplace-Based Inventions and Modified Work

An increased focus on workplace programs for the timely and safe RTW of employees with the provision of modified work has resulted in two well-cited literature reviews examining workplace-based interventions. The reviews suggest that there is moderate quality evidence to support the use of workplace interventions to reduce sickness absence (van Oostrom et al., 2009) and strong evidence that work accommodation offers reduced work disability but insufficient evidence to support the sustainability of the effects of these workplace interventions (Franche, Cullen, et al., 2005). The results from these literature reviews summarize a wide range of different interventions, ranging from modified work as the only intervention to modified work as one of the elements in a multidisciplinary rehabilitation program, although studies reviewed by van Oostrom et al. (2009) did not all report whether the injury being accommodated was work-related or not. Furthermore, Krause et al., (1998) found that employees with temporarily modified work were twice as likely to RTW as employees without access to any form of modified work. It was estimated that, on average, a 50 % reduction in days lost from work could be expected for those employees with modified job activities (Krause et al., 1998). Overall, modified work programs facilitate RTW for temporarily and permanently disabled workers (Schultz, Crook, & Winter, 2005) and reduce work absence duration (Crook et al., 2002; Franche, Frank, & Krause, 2005; Krause et al., 1998; Turner et al., 2008).

In current conceptual models of RTW, timing is of particular importance; thus, interventions should be early but also appropriate (Pransky, Shaw, & McLellan, 2001; Franche, Frank, et al., 2005). Pransky and associates suggest that appropriate timing of RTW and properly structured accommodations or job modifications to decrease ergonomic risks constitute potential key determinants of a safe and sustained RTW (Pransky et al., 2002). In sum, the quantitative and qualitative literature suggests that employers and workplace interventions play a key role in the RTW process and that the most commonly used workplace interventions include work accommodations (Franche, Cullen, et al., 2005; Krause et al., 1998; MacEachen et al., 2006). However, the term "modified work" is often broadly defined to include all forms of modified work, including combination with other interventions (Krause et al., 1998). Moreover, the interventions carried out in workplace interventions are very heterogeneous and are often ill defined and idiosyncratic. Thus, they may not be replicable in research and practice. As such, Durand et al. (2007) recommended that better descriptions of workplace interventions are necessary in future research.

Economic Studies of Accommodations

Legislative frameworks also vary with respect to employer efforts to deal with disabling medical conditions and provide reasonable accommodations. Financial incentives for employers to reduce sickness absence also vary by country and by insurance system. Economic studies have examined the effects of economic incentives for employers, differences on compensation type during time off work, and cost–benefit analysis for insurance/compensation systems and employers. These studies have provided mixed evidence about the economic benefits of RTW interventions and programs (Anema et al., 2007; Arnetz et al., 2003; Loisel et al., 1997). Overall, there is moderate strength evidence to support the financial merits of interventions with work accommodation offers (Franche, Cullen, et al., 2005; Tompa, de Oliveira, Dolinschi, & Irvin, 2008; van Oostrom et al., 2009). It was noted that "The financial costs and gains of providing work accommodation are of particular concern to employers given their immediate and important role in the planning of work accommodations" (Franche, Baril, et al., 2005, p. 529). Costs of accommodations are often considered prohibitive despite the lack of empirical support for this notion in economic studies. Employers are most likely to respond positively where financial implications are favorable to productivity and profitability and where workplace roles are clear and not burdening (Franche, Baril, et al., 2005). Baldridge and Veiga (2006) found that monetary costs and impositions on others negatively influenced the likelihood of requesting recurring accommodations and the assessment of the social consequences of making such requests in employees with hearing impairments.

The assessment methods utilized to determine costs have been criticized for not including indirect costs and direct and indirect benefits and for not distinguishing disability-related accommodation costs from generic employee costs unrelated to disability (Schartz et al., 2006). Blanck (1994) reported that most accommodations had no direct costs. Indirect costs of supervision and co-worker time were reported in accommodations for individuals with mental health disabilities (MacDonald-Wilson, Rogers, Massaro, Lyass, & Crean, 2002). Utilizing a model of direct and indirect costs, Schartz et al. (2006) suggest that accommodation costs may be even less than previously reported when disability-related costs are differentiated from general employee costs.

There has been an increase over the last decade in workplace accommodation offers from employers (Brooker et al., 2001). The discernible benefits of work accommodation include decreased worker anxiety (Pransky et al., 2001) and reduced re-injury rates (Yassi et al., 1995). Employers may also directly benefit from retaining valued employees, increasing employee productivity, and eliminating costs associated with training new employees (Hernandez et al., 2009; Job Accommodation Network (JAN), 2012). Indirect benefits include improving colleague interaction, increasing overall company morale, and increasing overall company productivity (JAN, 2012). However, a discrepancy continues to exist between the benefits and effectiveness of accommodations on the one hand and perceptions of workplace costs on the other (Schartz et al., 2006).

Workplace Factors in Accommodations

There are limited research studies on the relationship between accommodations and workplace factors. Worker-level, job-level, and workplace-level factors have been associated with offer and acceptance of work accommodation for individuals with musculoskeletal injuries (Franche et al., 2007). Job-level factors, workplace factors, and policies about mandatory work accommodation were stronger determinants of offer and acceptance of work accommodation than individual health factors (Franche et al., 2007). A number of factors may hinder workplace accommodation efforts, including organizational constraints and industry-specific barriers related to unions or legislation and barriers in the methods of assessing functional capacities relative to physical job demands, physical function, and workplace exposure that are not suited to the job accommodation process (Shaw & Feuerstein, 2004). Furthermore, providing adequate and sufficient accommodations can be challenging, particularly in small workplaces where there are fewer work options and, hence, larger companies often have more established policies and procedures and may have more flexibility in implementing accommodations (Schultz, Milner, Hanson, & Winter, 2011). Even with a detailed needs assessment and implementation process, significant obstacles may still remain for employers to allow or provide some accommodations (Lincoln et al., 2002). As well, the rights of an injured worker to modified duty may conflict with the right of another worker to access the same position due to seniority within unions and conflicts with multiple unions. Johnson and associates found that the specific types of job accommodations provided had no separate significant effect on employment outcomes; rather, employment outcomes were improved in firms with more proactive RTW policies, involving job accommodations, than in firms with more restrictive policies (Johnson, Butler, Baldwin, & Côté, 2012).

Examining factors affecting employee satisfaction with accommodations with mobility-related disabilities, Balser and Harris (2008) found that those employees whose input was sought by the organization and who later received the requested accommodation were significantly more satisfied with their accommodation. Also, the authors reported that employee race/ethnicity was indirectly related to employee satisfaction as these individuals often had less input in the process and were less likely to be granted accommodations (Balser & Harris, 2008). As well, Burkhauser, Butler, and Kim (1995) examined a dynamic model of job exit and found that the risk of a worker leaving the employer after a work-limiting health condition is significantly reduced when an employer accommodates the worker.

Emergence of Conceptual Models

A number of conceptual models of the accommodation process have been postulated and well cited though they have yet to be empirically validated. Cleveland, Barnes-Farrell, and Ratz (1997) consider the workplace's reaction to accommodation to be related to four major factors: (1) the rationale for the accommodation; (2) the nature of the accommodation; (3) whether the accommodation is organization, employee, or jointly initiated; and (4) the characteristics of the person being accommodated. The rationale for accommodation may be a legal mandate, social/moral obligation, or business consideration. Cleveland et al. (1997) describe business considerations, changing workforce demographic characteristics and enhancing productivity and reward for performance as reasons and incentives for employers to implement accommodations. The authors assert that accommodations are not limited to responses to disabled individuals and that organizations routinely use accommodations to compete for qualified individuals by adjusting work activities or the work environment. These accommodations are often labeled extra benefits or perks of the job.

Co-worker responses may be a factor supervisors consider when deciding whether to grant an accommodation (Cleveland et al., 1997). Baldridge and Veiga (2001) considered the decision process to request accommodations by workers and proposed that past responses to accommodation of group members would influence the likelihood of future requests being made. An employee would request an accommodation based on the perceived usefulness of an accommodation, the appropriateness of seeking help, and the workplace accommodation culture (Bainbridge & Veiga, 2001). Organizational justice models have also been utilized to explain that the conditions of "fairness" or justice may be relevant to understanding the employers' and employees' reactions to accommodations (Cleveland et al., 1997; Colella, 2001). Two of the components of organizational justice are *distributive justice* and *procedural justice*. Distributive fairness or justice refers to the perceived fairness of the outcome of a decision, which in this case means how fair co-workers believe the accommodation is in terms of its effect on the distribution of rewards and resources (Cleveland et al., 1997). Procedural fairness or justice is defined as the perceived fairness of the processes or procedures through which outcome decisions were made (Colella, Paetzold, & Belliveau, 2004). In this case, procedural justice judgments would refer to the degree to which the process of granting an accommodation was fair (Cleveland et al., 1997). Colella (2001) proposed a model that focuses on co-workers' perceptions of distributive fairness and suggested that if the accommodation is salient and relevant to co-workers, those co-workers will engage in evaluating the distributive fairness of the accommodation based on rules of fairness and need. Colella et al. (2004) further proposed that individual and organizational factors are likely to influence co-workers' procedural justice inferences.

RTW Accommodation Process: Lessons from Mental Health, Musculoskeletal and Social Interaction Research

The focus of accommodation research has recently shifted to individuals with mental health conditions. This literature is relevant for understanding of the work accommodation in MSD for two reasons: mental health conditions, such as depression and anxiety, often develop in chronic pain conditions, and both mental health and pain disabilities are non-visible and more stigmatized than other clinical conditions. Despite an extensive body of research on RTW, much of the literature has focused on strategies most successful in reducing the duration of work disability and returning injured workers to the workplace rather than on how these strategies are implemented (Hepburn, Franche, & Francis, 2010). The mental health research literature has made strides in this area. Schultz and her team found that employers are generally familiar with communication and interaction-oriented, management-based job accommodations such as open communication, positive reinforcement, and additional training (Schultz, Milner, et al., 2011). Employers were less familiar with structural, environmental, and organizational aspects of job accommodations that required multilevel support with the workplace and were more complicated to implement for individuals with mental disorders (Schultz, Milner, et al., 2011) and relationship accommodations (Gates, Akabas, & Oran-Sabian, 1998). Recent research evidence supports the following components and needs in the accommodation process, which apply well to MSD:

1. Assessment of the accommodation needs and the workplace environment's readiness, such as mutual impact of accommodation on individual and work group, support for effective communication, and flexibility to accommodate the individual (Gates & Akabas, 2011).
2. Additional training, education, and increased awareness of accommodations may be needed for the workplace (Schultz, Milner, et al., 2011).
3. Importance of social factors—multisystem collaboration, workplace social support, and relationships (Schultz, Duplassie, Hanson, & Winter, 2011).
4. Monitoring effectiveness of accommodations and relationships that support them at work (Gates & Akabas, 2011) as accommodation may not be a static process due to changing symptoms of the condition or changes to the job or relationships at work.

Clearly, the work accommodation is a complex and worker-oriented, multistep, and multifaceted process. It involves multiple party and stakeholder interactions within a social context of the workplace and other involved systems, such as healthcare, rehabilitation, disability management, and insurance.

Expectations of RTW Accommodations

Expectations of RTW have emerged as an important factor in need of further research and examination, but little is known about the specific worker expectations of RTW accommodations. Shaw, Robertson, Pransky, and McLellan (2003) researched the worker's perceptions of supervisor roles in work accommodation after a work injury. Workers' perceived that interpersonal aspects of supervision were as important as physical work accommodation to facilitate RTW after injury. Injured workers expected that employers would provide appropriate accommodations, follow-up to ensure that accommodations are helpful, use ergonomic principles to modify work, and maximize all available resources to accommodate (Shaw et al., 2003).

In a qualitative study about expectations in RTW with subacute back injured workers, Stewart and associates found that concerns about workplace accommodations involved uncertainty and doubt about the availability of job accommodations and about the willingness of employers to accommodate individuals with a history of back injury and compensation claim (Stewart, Polak, Young, & Schultz, 2012). This uncertainty is well grounded. The stratified survey of 80 Canadian employers regarding work accommodations (Schultz, Milner, et al., 2011) indicated that only about 50 % of employers were familiar with the types of work accommodations listed on the *Job Accommodation Network* website. During this study, a large number of employers could not be included in the survey because they were not familiar with the term and concept of work accommodation at all. Those employers with prior experience with accommodations, and those which were larger, held better attitudes toward work accommodations. A qualitative study of interviews with over 40 experts in vocational rehabilitation, both researchers and senior professionals, revealed multiple systemic, organizational, knowledge- and skill-based, and attitudinal barriers related to difficulties in implementation of work accommodations (Schultz, Duplassie, et al., 2011).

Key Stakeholders and Social Interaction Research

A large amount of RTW research focuses on outcomes related to the duration of work disability. As RTW researchers shifted exclusive focus from workers and the physical nature of their injury and recovery, researchers began to include the key roles of other stakeholders and the psychosocial factors in these strategies to reduce work disability. There is a limited body of research on how social interactions influence RTW and the RTW accommodation process. Long-term work disability is seen as a result of interactions between the worker and three systems: the healthcare system, the work environment, and the financial compensation system (Franche & Krause, 2002; Loisel et al., 2001; van Oostrom et al., 2009). The provision of work accommodation is a complex and multifaceted workplace-based intervention requiring balancing needs of various stakeholders (Franche et al., 2007). As such, workplace interventions must take into account the social context and provide opportunity for communication and interaction in order to ensure the success of the accommodations (Gates, 2000). Furthermore, a prospective study conducted in the Netherlands by van Duijn, Lötters, and Burdorf (2005) found that modified work as the only advice (given by an occupational health physician) did not influence the duration of sick leave for workers with MSD but that a positive relationship with colleagues supported the implementation of modified work (van Duijn et al., 2005). Gates (2000) proposed that the traditional approach that views accommodation as technical changes to job tasks, routines, or the physical environment is missing a key component of the social impact of accommodations in successful RTW outcomes. Similarly, Gates and Akabas (2011) suggest that accommodation requests and implementation are a negotiated process requiring a balance of worker, employer, and workplace needs. Supervisors, human resource or legal departments, and/or unions may need to be part of the RTW accommodation process because many accommodations require the cooperation and support of others in the work group (Colella, 2001; Tjulin, MacEachen, Stiwne, & Ekberg, 2011; Unger & Kregel, 2003). When accommodation is recognized as a social process, "there is the ongoing need to evaluate whether or not the accommodation best meets the needs of the worker, his or her supervisor and work group" (Gates & Akabas, 2011, p. 385). Under-accommodation or over-accommodation can also have adverse implications for involved parties (Gates & Akabas, 2011).

The RTW accommodation research has also begun to consider the perspectives of the various stakeholders. A review of the research shows that supervisors play a significant role for successful RTW at the workplace (Loisel et al., 1997; Yassi et al., 1995), and their role is also evident from the systematic reviews that support the use of workplace-based interventions in better RTW outcomes (Franche, Baril, et al., 2005; Krause et al., 1998; MacEachen et al., 2006; van Oostrom et al., 2009). Supervisors may be involved in determining a suitable work accommodation offer. The supervisor can lend legitimacy to a reentering worker's condition and restrictions concerning work ability and contribute to smoothing the social relations at work (Franche, Baril, et al., 2005; Gates, 1993). Unger and Kregel (2003) found in their sample population that supervisors were confident in identifying and developing accommodations for employees with disabilities but did not have the authority to secure accommodations.

Franche, Baril, et al. (2005) found that, within the compensation system, case managers must have (1) sufficient authority to recommend work restrictions and accommodations in consultation with care providers; (2) sufficient time and resources to view the physical work environment, engage the worker and supervisor in collaborative problem-solving, and facilitate individualized accommodations; and (3) recent suggestions to expand their training to include problem-solving and work accommodation planning. Early contact with the injured worker, the involvement of a designated RTW coordinator, and contact between the worker's employer and healthcare provider were also strategies the researchers found to be particularly effective in RTW (Franche, Baril, et al., 2005).

Not surprisingly, the worker's active participation has been found to be instrumental in successful modified work programs (Loisel et al., 1997). A concept closely linked to the social climate of work and the worker's role in RTW is *legitimacy* (Franche et al., 2007). For the reentering injured worker, a problem of *legitimacy* appears to emerge from two key structural factors associated with work-related injuries (Tarasuk & Eakin, 1995).

First is the relative inability of medical practitioners to explain and effectively treat pain and to clearly identify disabling pain. The second factor is the structure of workers' compensation systems, which include financial rewards to employers for the absence of compensation claims and effectively place the onus on the injured worker to legitimate his or her need for compensable time off work. This backdrop of conflicting interests between labor and capital, and a climate of fiscal restraint, create an atmosphere in which claims of work-related injuries are particularly suspect (Niemeyer, 1991; Tarasuk & Eakin, 1995). This experience is associated with potential to damage relations in the workplace and create job insecurity, which may hamper recovery and RTW (Tarasuk & Eakin, 1995). According to Friesen et al. (2001), human interactions and structures which allow for and encourage worker participation and empowerment in the RTW process are vital to the well-being of the worker and his/her ultimate RTW.

Friesen et al.'s (2001) study found all stakeholders groups agreed that "positive relationships," good communication, and working together were important to success in the RTW process. Structures which promote communication among all stakeholders were most effective if the individuals involved exercise trust and establish credibility by following through with the formal plans and programs (Friesen et al., 2001). However, Franche, Baril, et al. (2005) challenge the assumption that all stakeholders need to be involved for optimal RTW outcomes. They postulate that modulating the level of involvement of stakeholders may lead to a reduction in conflict and improve RTW outcomes.

Workplace Social Relations

In a systematic review of the qualitative literature on RTW, MacEachen et al. (2006) emphasized the importance of the social environment. The injured worker may have to deal with co-workers who resent having to take over some of his or her workload or who may feel that the worker has managed to get an "easier" job (Colella, 2001; Franche, Baril, et al., 2005; MacEachen et al., 2006). Social dislocation can arise in modified work if the worker is placed in a new work area, producing a new set of relationships and routines for the returning worker. Physical arrangements in modified work can be problematic if the selection of tasks is not based on ergonomic considerations creating strain and conflict in relationships.

Furthermore, when modified work is considered difficult or expensive, workers may be given meaningless work affecting worker job satisfaction and retention (MacEachen et al., 2006). Hepburn et al. (2010) also examined injured workers', with MSD conditions, perceptions of the interactional justice which is defined as how one is treated while engaging in the RTW process as related to duration of work disability, mental health, and organizational commitment. Specifically, the authors looked at two aspects of interactional justice: interpersonal fairness in terms of being treated with dignity and respect and informational fairness in terms of being dealt with in a truthful manner and receiving adequate explanations about processes (Hepburn et al., 2010). The authors report that their findings underscore the critical importance of the manner in which employers' representatives treated injured workers during the implementation of RTW strategies. Hence, injured workers' perceptions of interactional justice contributed to their self-reported days absent, depressive symptoms, and affective commitment beyond what was accounted for by the workplace-based strategies alone (Hepburn et al., 2010).

The research in RTW and social support has mainly used qualitative methods. In one study by Lysaght and Larmour-Trode (2008), support of a personal or empathetic nature seemed to be most important to workers, and respondents identified trust, communication, and knowledge of disability as key precursors to a successful RTW process. Williams-Whitt and Taras (2010) explored the dynamics of accommodations in workplaces, with a particular focus on performance of employees with disabilities and found four associated themes of (1) attendance, (2) disciplinary history, (3) peer interactions, and (4) task function. From qualitative interviews and review of arbitration case files, the authors suggest that absenteeism contributed to development of conflict and increased likelihood of dismissal. In addition, a history of absenteeism, whether disability-related or not, appears more damaging than post-return absenteeism. Negative interpretations of disability-related absenteeism are compounded when the employer initially believes the absenteeism is of a culpable nature (choice-based) and suspicion about the purposes of absences that can lead to significant mistrust (Williams-Whitt & Taras, 2010). Whether disability-related or not, the effect of prior disciplinary history affected perceptions of performance and was likely to be held partially responsible for the onset of their disabilities. Overall, the authors report that a key finding was that failing to adhere to established organizational and cultural norms was a precursor to negative perceptions of performance and thus adversely affecting the social capital or goodwill available to the person. Communication and interactional patterns, whether established before the workplace injury or post injury, can influence RTW outcomes.

The role of co-workers in the RTW process has also become apparent. Tjulin, MacEachen and Ekberg (2010) explored the experience of workplace actors and the social exchange among these individuals in the RTW process (2010). A key finding was the active role of co-workers and the issue of uncertainty and invisibility of their RTW efforts during the process. For example, RTW accommodations were made informally or in an ad hoc manner by co-workers and returning workers, whose efforts were generally not visible to the supervisors. Other psychosocial aspects of the workplace, which have been shown to be related to RTW outcomes, include low or inadequate social support from supervisors and colleagues (Gates, 1993; Shaw et al., 2003). MacEachen et al. (2006) also found that RTW involves complexities related to beliefs, roles, and perceptions of many players. Good will and trust were overarching conditions that were central to successful RTW arrangements, but that the condition for goodwill existed largely in the social environment of the firm. The absence of goodwill can undermine efforts by all parties in the RTW process and can lead to a suspicion-laden work environment.

Conclusions: Toward Evidence-Informed Practices

Evidence-informed practice in accommodations is still lacking for individuals with musculoskeletal disabilities and all disabilities in general (Sanford & Milchus, 2006). Despite the extensive body of research on work-related injuries, the RTW accommodation process has not garnered any published large-scale research studies that have distinguished the nuances and variations in the type or user group, rationale, and duration of accommodations (Sanford & Milchus, 2006). The recent emphasis on accommodations for mental health conditions sheds some light in the move toward informed practice with RTW accommodations. Schultz, Krupa, and Rogers (2011) suggest that the following interventions and accommodations can be now considered evidence-informed: modified work duties, flexible scheduling, modified work environment, job sharing, and assistive technologies. Schultz, Winter, and Wald (2011) proposed in their systematic review of job accommodations for individuals with mental disorders that the use of improved methodologies, including mixed qualitative–quantitative designs, may help answer some of the key questions about the effectiveness of a wider range of accommodations, the processes involved, and matching individual strengths, needs, and limitations to the right accommodations (Schultz, Winter, et al., 2011).

As interest in factors associated with disability management versus pain management has increased, so have the number of clinical and workplace interventions intended to facilitate a safe RTW and/or prevent lengthy work absences (e.g., Shaw, Linton, & Pransky, 2006). Few of these interventions, however, have been designed to target specific risk factors in the social interactions, particularly with the increased practice of early RTW before the individual is fully recovered. Therefore, gaps exist between known interventions of accommodations and how to implement the accommodations in the social context of the workplace. The accommodation research has mainly reviewed the effectiveness of modified work programs and factors that impact

RTW outcomes. It requires further investigation of the social interactions in the RTW accommodation process and the most effective process to offer work accommodation could be developed and provided to facilitate a sustained RTW (Franche, Baril, et al., 2005; Franche, Cullen, et al., 2005; Schultz, Winter, et al., 2011).

There is an emerging consensus that work accommodations are best understood in research and practice as complex social interactional processes among multiple RTW stakeholders (including active involvement of the worker) that involve the optimization of the match between the needs of the worker (who has functional limitations on one hand) and the demands and supports offered by the system that offers and facilitates work accommodations on the other hand. The range of accommodations in MSD is diverse and not limited, as often conceived, to ergonomic solutions only (see details of Ergonomic Model in Chap. 24). The research in the emerging field of accommodations has been slow to develop and methodologically lagging behind other workplace and clinical interventions, especially with respect to effectiveness and outcomes of various accommodations, as well as the role of social context and multiparty interactions involved in the implementation and maintenance of accommodations.

References

Anema, J. R., Steenstra, I. A., Bongers, P. M., de Vet, H. C. W., Knol, D. L., Loisel, P., et al. (2007). Multidisciplinary rehabilitation for subacute low back pain: Graded activity or workplace intervention or both? A randomized controlled trial. *Spine, 32*(3), 291–298.

Arnetz, B. B., Sjögren, B., Rydéhn, B., & Meisel, R. (2003). Early workplace intervention for employees with musculoskeletal-related absenteeism: A prospective controlled intervention study. *Journal of Occupational and Environmental Medicine, 45*(5), 499–507.

Baldridge, D. C., & Veiga, J. F. (2001). Toward a greater understanding of the willingness to request an accommodation: Can requesters' beliefs disable the Americans with disabilities act? *Academy of Management Review, 26*(1), 85–99.

Baldridge, D. C., & Veiga, J. F. (2006). The impact of anticipated social consequences on recurring disability accommodation requests. *Journal of Management, 32*(1), 158–179.

Balser, D., & Harris, M. (2008). Factors affecting employee satisfaction with disability accommodation: A field study. *Employee Responsibilities & Rights Journal, 20*(1), 13–28.

Baril, R., Clarke, J., Friesen, M., Stock, S., & Cole, D. (2003). Management of return-to-work programs for workers with musculoskeletal disorders: A qualitative study in three Canadian provinces. *Social Science & Medicine, 57*(11), 2101–2114.

Blanck, P. D. (1994). *Communicating the Americans with Disabilities Act, transcending compliance: A case report on Sears, Roebuck and Co*. Iowa City, IA: Annenberg Washington Program.

Brooker, A., Cole, D., Hogg-Johnson, S., Smith, J., & Frank, J. (2001). Modified work: Prevalence and characteristics in a sample of workers with soft-tissue injuries. *Journal of Occupational and Environmental Medicine, 43*(3), 276–284.

Bültmann, U., Sherson, D., Olsen, J., Hansen, C., Lund, T., & Kilsgaard, J. (2009). Coordinated and tailored work rehabilitation: A randomized controlled trial with economic evaluation undertaken with workers on sick leave due to musculoskeletal disorders. *Journal of Occupational Rehabilitation, 19*(1), 81–93.

Burkhauser, R., Schmeiser, M. D., Weathers, I., & Robert, R. (2011). The importance of anti-discrimination and workers' compensation laws on the provision of workplace accommodations following the onset of a disability. *Industrial & Labor Relations Review, 65*(1), 9.

Burkhauser, R. V., Butler, J. S., & Kim, Y. (1995). The importance of employer accommodation on the job duration of workers with disabilities: A hazard model approach. *Labour Economics, 2*(2), 109–130.

Burton, A. K., Kendall, N. A. S., Pearce, B. G., Birrell, L. N., & Bainbridge, L. C. (2009). Management of work-relevant upper limb disorders: A review. *Occupational Medicine, 59*(1), 44–52.

Butterfield, T. M., & Ramseur, J. (2004). Research and case study findings in the area of workplace accommodations including provisions for assistive technology: A literature review. *Technology & Disability, 16*(4), 201–210.

Carroll, C., Rick, J., Pilgrim, H., Cameron, J., & Hillage, J. (2010). Workplace involvement improves return to work rates among employees with back pain on long-term sick leave: A systematic review of the effectiveness and cost-effectiveness of interventions. *Disability & Rehabilitation, 32*(8), 607–621.

Cleveland, J., Barnes-Farrell, J., & Ratz, J. (1997). Accommodation in the workplace. *Human Resource Management Review, 7*(1), 77–107.

Colella, A. J. (2001). Co-worker distributive fairness judgments of the workplace accommodation of employees with disabilities. *Academy of Management Review, 26*, 100–117.

Colella, A., Paetzold, R., & Belliveau, M. A. (2004). Factors affecting coworkers' procedural justice inferences of the workplace accommodations of employees with disabilities. *Personnel Psychology, 57*(1), 1–23.

Crook, J., Milner, R., Schultz, I. Z., & Stringer, B. (2002). Determinants of occupational disability following a low back injury: A critical review of the literature. *Journal of Occupational Rehabilitation, 12*(4), 277–295.

Durand, M. J., Vezina, N., Loisel, P., Baril, R., Richard, M. C., & Diallo, B. (2007). Workplace interventions for workers with musculoskeletal disabilities: A descriptive review of content. *Journal of Occupational Rehabilitation, 17*(1), 123–136.

Franche, R. L., Baril, R., Shaw, W., Nicholas, M., & Loisel, P. (2005). Workplace-based return-to-work interventions: Optimizing the role of stakeholders in implementation and research. *Journal of Occupational Rehabilitation, 15*(4), 525–542.

Franche, R. L., Cullen, K., Clarke, J., Irvin, E., Sinclair, S., & Frank, J. (2005). Workplace-based return-to-work interventions: A systematic review of the quantitative literature. *Journal of Occupational Rehabilitation, 15*(4), 607–631.

Franche, R. L., Frank, J., & Krause, N. (2005). Prediction of occupational disability. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention, and prevention* (pp. 93–116). New York: Springer.

Franche, R. L., & Krause, N. (2002). Readiness for return to work following injury or illness: Conceptualizing the interpersonal impact of health care, workplace, and insurance factors. *Journal of Occupational Rehabilitation, 12*(4), 233–256.

Franche, R. L., Severin, C. N., Hogg-Johnson, S., Côté, P., Vidmar, M., & Lee, H. (2007). The impact of early workplace-based return-to-work strategies on work absence duration: A 6-month longitudinal study following an occupational musculoskeletal injury. *Journal of Occupational and Environmental Medicine, 49*(9), 960–974.

Friesen, M. N., Yassi, A., & Cooper, J. (2001). Return-to-work: The importance of human interactions and organizational structures. *Work, 17*(1), 11–22.

Gates, L. B. (1993). The role of the supervisor in successful adjustment to work with a disabling condition: Issues for disability policy and practice. *Journal of Occupational Rehabilitation, 3*(4), 179–190.

Gates, L. B. (2000). Workplace accommodation as a social process. *Journal of Occupational Rehabilitation, 10*(1), 85–98.

Gates, L. B., Akabas, S. H., & Oran-Sabia, V. (1998). Relationship accommodations involving the work group: Improving work prognosis for persons with mental health conditions. *Psychiatric Rehabilitation Journal, 21*(3), 264–272.

Gates, L. B., & Akabas, S. H. (2011). Inclusion of people with mental health disabilities into the workplace: Accommodation as a social process. In I. Z. Schultz & E. Rogers (Eds.), *Work accommodation and retention in mental health* (pp. 375–391). New York: Springer.

Habeck, R., Kregel, J., Head, C., & Yasuda, S. (2007). Salient and subtle aspects of demand side approaches for employment retention: Lessons for public policymakers. *Journal of Vocational Rehabilitation, 26*(1), 21–27.

Hepburn, C. G., Franche, R. L., & Francis, L. (2010). Successful return to work: The role of fairness and workplace-based strategies. *International Journal of Workplace Health Management, 3*(1), 7–24.

Hernandez, B., Mcdonald, K., Lepera, N., Shahna, M., Wang, T., & Levy, J. M. (2009). Moving beyond misperceptions: The provision of workplace accommodations. *Journal of Social Work in Disability & Rehabilitation, 8*(3/4), 189–204.

Job Accommodation Network. (Original 2005, Updated 2007, Updated 2009, Updated 2010, Updated 2011, Updated 2012). *Workplace accommodations: Low cost, high impact*. Retrieved May 2012, from http://AskJAN.org/media/LowCostHighImpact.doc

Johnson, W. G., Butler, R. J., Baldwin, M. L., & Côté, P. (2012). Disability risk management and postinjury employment of workers with back pain. *Risk Management and Insurance Review, 15*(1), 35–55.

Karjalainen, K., Malmivaara, A., Pohjolainen, T., Hurri, H., Mutanen, P., Rissanen, P., et al. (2003). Mini-intervention for subacute low back pain: A randomized controlled trial. *Spine, 28*(6), 533–541.

Krause, N., Dasinger, L. K., & Neuhauser, F. (1998). Modified work and return to work: A review of the literature. *Journal of Occupational Rehabilitation, 8*(2), 113–139.

Krause, N., Frank, J. W., Dasinger, L. K., Sullivan, T. J., & Sinclair, S. J. (2001). Determinants of duration of disability and return-to-work after work-related injury and illness: Challenges for future research. *American Journal of Industrial Medicine, 40*(4), 464–484.

Lincoln, A. E., Feuerstein, M., Shaw, W. S., & Miller, V. I. (2002). Impact of case manager training on worksite accommodations in workers' compensation claimants with upper extremity disorders. *Journal of Occupational and Environmental Medicine, 44*(3), 237–246.

Loisel, P., Abenhaim, L., Durand, P., Esdaile, J. M., Suissa, S., Gosselin, L., et al. (1997). A population-based, randomized clinical trial on back pain management. *Spine, 22*(24), 2911–2918.

Loisel, P., Durand, M. J., Baril, R., Gervais, J., & Falardeau, M. (2005). Interorganizational collaboration in occupational rehabilitation: Perceptions of an interdisciplinary rehabilitation team. *Journal of Occupational Rehabilitation, 15*(4), 581–590.

Loisel, P., Durand, M., Berthelette, D., Vézina, N., Baril, R., Gagnon, D., et al. (2001). Disability prevention: New paradigm for the management of occupational back pain. *Disease Management and Health Outcomes, 9*, 351–360.

Lysaght, R. M., & Larmour-Trode, S. (2008). An exploration of social support as a factor in the return-to-work process. *Work: A Journal of Prevention, Assessment and Rehabilitation, 30*(3), 255–266.

MacDonald-Wilson, K. L., Rogers, E., Massaro, J. M., Lyass, A., & Crean, T. (2002). An investigation of reasonable workplace accommodations for people with psychiatric disabilities: Quantitative findings from a multi-site study. *Community Mental Health Journal, 38*(1), 35–50.

MacEachen, E., Clarke, J., Franche, R. L., Irvin, E., & Workplace-based Return to Work Literature Review Group. (2006). Systematic review of the qualitative literature on return to work after injury. *Scandinavian Journal of Work, Environment & Health, 32*(4), 257–269.

McCluskey, S., Burton, A., & Main, C. (2006). The implementation of occupational health guidelines principles for reducing sickness absence due to musculoskeletal disorders. *Occupational Medicine (Oxford, England), 56*(4), 237–242.

Moon, N. W., & Baker, P. M. A. (2012). Assessing stakeholder perceptions of workplace accommodations barriers: Results from a policy research instrument. *Journal of Disability Policy Studies, 23*(2), 94–109.

Niemeyer, L. O. (1991). Social labeling, stereotyping, and observer bias in workers' compensation: The impact of provider-patient interaction on outcome. *Journal of Occupational Rehabilitation, 1*(4), 251–269.

Pransky, G., Benjamin, K., Hill-Fotouhi, C., Fletcher, K. E., Himmelstein, J., & Katz, J. N. (2002). Work-related outcomes in occupational low back pain: A multidimensional analysis. *Spine, 27*(8), 864–870.

Pransky, G., Shaw, W., & McLellan, R. (2001). Employer attitudes, training, and return-to-work outcomes: A pilot study. *Assistive Technology: The Official Journal of RESNA, 13*(2), 131–138.

Sanford, J. A., & Milchus, K. (2006). Evidence-based practice in workplace accommodations. *Work: A Journal of Prevention, Assessment & Rehabilitation, 27*(4), 329–332.

Schartz, H. A., Hendricks, D. J., & Blanck, P. (2006). Workplace accommodations: Evidence based outcomes. *Work: A Journal of Prevention, Assessment & Rehabilitation, 27*(4), 345–354.

Schultz, I. Z., Crook, J., & Winter, A. (2005). Evidence-informed best practices for injured workers at risk for disability at the subacute stage: Secondary prevention. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention, and prevention* (pp. 443–460). New York: Springer Science + Business Media.

Schultz, I. Z., Duplassie, D., Hanson, D. B., & Winter, A. (2011). Systemic barriers and facilitators to job accommodations in mental health: Experts' consensus. In I. Z. Schultz & E. Rogers (Eds.), *Work accommodation and retention in mental health* (pp. 353–372). New York: Springer.

Schultz, I. Z., Krupa, T., & Rogers, E. (2011). Best practices in accommodating and retaining persons with mental health disabilities at work: Answered and unanswered questions. In I. Z. Schultz & E. Rogers (Eds.), *Work accommodation and retention in mental health* (pp. 445–465). New York: Springer.

Schultz, I. Z., Milner, R. A., Hanson, D. B., & Winter, A. (2011). Employer attitudes towards accommodations in mental health disability. In I. Z. Schultz & E. Rogers (Eds.), *Work accommodation and retention in mental health* (pp. 325–340). New York: Springer.

Schultz, I. Z., Stowell, A. W., Feuerstein, M., & Gatchel, R. J. (2007). Models of return to work for musculoskeletal disorders. *Journal of Occupational Rehabilitation, 17*(2), 327–352.

Schultz, I. Z., Winter, A., & Wald, J. (2011). Evidentiary support for best practices in job accommodation in mental health: Employer-level interventions. In I. Z. Schultz & E. Rogers (Eds.), *Work accommodation and retention in mental health* (pp. 409–423). New York: Springer.

Shaw, W. S., & Feuerstein, M. (2004). Generating workplace accommodations: Lessons learned from the integrated case management study. *Journal of Occupational Rehabilitation, 14*(3), 207–216.

Shaw, W. S., Linton, S. J., & Pransky, G. (2006). Reducing sickness absence from work due to low back pain: How well do intervention strategies match modifiable risk factors? *Journal of Occupational Rehabilitation, 16*(4), 591–605.

Shaw, W. S., Robertson, M. M., Pransky, G., & McLellan, R. K. (2003). Employee perspectives on the role of supervisors to prevent workplace disability after injuries. *Journal of Occupational Rehabilitation, 13*(3), 129–142.

Soeker, M. S., Wegner, L., & Pretorius, B. (2008). I'm going back to work: Back injured clients' perceptions and experiences of their worker roles. *Work: A Journal of Prevention, Assessment & Rehabilitation, 30*(2), 161–170.

Steenstra, I., Verbeek, J., Heymans, M., & Bongers, P. (2005). Prognostic factors for duration of sick leave in patients sick listed with acute low back pain: A systematic review of the literature. *Occupational and Environmental Medicine, 62*(12), 851–860.

Stewart, A. M., Polak, E., Young, R., & Schultz, I. Z. (2012). Injured workers' construction of expectations of return to work with sub-acute back pain: The role of perceived uncertainty. *Journal of Occupational Rehabilitation, 22*(1), 1–14.

Tarasuk, V., & Eakin, J. M. (1995). The problem of legitimacy in the experience of work-related back injury. *Qualitative Health Research, 5*(2), 204–222.

Tjulin, Å., MacEachen, E., & Ekberg, K. (2010). Exploring workplace actors experiences of the social organization of return-to-work. *Journal of Occupational Rehabilitation, 20*(3), 311–321.

Tjulin, Å., MacEachen, E., Stiwne, E. E., & Ekberg, K. (2011). The social interaction of return to work explored from co-workers experiences. *Disability & Rehabilitation, 33*(21–22), 1979–1989.

Tompa, E., de Oliveira, C., Dolinschi, R., & Irvin, E. (2008). A systematic review of disability management interventions with economic evaluations. *Journal of Occupational Rehabilitation, 18*(1), 16–26.

Turner, J. A., Franklin, G., Fulton-Kehoe, D., Sheppard, L., Stover, B., Wu, R., et al. (2008). ISSLS prize winner: Early predictors of chronic work disability: A prospective, population-based study of workers with back injuries. *Spine, 33*(25), 2809–2818.

Unger, D., & Kregel, J. (2003). Employers' knowledge and utilization of accommodations. *Work, 21*(1), 5–15.

Uppal, S. (2005). Disability, workplace characteristics and job satisfaction. *International Journal of Manpower, 26*(4), 14.

van Duijn, M., Lötters, F., & Burdorf, A. (2005). Influence of modified work on return to work for employees on sick leave due to musculoskeletal complaints. *Journal of Rehabilitation Medicine, 37*(3), 172–179.

van Oostrom, S. H., Driessen, M. T., de Vet, H. C., Franche, R. L., Schonstein, E., Loisel, P., et al. (2009). Workplace interventions for preventing work disability. *Cochrane Database of Systematic Reviews, 2009*(2), CD006955. doi:10.1002/14651858.CD006955.pub2

Waddell, G., & Burton, A. K. (2001). Occupational health guidelines for the management of low back pain at work: Evidence review. *Occupational Medicine, 51*(2), 124–135.

Williams, M., Sabata, D., & Zolna, J. (2006). User needs evaluation of workplace accommodations. *Work: A Journal of Prevention, Assessment & Rehabilitation, 27*(4), 355–362.

Williams, R., Westmorland, M., Schmuck, G., & MacDermid, J. (2004). Effectiveness of workplace rehabilitation interventions in the treatment of work-related upper extremity disorders: A systematic review. *Journal of Hand Therapy, 17*(2), 267–273.

Williams-Whitt, K., & Taras, D. (2010). Disability and the performance paradox: Can social capital bridge the divide? *British Journal of Industrial Relations, 48*(3), 534–559.

Yassi, A., Khokhar, J., Tate, R., Cooper, J., Snow, C., & Vallentype, S. (1995). The epidemiology of back injuries in nurses at a large Canadian tertiary care hospital: Implications for prevention. *Occupational Medicine, 45*(4), 215–220.

Yeager, P., Kaye, H., Reed, M., & Doe, T. M. (2006). Assistive technology and employment: Experiences of Californians with disabilities. *Work, 27*(4), 333–344.

Models of Return to Work for Musculoskeletal Disorders: Advances in Conceptualization and Research

24

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Overview

As noted in various chapters throughout this handbook, musculoskeletal pain disorders involve injury disorders of muscles, ligaments, tendons, joints, cartilage, and/or spinal discs, and they represent the most costly, disabling, prevalent, and commonly researched conditions in the workplace (Merriam-Webster, 2012; Schultz, Stowell, Feuerstein, & Gatchel, 2007; U.S. Department of Labor, 2011). However, it has been noted that comprehensive conceptual models of return to work (RTW) for these pain-related conditions are still lacking (U.S. Department of Labor, 2011). Although many researchers and clinicians from various fields, including occupational medicine, nursing, rehabilitation medicine, physical therapy, exercise physiology, physical and occupational therapy, ergonomics, engineering, psychology, vocational counseling, economics, and public health, have devoted a significant amount of time and effort into accumulating knowledge related to the prevention of musculoskeletal pain disorders and associated disability, a single theoretical framework combining these fields remains elusive. Indeed, since an earlier review article published by Schultz et al. (2007), no substantial advancements in developing an integrative comprehensive conceptual model of RTW have been made. However, the roles of fear of movement, depression, catastrophizing, and perception of injustice in musculoskeletal and other pain disorders have become better understood (e.g., Sullivan, Adams, Martel, Scott, & Wideman, 2011; Sullivan, Scott, & Trost, 2012; Wideman & Sullivan, 2012). Most recently, the role of *perceived uncertainty* as a key factor in formation of expectations of RTW has come to light (Stewart, Polak, Young, & Schultz, 2012), and its potential importance in the conceptualization of RTW will be explored. In this chapter, we will first discuss the current way in which RTW and disability are defined and then provide a summary of the current conceptual models. These models include the biomedical, the psychosocial, the forensic, the ecological/case management, and the biopsychosocial (see Table 24.1). The chapter will also focus on more recently articulated ergonomic

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Table 24.1 Comparison of underlying constructs and research tradition in conceptual RTW models

Current model	Former model name	Research tradition	System versus individual focus	Key determinants of RTW
Biomedical	Same	Medicine	Individual	Medical impairment
Psychosocial	Psychiatric	Health and rehabilitation psychology	Individual: evolving towards integration of system-based focus	Psychosocial factors: beliefs, perceptions, and expectations re: RTW
Forensic	Insurance	Forensic psychology	Individual: evolving towards recognition of system factors	Secondary gain: evolving into interaction among primary, secondary, and tertiary gains and losses
Ecological/case management	Labor relations	Sociology; anthropology; social, organizational, occupational health psychology; occupational health/therapy	System/system–individual interaction	Proactive system-based RTW policies and practices
Ergonomic	*N/A*	*Kinesiology*, *psychology*, *engineering*, *occupational and physical therapy*, *medicine*	*Individual/system interaction*	*Adaptation after injury*
Economic	N/A	Health economics	System	Economic incentives built into the macrosystem
Biopsychosocial	Same	Interdisciplinary/transdisciplinary	System and individual interaction	The interaction among medical, psychosocial, and system-based factors in RTW

Adapted and expanded from Schultz et al. (2000) (additions are italicized) models of RTW, such as the models presented by the Institute of Medicine (IOM) and the World Health Organization (WHO).

Of course, at the outset, one needs to develop an operational definition of RTW. Even though much research has centered on RTW in the field of occupational disability, a clear definition of RTW still remains elusive (Young et al., 2005). Several investigators have tried to identify a broadly accepted operational definition of RTW, but differences still remain in how investigators understand and operationalize the terms "disability" and "RTW." For example, occupational or work disability has been operationally defined as time off of work, reduced productivity, or working with functional limitations as a result (outcome) of either traumatic or nontraumatic clinical conditions. As such, the term "return to work" has been utilized as both a process and an outcome measure (Schultz et al., 2007). Specifically, RTW has been conceptualized as a process or measureable outcome of an injured worker, either returning or not returning to work, or incurring repeated work absences (Baldwin, Johnson, & Butler, 1996; Krause, Dasinger, Deegan, Rudolph, & Brand, 2001). Yet, a conclusive and comprehensive definition of RTW is still much needed today. Nevertheless, we will proceed with a review of the various models of RTW that have been proposed.

Current Models of RTW

Biomedical and Forensic Models

Currently, the biomedical model remains the most predominant framework for many researchers and professionals in clinical sciences and healthcare (Leibowitz, 1991; Schultz, Crook, Fraser, & Joy, 2000; Schultz et al., 2007; Turk, 1996). However, its use has been declining, mainly because it is no longer thought of as a complete or accurate conceptual framework due to the recognition of many nonmedical factors that impact disability (e.g., psychosocial factors, environmental influences, Cocchiarella & Andersoon, 2001; Cocchiarella, Turk, & Andersson, 2000; Hunt et al., 2002; Kelly & Field, 1994; Robinson, Turk, & Loeser, 2004; Schultz et al., 2000; Stowell & McGeary, 2005). Within the context of occupational disability, the biomedical and forensic models evolved. The biomedical model primarily involves two individuals [the patient (injured worker) and the treating physician], and the decision to RTW is mainly based upon the evaluation done by the physician, the treatment, and any recommendations involving the injury (Pransky, Shaw, Franche, & Clarke, 2004; Schultz et al., 2000). The forensic model (formerly known as the "insurance model"; Schultz et al., 2007) mimics the psychosocial approach (Hadjistavropoulos & Bieling, 2001; Sherman & Ohrback, 2006) by integrating cognitions and motivations, in the context of compensation-related factors arising from interactions between the injured worker and the disability benefit system. Finally, the biomedical model relies heavily on the quest for objective findings of impairment, whereas the forensic model attempts to explain the motivations that may influence the worker's RTW decision. One commonality between the two models is that they both primarily rely on an individual focus on the patient (Schultz et al., 2007). Both models, however, do not apply well to those individuals with complex chronic pain conditions. Table 24.2 provides a summary of the features of the biomedical and forensic models.

Ecological/Case Management and the Economic Models

The primary focus of ecological and economic models is taken from the viewpoint of the stakeholder, where the decision and determinants of RTW are conceptualized as reflective of a complex multisystem interaction among the workplace, disability payers, insurance carriers, and healthcare utilization professionals (Schultz et al., 2007). One noted strength of these models is their complex and multidimensional nature. However, these models do require more construct validity investigation and further development in order to understand the key contributions of the system components and their interactions (Schultz et al., 2007). To date, this goal has

Table 24.2 Comparison of the biomedical model and the forensic model

	Biomedical model	Forensic model
Main tenets	• Pathology and illness	• Anticipation of secondary gain can lead to dishonesty about symptomatology
	• Symptoms and disability are directly proportionate to physical pathology	• Objective proof of impairment and disability must be provided
	• Mind and body are separate	• It is paramount to clearly discriminate between “honest” and “dishonest” clients
	• Physicians in control of diagnosis and treatment direction	• Interactions among primary, secondary, and tertiary gains and losses should be considered
Underlying values	• Scientific evidence and objectivity	• Scientific truth
		• Protection of the system from abuse and dishonesty
		• Cost-effectiveness
Implications for diagnosis	• Focus on uncovering organic pathology	• Thorough and exhaustive assessment using special forensic methods aimed at detection of inconsistencies and deception
	• Sequential diagnostic approach	• Utilization of interdisciplinary model
		• Individuals showing inconsistencies in testing identified as “illegitimate,” “malingerers,” “symptom magnifiers,” and/or motivated by secondary gain
		• Adversarial service climate
Implications for treatment	• Cure-oriented versus coping-oriented	• “Honest” clients may receive a wide array of treatment options
	• Need to relate physical treatment to underlying pathology	• “Dishonest” clients receive no treatment
	• Focus on physical treatment modalities	
Implications for compensation	• Compensation for impairments with clearly identified medical causes	• Compensation for “honest” clients only
	• Lack of specific built-in financial incentives for coping	• Appears an attractive option due to simplicity
		• Long-term costs due to chronicity in incorrectly identified clients
		• Multiple systemic safeguards necessary to detect malingering may cause service inefficiencies

From Schultz et al. (2000, p. 333)

not been accomplished. The models, though, do differ in terms of their basic foundations. While the ecological/case management model is founded on a whole host of disciplines, including anthropology, health psychology, industrial/organizational psychology, nursing, occupational health and therapy, sociology, and social work, the economic model is tightly tied to the field of economics (Schultz et al., 2007). In addition, the ecological/case management model is focused on the role of systems and the impact of systems on the individual. Most of the input coming from *Bronfenbrenner's systems theory* (Bronfenbrenner, 1979), involving the interaction of

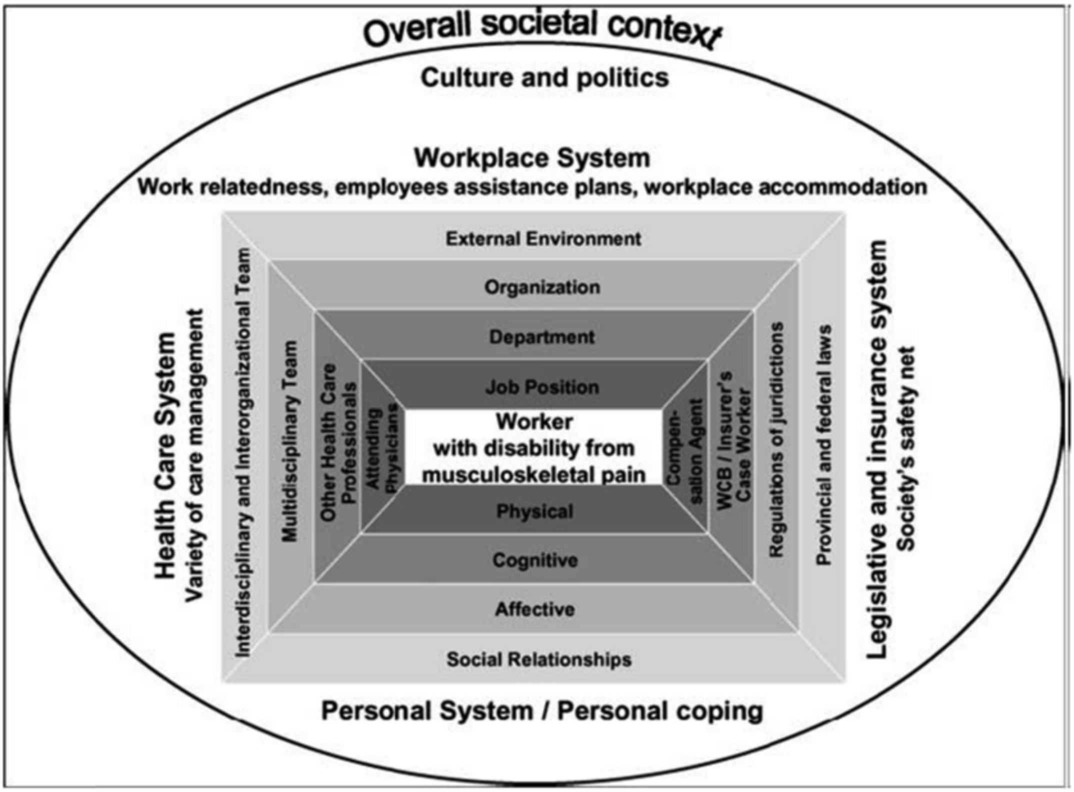

Fig. 24.1 The areas in occupational disability prevention (Loisel, Durand, et al., 2001, p. 509)

microsystems, mesosystems, and macrosystems (Baril & Berthelette, 2000; Friesen, Yassi, & Cooper, 2001; Krause & Ragland, 1994; Loisel et al., 2005; Loisel, Durand, et al., 2001), is incorporated in this ecological/case management model. Loisel et al., (2001, 2005) has presented and also empirically validated the most up-to-date ecological/case management model of RTW. Loisel's conceptual model of RTW and secondary prevention is illustrated in Fig. 24.1. This model emphasizes that the most important stakeholders are the workplace, healthcare system, and compensation system, and the actions and attitudes of these stakeholders are crucial in conceptualizing RTW. The economic model focuses mainly on macrosystem factors (Baldwin & Johnson, 1995; Baldwin et al., 1996; Butler, Johnson, & Baldwin, 1995; Chirikos & Nestel, 1984; Johnson & Baldwin, 1993). Table 24.3 summarizes the key features of this model.

Ergonomic Model

The ergonomic perspective of disability focuses on understanding the interactions among humans and other elements of a system and then applying these principles and methods to optimize human well-being (International Ergonomics Association, 2012). While the field of ergonomics covers three distinct disciplines (physical, cognitive, and organizational) in the context of disability, this section will focus on the physical and cognitive aspects of the model. Table 24.4 summarizes the major features of this model.

Evolution and Conceptualization of Occupational Disability/RTW and Determinants of RTW

The primary and more traditional focus of this model centers around the interaction among the disabled worker, other elements in his/her system, and injury prevention (Leyshon & Shaw,

Table 24.3 Comparison of the ecological/case management model and the economic model

	Ecological/case management model	Economic model
Main tenets	• Occupational disability (previous injury) should be understood in a systemic context considering the interplay among the macrosystem, mesosystem, and microsystem (the individual)	• Macrosystem of economic forces plays a predominant role in disability
	• Occupational disability has multiple societal stakeholders, including employer, healthcare, insurance system, and family; each of the stakeholders has different disability paradigms and anticipated RTW outcomes	• Focus on labor force participation, economic incentives, shifts in labor demand, the effects of discrimination, and the long-term economic impact of injury
	• Work injury is understood and managed within the sociopolitical context of the workplace	• Disability periods are not simple episodes, but are recurrent, and these patterns are predictors of future disability
	• The needs of the workers and the employers can be complementary	• Longitudinal approach
	• System-based responsibility for outcomes	
	• Workplace characteristics significantly influence injury sequelae/recovery and rehabilitation	
	• Employer has a critical role in RTW and needs incentives to assist injured workers. System changes necessary to accommodate RTW needs of injured worker	
	• Multidisciplinary approach	
	• Proactive and disability prevention focused	
	• Early intervention in the workplace	
	• Service recipient seen as microsystem	
Underlying values	• Integration of prevention, rehabilitation, and RTW	• Improvement of macrosystem
	• Harmonious multisystem relationships	
	• Protection of injured worker from exploitation	
	• Cost containment	

Implications for diagnosis	• Assessment of the impact of macrosystems, mesosystems, and multisystem interactions on RTW	• Individual clinical diagnosis is of secondary importance
	• Define outcome according to the stakeholder	• The identification of longitudinal patterns of disability in a macrosystem is of key importance
	• Focus on the assessment of functional work capacity, preferably "in vivo"	
	• Analyze the impact of work characteristics and workplace barriers and facilitator on RTW	
	• Identification of early risk markers for occupational disability (flagging)	
	• Importance of correct clinical diagnosis (label) is secondary	
Implications for treatment	• Disability management in the workplace	• Effective treatment is expected to impact disability
	• Treatment integrated with RTW process	• RTW patterns over time, not a single episode
	• Work conceptualized as therapy	• Cost-offset data on RTW interventions are important
	• Work return transition programs and job accommodation	
	• Integrated case management approach	
Implications for compensation	• Reduction in long-term disability costs	• Can account for multiple economic factors that impact long-term RTW among injured workers
	• Costs partly shifted to the specific accident employer	• Able to identify and quantify the macrosystem inputs to work disability instantly and over time
		• Cost reduction due to improved system-based identification and intervention targeting multiple economic factors in RTW over time

From Schultz et al. (2000, p. 336)

Table 24.4 Summary of the ergonomic model

	Ergonomic model
Main tenets	• Adaptation • Prevention • Identify workplace risk factors
Underlying values	• Injury prevention • Outcome = return to work
Implications for diagnosis	• Multidimensional/interdisciplinary diagnosis • Identifying prevention strategies in order to lower costs
Implications for treatment	• Injury prevention and adaptation are important • Worker and system are co-responsible for RTW outcome
Implications for compensation	• Improved rehabilitation, lower costs

2008). From this viewpoint, whether or not an individual is able to RTW is an outcome based on adaptations made in the workplace. This ranges from adaptations of job tasks to adaptation of working hours (Stewart et al., 2012). Often, ergonomics have been split into two camps: macroergonomics and microergonomics. *Macroergonomics* deal with the large scale, more global approach, which addresses policies, attitudes, and processes (Hendrick, 2003; Leyshon & Shaw, 2008). *Macroergonomics* can be applied at both the company and governmental levels (Leyshon & Shaw, 2008). On the other hand, *microergonomics* are more often than not what people think of when they think of ergonomics: mainly referring to worker-specific interventions and/or the worker and machine interface (Leyshon & Shaw, 2008). *Microergonomics* can, therefore, be applied to the worker or machine themselves, and common examples of this are the adapted computer keyboard or ergonomic desk chair, both designed to reduce and/or prevent injury (Leyshon & Shaw, 2008).

Importantly, ergonomics is a multidisciplinary field that encompasses professionals with various backgrounds, including kinesiology, psychology, engineering, occupational and physical therapy, and medicine. Three main disciplines in ergonomics have emerged: physical, cognitive, and organizational; and ergonomists often describe themselves in one of those three categories.

Individual Versus System Focus

The ergonomic model of RTW is based on the interaction between the individual and the system. More recent contributions to the model have moved away from the traditional ergonomic approach, to one called a "participatory ergonomic" approach (Anema et al., 2003). *Participatory ergonomics* involve active participation and a strong commitment from both the employee and employer in order to identify workplace risk factors and interventions to prevent long-term disability (Anema et al., 2003).

Examples of Ergonomic Models

There is increasing evidence that ergonomic interventions may be useful in preventing musculoskeletal disorders among workers and reducing injury rates (Anema et al., 2003, 2004; De Jong & Vink, 2000; Droeze & Johnson, 2005; Halpern & Dawson, 1997; Haslam, 2002; Hendrick, 2003; Jack, 2005; Ketola et al., 2002; Koningsveld, Dul, Van Rhijn, & Vink, 2005; Kuorinka et al., 1994; Leyshon & Shaw, 2008; Marcal & Mazzoni, 1998; McCluskey, Burton, & Main, 2006; Pohjonen, Punakallio, & Louhevaara, 1998; Vedder & Carey, 2005; Vink et al., 1995, 1997; Wickstrom, Hyytiainen, Laine, Pentti, & Selonen, 1993; Wilson, 1995). The use of ergonomic interventions in long-term disability prevention, or in improving actual RTW outcomes, has not been as prevalent. Less evidence exists in the literature concerning the use of ergonomics for injured workers' rehabilitation and RTW strategies (Leyshon & Shaw, 2008). However, there is emerging empirical evidence suggesting that ergonomic interventions may be effective for workers' RTW outcomes (Anema et al., 2004; Baldwin et al., 1996; Habeck, Hunt, & Van Tol, 1998; Loisel, Gosselin, et al., 2001). More research is needed using the ergonomic model and examining RTW outcomes.

Table 24.5 Summary of the psychosocial model

	Psychosocial model
Main tenets	• Psychosocial factors play predominant role in disability and readiness to RTW
	• Psychosocial factors are both individual-related and system-related
	• Perceptions, beliefs, and expectations of recovery and disability, self-efficacy, and ways of coping are more important than objective factors in disability formation
	• Motivational factors mediate between impairment and disability
Underlying values	• Scientific evidence
	• Comprehension of disability drivers
Implications for diagnosis	• Psychosocial factors must be assessed and identified at any stage of disability
	• Beliefs about disability need to be investigated
	• Stage of readiness for RTW including self-efficacy and decisional balance should be identified
	• Psychological diagnosis is of secondary importance
Implications for treatment	• Modifiable psychosocial factors must be targeted in treatment on a priority basis
	• Psychological treatment of choice: cognitive-behavioral interventions
	• Prevention targeting psychosocial factors can be undertaken in the interdisciplinary intervention context, not only in psychological therapy context
Implications for compensation	• Psychological factors must be accounted for in treatment even if they are non-compensable
	• Expedited RTW, possible increase in benefits

Adapted from Schultz et al. (2000, p. 334)

Psychosocial Model

Currently, the focus of the earlier psychiatric perspective of disability, which centered primarily on psychopathology, has evolved into a broader psychosocial adaptation perspective (Schultz et al., 2007). According to the psychological/psychiatric perspective, RTW is considered a behavior, associated with sets of respective cognitions and affect. Additionally, in this model, occupational disability is no longer viewed as an individual attribute, but as a product of the interaction between the worker's immediate social environment and other societal institutions (Baril & Berthelette, 2000; Olkin & Pledger, 2003; Schultz & Gatchel, 2005; Tate & Pledger, 2003). The concepts of expectations of outcome and efficacy in predicting an individual's ability to achieve a desirable outcome, such as RTW, have been gaining empirical research support (Cole, Mondloch, & Group, 2002; Sandstrom & Esbjornsson, 1986; Schultz et al., 2004; Turner et al., 2006). This perspective suggests that Bandura's *social learning theory* (Bandura, 1977, 1986) may still hold significant conceptual promise, this time in the RTW context. Some of the mechanisms underlying disability in this model focus on beliefs, expectations, perceptions, locus of control, self-efficacy, and coping skills of the individual (Burton, Tilloston, Main, & Hollis, 1995; Haldorsen, Indahl, & Ursin, 1998; Jensen, Romano, Turner, Good, & Wald, 1999; Linton, 2000; Turk & Gatchel, 2000). Recent work with this model has included not only the role of the individual's cognitive-behavioral attributes but also psychosocial factors of systems including the workplace, unions, healthcare, and disability insurers (Franche, Baril, Shaw, Nicholas, & Loisel, 2005; Schultz et al., 2007; Stowell & McGeary, 2005; Sullivan, Feuerstein, Gatchel, Linton, & Pransky, 2005). Table 24.5 provides a summary of the features of this model.

Other Psychosocial Factors to Consider

The Role of Perceived Uncertainty in RTW

Research has shown that many psychosocial factors influence expectations for RTW and expectations of health outcomes in musculoskeletal pain disorders constitute the most powerful predictor of disability and RTW (e.g., Schultz et al., 2002, 2004). While expectations have been shown to influence medical outcomes and prejudice interpretations (Halligan, 2006), there is emerging empirical evidence supporting the notion that expectations may play a key role in the RTW process (Sampere et al., 2012; Stewart et al., 2012). In addition, it has been shown that expectations can hinder recovery (Burton, Waddell, & Main, 2006). Much of the literature has focused on the biomedical or forensic models of RTW, without taking into consideration either the problems inherent to the process per se or other factors that may play a role (Stewart et al., 2012).

More recently, Stewart et al. (2012) used a grounded theory approach and biopsychosocial framework to identify a new and important factor that plays a key role in RTW expectations and outcomes—*perceived uncertainty*. Based on emerging qualitative research evidence, the investigators defined *perceived uncertainty* as "an awareness of not knowing what will happen in relation to health, work and life in general" (Stewart et al., 2012, p. 7), and it can consist of "anxiety, despair, and confusion, or hope and opportunity" (Stewart et al., 2012, p. 11). *Perceived uncertainty* is the overarching construct, composed of five interrelated sub-constructs: (1) perceived lack of control over the RTW process, (2) perceived lack of recognition by others of the impact of the injury on the worker, (3) perceived inability to perform pre-injury job(s), (4) perceived lack of workplace accommodation, and (5) fear of movement/(re)injury. Some of the key elements of the construct of *perceived uncertainty* are as follows: (1) the ability of each element to interact with the other; (2) in regard to the biopsychosocial model, each sub-construct can be individually influenced; and (3) perceived uncertainty in one sub-construct may lead to increased perceived uncertainty in another sub-construct (Stewart et al., 2012).

Stewart et al. (2012) found that most patients, who had back pain and had been off work between 3 and 6 months, were reluctant to articulate expectations of RTW because they were uncertain about the process and were uncertain they would be able to return to pre-injury work status. These findings provide empirical support for the role of *perceived uncertainty* in the RTW process. Sampere et al. (2012) also provide further support that RTW expectations are an important factor in the RTW process for workers on long-term nonwork-related sick leave. In addition, Tjulin, MacEachen, and Ekberg (2010) found that uncertainty plays a role in the workplace in terms of how coworkers of the injured individual act during the RTW process. Future research may be aimed at examining the interaction among the sub-constructs of perceived uncertainty, how they influence expectations of RTW, and how they play a role in the workplace among coworkers. Table 24.6 lists the categories, properties, dimensions, and examples of the core concepts of *perceived uncertainty*. Figure 24.2 represents the relationship of *perceived uncertainty* to the formation of expectations of RTW.

Catastrophizing and RTW

Another psychosocial factor found to influence the potential for RTW is the construct of catastrophizing. Pain catastrophizing is usually defined as an exaggerated negative orientation towards actual or anticipated pain experiences. Current conceptualizations of catastrophizing most often describe it in terms of appraisal or a set of maladaptive beliefs (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). Indeed, the role of pain catastrophizing in chronic pain adjustment and recovery from disability is quite substantial. For example,

> cross-sectional studies have demonstrated that catastrophizing is associated with increased pain, increased illness behavior, and physical and psychological dysfunction across numerous clinical and non-clinical populations. Prospective studies indicated that catastrophizing might be predictive of the inception of chronic musculoskeletal pain in the general population…and of more intense pain and slower recovery after surgical intervention. (Gatchel et al., 2007, p. 603)

In order for a chronically disabled patient to RTW, the role of catastrophizing needs to be taken into account. The worker will need to be educated that the perception that pain means harm, and activity should therefore be avoided, has to be addressed. Memory of past pain experiences

Table 24.6 Categories, properties, and dimensions of perceived uncertainty in the formation of expectations of return to work for injured workers with subacute back pain

Category	Properties	Dimensions	Examples
Perceived uncertainty	Awareness of ambiguity about present and future options in relation to RTW and life in general	Individual differences regarding tolerance of perceived uncertainty, interpersonal relationship stressors, systemic powerlessness	*Microsystem*: physical abilities, pain management, recovery timeline, home life, leisure activities
			Mesosystem: rehabilitation services, financial concerns, coworkers, accommodations, stigma
			Macrosystem: future employment, labor market, retirement plans
Perceived (lack of) control over the RTW process	(Lack of) participation in decision-making processes related to rehabilitation and RTW	Degree of collaboration in RTW process, relative power or powerlessness, feelings of self-worth, (lack of) voice, being suspected of malingering	*Microsystem*: (in)ability to manage pain, medications, sleep, concentration
			Mesosystem: coordinating appointments, mobility challenges, changing family roles/tasks, (lack of) workplace accommodations
			Macrosystem: rehab timelines, rights re: accommodations, insurance policies re: objective findings
Perceived (lack of) recognition by others of impact of injury on worker	Invisible nature of back injury, sudden, unexpected event, subjective nature of pain, being suspected of malingering	Self-doubt about extent of injury, feeling blamed/guilty re: cause of injury, disclosure and accommodation concerns, stigma, discrimination	*Microsystem*: feel guilty while off work
			Mesosystem: concern about RTW too early, high-risk job demands, changing family roles, unsympathetic friends, coworkers
			Macrosystem: stigma, accommodations, future employment prospects, need for objective findings

(continued)

Table 24.6 (continued)

Category	Properties	Dimensions	Examples
Perceived (lack of) ability to perform pre-injury job	Level of confidence in relation to work tasks, future employment possibilities	Self-doubt re: physical and psychological capabilities, being judged by others, changing identity, concerns re: future prospects	*Microsystem*: stamina, strength, fear of pain, safety concerns
			Mesosystem: concerns re: adequacy of work simulation at rehab clinic, coworker resentments, employment termination
			Macrosystem: stigma, work history
Fear of movement/(re)injury	Fear of dangerous workplace, high-risk job demands, fear of pain, avoidance behaviors	Pain experience, physical limitations, fear of permanent disability/dependence	*Microsystem*: previous injury, pain management
			Mesosystem: workplace safety, financial pressure, changing roles at home
			Macrosystem: accountability re: GRTW, accommodations, concerns re: long-term disability
Perceived (lack of) workplace accommodations	Level of confidence in relation to requesting accommodations or belief in their likelihood	Previous unsuccessful attempt at RTW, witnessing unmet coworker needs for accommodations, difficulty imagining their implementation	*Microsystem*: previous RTW attempt
			Mesosystem: communication with employer re: accommodations
			Macrosystem: awareness of lack of implementation of accommodations in workplace, stigma, needing accommodations

From Stewart et al. (2012, p. 6)

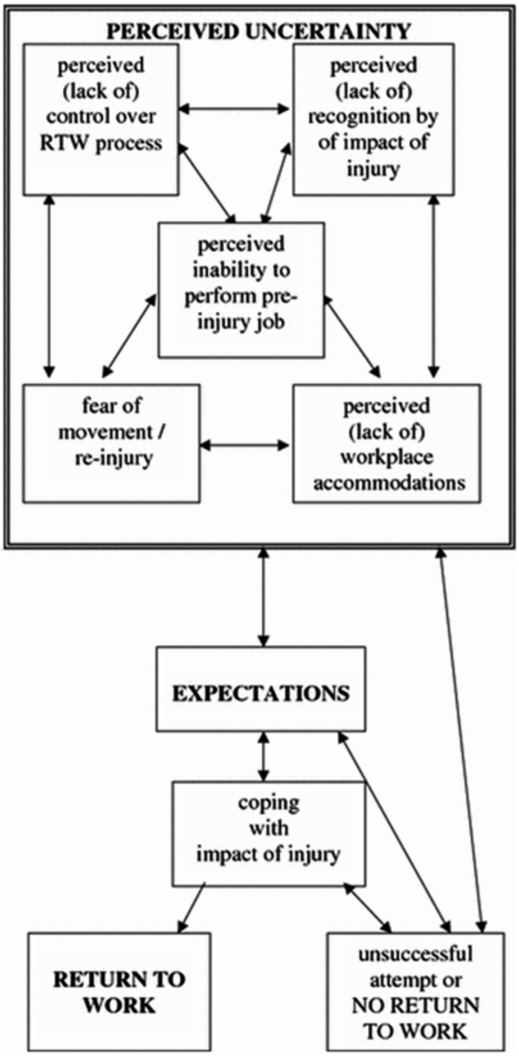

Fig. 24.2 The relationship of *perceived uncertainty* to the formation of expectations of RTW (Stewart et al., 2012, p. 5)

associated with the initial injury, and the belief that RTW and the associated activity will lead to a pain increase needs to be directly challenged so that this maladaptive thought can be replaced by more adaptive coping mechanisms. Such positive coping mechanisms can be in the form of education about safe lifting/working conditions that will eliminate the possibility of reinjury at the job. In fact, cognitive-behavioral treatment techniques have been found to be effective in reducing catastrophizing and the fear of reinjury (e.g., Gatchel et al., 2007; Sullivan, Adams, & Ellis, 2012; Wideman & Sullivan, 2011).

Perception of Injustice in RTW

Research evidence has also been accumulating regarding perception of injustice as a significant risk factor for problematic pain outcomes (Sullivan, Scott, et al., 2012). Together with catastrophizing, perceived injustice constitutes a major risk factor for chronic disability in studies of musculoskeletal disorders (Sullivan et al., 2011; Sullivan, Davidson, Garfinkel, & Scott, 2009). Perception of injustice has rarely been explicitly targeted in RTW interventions although injured workers' and other claimants' anger and blaming employers and insurance systems have been clinically observed to hinder recovery and RTW. With new advances in the understanding of the role of perceived injustice and perceived uncertainty, the focus of RTW interventions is bound to shift away from individual-oriented interventions (e.g., those targeting depression, fear of injury, and catastrophizing) to system-based interventions within healthcare, rehabilitation, workplace, and compensation systems. This shift towards targeting the sense of justice and predictability of outcomes has the potential to reduce perception of uncertainty.

Biopsychosocial Model

The biopsychosocial model of RTW integrates key aspects from both the biomedical model and psychosocial model. In the literature, it focuses on the conceptual interaction among biological, physical, behavioral/psychological, and social factors. However, a more complete comprehensive biopsychosocial model would require integration of medical, psychosocial, environmental, and ergonomic factors (in addition to those mentioned previously), all within a system-based approach (Schultz et al., 2007). The biopsychosocial model has as its strength the fact that it was developed by using empirically driven risk factors and a cumulative clinical experience with patients who have chronic musculoskeletal pain. Although some have seen the latter as a limitation to the model (Schultz et al., 2007), others have emphasized it as a strength (Gatchel & Turk, 2008). Table 24.7 provides a summary of the biopsychosocial model.

Table 24.7 Summary of the biopsychosocial model

	Biopsychosocial model
Main tenets	• Response to injury considered to be multidimensional
	• Medically-defined impairment does not reliably predict disability and symptoms. Psychosocial factors mediate one's reaction to injury
	• Interdisciplinary/transdisciplinary whole person approach
	• Focus on self-responsibility and self-management of the worker
	• Disablement and RTW are time-based processes
	• *Role of beliefs and expectations*
Underlying values	• Client and his/her well-being
	• Outcome = improved function
	• Chronicity prevention
Implications for diagnosis	• Multidimensional/interdisciplinary diagnosis
	• Admission of limitations of diagnosis
	• Functional focus in assessment
	• Early assessment of medical, psychosocial, and system-based risk factors for disability
	• Identification of biopsychosocial factors responsible for readiness to RTW, including stage/temporal aspects of the process
	• Treatment-oriented assessment
Implications for treatment	• Treatment and RTW more important than diagnosis
	• Coping is a desirable outcome if cure not possible
	• Worker as an active participant in the process and responsible for the outcome
	• Coordinated team and case management approach
	• Linkages with the environment the worker returns to (e.g., employer, family)
	• Time-based intervention approach with flexible early intervention dependent on readiness to RTW
	• *Expectancies are related to recovery and RTW*
Implications for compensation	• Clear guidelines required for compensability if exact causality/etiology unknown or interactive
	• Higher rehabilitation, lower compensation costs
	• Compensability primarily for treatment failures and permanent impairment
	• Compensation used as an incentive for rehabilitation/RTW

Adapted from Schultz et al. (2000, p. 337), additions are Italicized

Regarding disability and RTW within the biopsychosocial model, a complex relationship exists among many factors, including pain, physical and psychological impairment, as well as functional and social disability (Gatchel, 1996; Schultz et al., 2000; Turk & Monarch, 2002). Because of the complexity of the biopsychosocial model, it is able to not only account for interactions among the injured worker, the employer, case managers, medical providers, and social environment but also account for interactions within each of those components (Schultz et al., 2007). An example of an early development of a biopsychosocial model was a functional restoration model presented by Feuerstein (1991). In general, his model proposed that in relation to the work demands required by the job, RTW was a function of the worker's current physical condition. The *Center for Occupational Rehabilitation* at the University of Rochester used this model as the basis for its comprehensive multidisciplinary rehabilitation program (Feuerstein & Zastowny, 1996; Linton et al., 2005). While this model incorporated ergonomic factors related to the work demand component, the overall system was not reflected. Figure 24.3 presents the multiple factors potentially affecting RTW in Feuerstein's model.

Recognition of dynamic, time-based (temporal) dimensions of the RTW process has led to a more

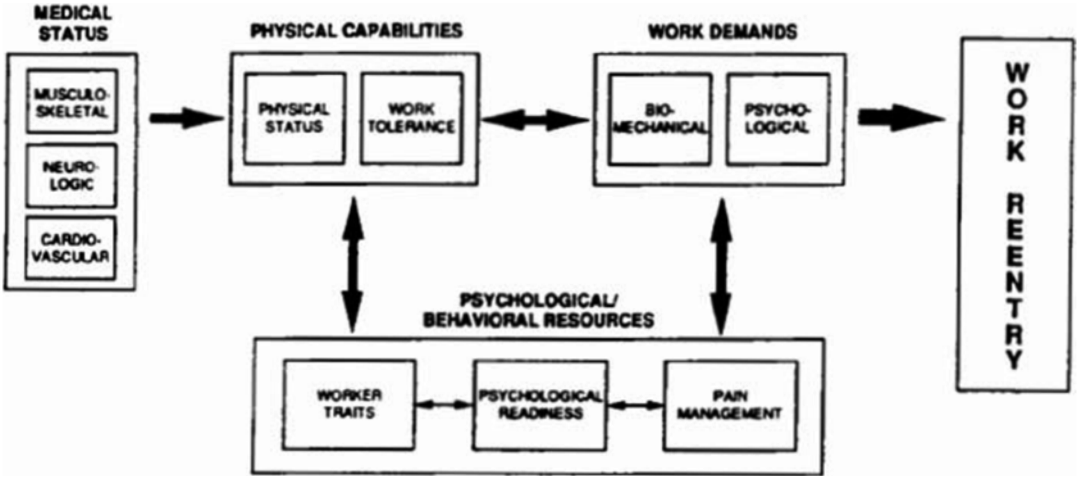

Fig. 24.3 From Feuerstein (1991, p. 10), multiple factors potentially affecting RTW

recent addition to the biopsychosocial model. Evidence suggests that RTW and occupational disability should not be considered simply as static employment outcomes (Linton et al., 2005). Rather, recognition that risk factors may change over time was a significant advancement of the model. Moreover, among worker cognitions associated with RTW, it has been proposed that the model takes workers' beliefs and expectations of disability and RTW into account. Beliefs and expectations have been shown to play a significant role in both recovery and RTW (e.g., Schultz et al., 2007; Stewart et al., 2012). Underlying this conceptualization is the notion that beliefs may shape expectancies of RTW (Halligan, 2006; Main & Spanswick, 2000). To demonstrate this relationship, investigators have found that beliefs and corresponding expectations may hinder recovery and dysfunctional or inappropriate expectations are central to failure to RTW (Burton et al., 2006). However, it must be noted that, at present, the biopsychosocial model is still evolving and potential problems with its generic nature and lack of specificity (Imrie, 2004) still need to be addressed. Notably, the International Classification of Functioning, Disability and Health (ICF) model (WHO, 2001) has been conceptualized as a biopsychosocial model, emphasizing a dynamic interaction between individual functioning and the environment. Most recent advances in the biopsychosocial model are arising from multidisciplinary efforts to operationalize and empirically validate the WHO model. The application of this promising integrative model to musculoskeletal disorders requires further conceptual and empirical research (Schultz et al., 2007).

In another chapter of this handbook, Gatchel, Kishino, and Schultz discuss how early biopsychosocial intervention can be effective in preventing the development of chronic musculoskeletal pain disorders and disability. Using a biopsychosocial model, these authors reviewed clinical research demonstrating that "high risk" acute low back pain patients, for example, can be identified using an algorithm that identifies a "psychosocial disability factor" that makes some workers more or less prone to develop chronic disability problems after an initial acute injury. It should be noted that this algorithm did not include any actual physical measures, but primarily psychosocial variables (such as somatization, reports of high pain levels, and workers' compensation status). In a second series of studies, a biopsychosocial early intervention program was administered to acute low back pain workers who were identified as being "high risk" for developing chronic disability. One-half of these workers were administered a biopsychosocial early intervention program, while the other half were administered treatment as usual. The biopsychosocial intervention program utilized techniques such as cognitive-behavioral therapy and stress management to decrease the pain and uncertainty/fear of reinjury associated with the acute injury. Results of that study clearly demonstrated that the biopsychosocial early intervention produced a significantly greater reduction in subsequent chronic disability (as measured 1 year post-injury), relative to a treatment-as-usual group. Thus, again, within a biopsychosocial context, gains are being made in terms of identifying and then effectively intervening with workers who may be prone to develop chronic musculoskeletal pain and disability problems.

Institute of Medicine and World Health Organization Models

The IOM and the WHO have proposed models of RTW that integrate the most salient features of the aforementioned models. The model presented by the IOM (Fig. 24.4), which was proposed by a group of clinicians and scientists from a wide range of disciplines, integrated certain factors that could potentially impact pain and disability (Wunderlich, Rice, & Amado, 2002). In order to obtain a more complete view of work-related musculoskeletal disorders, this model acknowledged the need for understanding the epidemiological, laboratory, and clinical research (Panel on Musculoskeletal Disorders, 2001a, 2001b).

The World Health Organization's (WHO) most recent model of disability is the ICF *model* (Dahl, 2002; Steiner et al., 2002; WHO, 2001). As can be seen in Fig. 24.5, it places emphasis on health and functioning, rather than solely on disability. This model classifies two main domains: health and health-related outcomes. In addition to the environmental factors that are contained in the ICF model, it also incorporates biological and societal perspectives, while embracing a

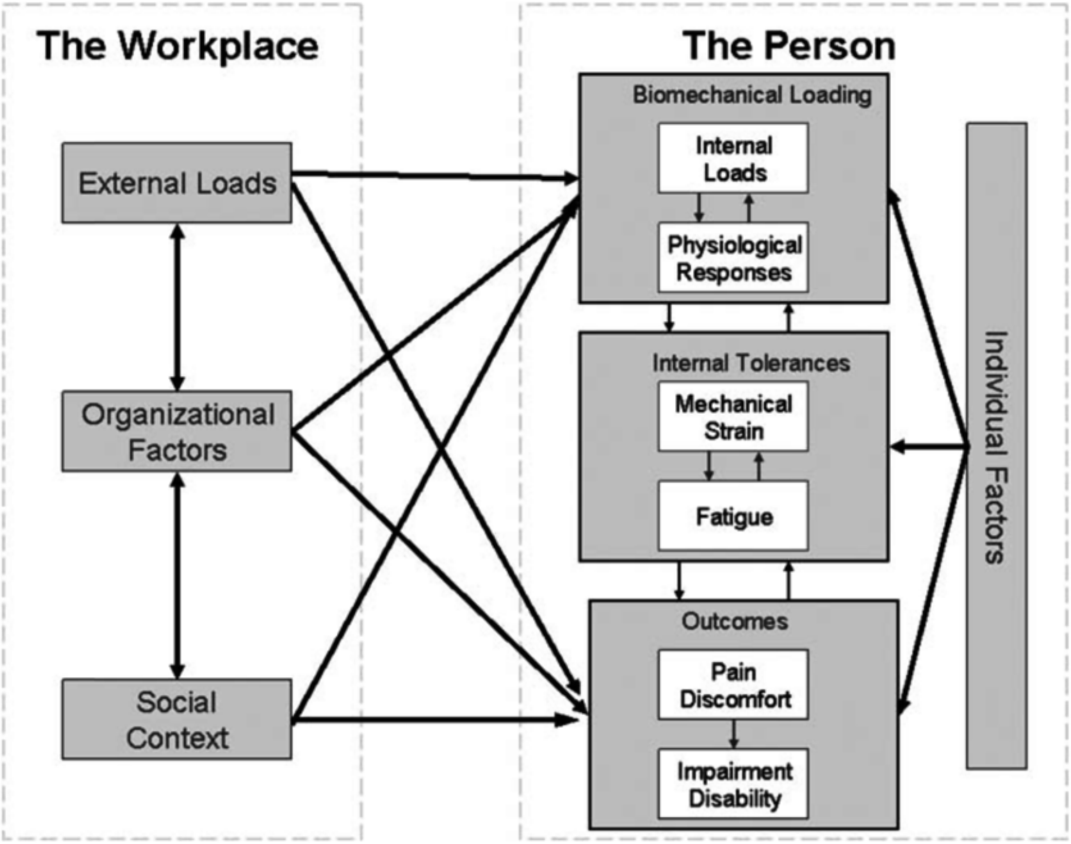

Fig. 24.4 Institute of Medicine model of disability (2001)

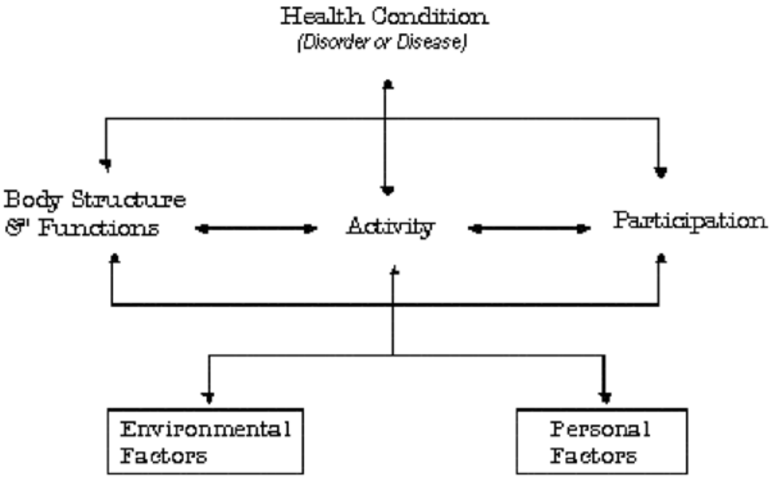

Fig. 24.5 The World Health Organization International Classification of Functioning, Disability and Health (ICF) model of health (2001, p. 9)

biopsychosocial conceptualization. However, even though it emphasizes societal elements, medicine continues to be at the core of the model (WHO, 2012).

The ICF does put the concepts of "health" and "disability" into a new framework by examining these factors at both individual and population levels. This model emphasizes that disability is something that may happen to anyone, at any time, and that every individual may be susceptible to declines in health and functioning and therefore prone to experiencing some degree of disability in their life (WHO, 2012). The model also attempts to shift the focus from "cause" to "impact," comparing health conditions equally across one metric. Moreover, the ICF can be applied in a variety of contexts, from answering questions involving clinical research to policy and development issues, from both individual and larger population levels. At the individual level, the ICF may be used to assess the individual, plan treatment, evaluate the treatment or other intervention, communicate among healthcare providers, and self-evaluate (WHO, 2002). At the institutional level, the ICF may be used for educational and training purposes, resource development and planning, quality improvement, and management and outcome evaluation (WHO, 2002). At the societal level, the ICF may be used to determine eligibility requirements for entitlements, social security benefits, disability pensions, and workers' compensation and insurance, social policy development, needs assessments, and environmental assessments (WHO, 2002). In a research context, the ICF may also assist scientific research by providing a framework for interdisciplinary research on disability and making research comparable (WHO, 2002). Concerning intervention studies, the ICF may facilitate studies that compare outcomes on similar populations (WHO, 2002). Also, even though the goal of the ICF is to compare health conditions on an "equal playing field," it has come under some criticism because of its failure to clearly specify the content of the biopsychosocial model that underlies it, as well as its atheoretical definition of impairment (Schultz et al., 2007; Van der Ploeg, van der Beek, van der Woude, & van Mechelen, 2004). In addition, some authors had initially noted difficulty in operationalization and application of this model (Dahl, 2002; Steiner et al., 2002; Van der Ploeg et al., 2004).

Future Construction of RTW Models

Based on the literature reviewed in this chapter, it is concluded that a more integrative and comprehensive biopsychosocial model of occupational disability and RTW for musculoskeletal disorders, although clearly advancing from both conceptual and empirical perspectives, is still greatly needed.

The role of cognitions, including beliefs, expectations, and perceived uncertainty, has been emerging as critical for the understanding of the RTW process and outcomes. Future quantitative and qualitative research on these models should examine the following: the interaction of factors/constructs within overarching models, multivariate aspects, validity, generalizability, reliability, and ecological validity. Thus, any new model needs to be evaluated using these criteria. This is not to say that the earlier developed models have not served to improve our understanding; they have. However, future models will benefit from using these evaluative criteria to survive, thrive, and drive the field forward. Indeed, the past models of RTW have not been as comprehensive as the current models summarized in this chapter, such as the biopsychosocial model. Most developing models discussed in this chapter are multidisciplinary, integrative, interactive, and translational and focus on the interplay between the individual and the systems within which they function. As seen with the ergonomic model, empirical evidence for the models is accumulating, and future research will continue to build upon this evidence.

Summary and Conclusions

Musculoskeletal pain disorders continue to remain one of the most costly, disabling, prevalent, and commonly researched conditions in the workplace. A critical review of the literature was presented, using multiple medical and health search engines in order to provide an evaluation of the evolution and the "state of the art" of health and disability models, with a focus on specific models of RTW. Since the earlier chapter published by Schultz et al. (2007), the biopsychosocial model has been updated to include the role of beliefs, expectations, and perceived uncertainty. Importantly, the concept of *perceived uncertainty* appears to play a key role in the formation of RTW expectations. One additional model (the ergonomic model) should be included in the current classification of models noted by Schultz et al. (2007), which explored the biomedical, psychosocial, forensic, ecological/case management, biopsychosocial models, as well as two models developed by the IOM and the WHO. It is still the case, though, that there is a need for a truly transdisciplinary model that addresses the temporal, interactive, and multidimensional aspects of disability and RTW. Moreover, the recent empirical work demonstrating the role of expectations of RTW, as well as *perceived uncertainty*, *catastrophizing*, and *perception of injustice* in RTW, also needs to be integrated into any new comprehensive model. Such a model is anticipated to lead to a better conceptual understanding of how to improve injury prevention and to the development of more effective clinical and vocational rehabilitation programs for people with musculoskeletal pain and disability.

References

Anema, J. R., Cuelenaere, B., van der Beek, A. J., Knol, D. L., de Vet, H. C. W., & van Mechelen, W. (2004). The effectiveness of ergonomic interventions on return-to-work after low back pain; a prospective study in six countries on low back pain patients sick-listed for 3–4 months. *Occupational and Environmental Medicine, 61*, 289–294.

Anema, J. R., Steenstra, I. A., Urlings, I. J. M., Bongers, P. M., de Vroome, E. M. M., & van Mechelen, W. (2003). Participatory ergonomics as a return-to-work intervention: A future challenge? *American Journal of Industrial Medicine, 44*, 273–281.

Baldwin, M. L., & Johnson, W. G. (1995). Labor market discrimination against women with disabilities. *Industrial Relations, 34*(4), 555–577.

Baldwin, M. L., Johnson, W. G., & Butler, R. J. (1996). The error of using returns-to-work to measure the outcomes of health care. *American Journal of Industrial Medicine, 29*, 632–641.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Bandura, A. (1986). *The social foundations of thought and action*. Englewood Cliffs, NJ: Prentice-Hall.

Baril, R., & Berthelette, D. (2000). *Les composantes et les déterminants organisationnels des interventions de maintien du lien d'emploi en enterprise* (Rapport No. R-238). Montréal: Institut de recherche en santé et en sécurité du travail du Québec.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge, MA: Harvard University Press.

Burton, A. K., Tilloston, K. M., Main, C. J., & Hollis, S. (1995). Psychosocial predictors of outcome in acute and subchronic low back trouble. *Spine, 20*, 722–728.

Burton, A. K., Waddell, G., & Main, C. J. (2006). Beliefs and obstacles to recovery in low back pain. In P. Halligan & M. Aylward (Eds.), *The power of belief: Psychosocial influences on illness, disability, and medicine* (pp. 11–26). New York: Oxford University Press.

Butler, R. J., Johnson, W. G., & Baldwin, M. L. (1995). Managing work disability: Why first return to work is not a measure of success. *Industrial and Labor Relations Review, 48*(3), 452–469.

Chirikos, T., & Nestel, G. (1984). Economic determinants and consequences of self-reported work disability. *Journal of Health Economics, 3*(2), 117–136.

Cocchiarella, L., & Andersoon, G. B. J. (Eds.). (2001). *Guides to the evaluation of permanent impairment* (5th ed.). Chicago, IL: AMA Press.

Cocchiarella, L., Turk, M. A., & Andersson, G. (2000). Improving the evaluation of permanent impairment. *Journal of the American Medical Association, 283*, 532–533.

Cole, D. C., Mondloch, M. V., & Group, E. P. M. (2002). Listening to workers: How recovery expectations predict outcomes. *Canadian Medical Association Journal, 166*, 749–754.

Dahl, T. (2002). International classification of functioning, disability and health: An introduction and discussion of its potential impact on rehabilitation services and research. *Journal of Rehabilitation Medicine, 34*, 201–204.

De Jong, A. M., & Vink, P. (2000). The adoption of technological innovations for glaziers; evaluation of a participatory ergonomics approach. *International Journal of Industrial Ergonomics, 26*, 39–46.

Droeze, E., & Johnson, H. (2005). Evaluation of ergonomic interventions to reduce musculoskeletal disorders of dentists in the Netherlands. *Work, 25*, 211–220.

Feuerstein, M. (1991). A multidisciplinary approach to the prevention, evaluation, and management of work disability. *Journal of Occupational Rehabilitation, 1*(1), 5–12.

Feuerstein, M., & Zastowny, T. (1996). Occupational rehabilitation: Multidisciplinary management of work-related musculoskeletal pain and disability. In R. J. Gatchel & D. C. Turk (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (Vol. xvi, pp. 458–485). New York: Guilford Press.

Franche, R., Baril, R., Shaw, W. S., Nicholas, M., & Loisel, P. (2005). Workplace-based return-to-work interventions: Optimizing the role of stakeholders in implementation and research. *Journal of Occupational Rehabilitation, 15*(4), 525–542.

Friesen, M., Yassi, A., & Cooper, J. (2001). Return to work: The importance of human interactions and organizational structures. *Work, 17*(1), 11–22.

Gatchel, R. J. (1996). Psychological disorders and chronic pain: Cause and effect relationships. In R. J. Gatchel & D. C. Turk (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (pp. 33–52). New York: Guilford.

Gatchel, R. J., Peng, Y., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin, 133*, 581–624.

Gatchel, R. J., & Turk, D. C. (2008). Criticisms of the biopsychosocial model in spine care: Creating and then attacking a straw person. *Spine, 33*, 2831–2836.

Habeck, R., Hunt, H. A., & Van Tol, B. (1998). Workplace factors associated with preventing and managing work disability. *Rehabilitation Counseling Bulletin, 42*, 98–145.

Hadjistavropoulos, T., & Bieling, P. (2001). File review consultation in the adjudication of mental health and chronic pain disability claims. *Consulting Psychology Journal: Practice and Research, 52*(1), 53–63.

Haldorsen, E., Indahl, A., & Ursin, H. (1998). Patients with low back pain not returning to work: A 12-month follow up study. *Spine, 23*, 1202–1208.

Halligan, P. W. (2006). Beliefs: Shaping experience and understanding illness. In P. Halligan & M. Aylward (Eds.), *The power of belief: Psychosocial influences on illness, disability, and medicine* (pp. 11–26). New York: Oxford University Press.

Halpern, C. A., & Dawson, K. D. (1997). Design and implementation of a participatory ergonomics program for machine sewing tasks. *International Journal of Industrial Ergonomics, 20*, 429–440.

Haslam, R. (2002). Targeting ergonomics interventions—Learning from health promotion. *Applied Ergonomics, 33*, 241–249.

Hendrick, H. (2003). Determining the cost-benefits of ergonomics projects and factors that lead to their success. *Applied Ergonomics, 34*, 419–427.

Hunt, D., Zuberbier, O. A., Kozlowski, A., Berkowitz, J., Schultz, I. Z., Milner, R. A., et al. (2002). Are components of a comprehensive medical assessment predictive of work disability following an episode of occupational low back trouble? *Spine, 27*(23), 2715–2719.

Imrie, R. (2004). Demystifying disability: A review of the international classification of functioning, disability and health. *Sociology of Health & Illness, 26*(3), 287–305.

International Ergonomics Association. (2012). *"What is ergonomics," "IEA members" and "Study programs."* Retrieved from http://www.iea.cc/index.php

Jack, R. (2005). The effectiveness of using two different types of anti-vibration gloves compared to bare hand condition at dampening the frequencies associated with hand-arm vibration syndrome. *Work, 25*, 197–203.

Jensen, M., Romano, J., Turner, J., Good, A., & Wald, L. (1999). Patient beliefs predict patient functioning: Further support for a cognitive-behavioral model of chronic pain. *Pain, 81*, 95–104.

Johnson, W. G., & Baldwin, M. L. (1993). The Americans with Disabilities Act: Will it make a difference? *Policy Studies Journal, 21*(4), 775–788.

Kelly, M., & Field, D. (1994). Comments on the rejection of the biomedical model in sociological discourse. *Medical Sociology News, 19*(3), 34–37.

Ketola, R., Toivonen, R., Hakkanen, M., Luukkonen, R., Takal, E., & Viikari-Juntura, E. (2002). Effects of ergonomic intervention in work with video display units. *Scandinavian Journal of Work, Environment & Health, 28*, 18–24.

Koningsveld, E. A. P., Dul, J., Van Rhijn, G. W., & Vink, P. (2005). Enhancing the impact of ergonomic interventions. *Ergonomics, 48*, 559–580.

Krause, N., Dasinger, L. K., Deegan, L. J., Rudolph, L., & Brand, R. J. (2001). Psychosocial job factors and return-to-work after compensated low back injury: A disability phase-specific analysis. *American Journal of Industrial Medicine, 40*(4), 374–392.

Krause, N., & Ragland, D. R. (1994). Occupational disability due to low back pain: A new interdisciplinary classification used in a phase model of disability. *Spine, 19*, 1011–1020.

Kuorinka, I., Cote, M. M., Baril, R., Geoffrion, R., Giguere, D., Dalzell, M. A., et al. (1994). Participation in workplace design with reference to low back pain: A case for the improvement of the police patrol car. *Ergonomics, 37*, 1131–1136.

Leibowitz, G. (1991). Organic and biophysical theories of behavior. *Journal of Developmental and Physical Disabilities, 3*, 201–243.

Leyshon, R. T., & Shaw, L. E. (2008). Using the ICF as a conceptual framework to guide ergonomic intervention in occupational rehabilitation. *Work, 31*, 47–61.

Linton, S. (2000). A review of psychological risk factors in back and neck pain. *Spine, 25*, 1148–1156.

Linton, S., Gross, D., Schultz, I., Main, C., Cote, P., Pransky, G., et al. (2005). Prognosis and the identification of workers risking disability: Research issues and directions for future research. *Journal of Occupational Rehabilitation, 15*(4), 469–474.

Loisel, P., Buchbinder, R., Hazard, R., Keller, R., Scheel, I., van Tulder, M., et al. (2005). Prevention of work disability due to musculoskeletal disorders: The challenge of implementing evidence. *Journal of Occupational Rehabilitation, 15*(4), 507–524.

Loisel, P., Durand, M.-J., Berthelette, D., Vézina, N., Baril, R., Gagnon, D., et al. (2001). Disability prevention: The new paradigm of management of occupational back pain. *Disease Management and Health Outcomes, 9*(7), 351–360.

Loisel, P., Gosselin, L., Durand, P., Lemaire, J., Poitras, S., & Abenhaim, L. (2001). Implementation of a participatory ergonomics program in the rehabilitation of workers suffering from subacute back pain. *Applied Ergonomics, 32*, 53–60.

Main, C. J., & Spanswick, C. C. (2000). *Pain management: An interdisciplinary approach*. London: Harcourt Publishers.

Marcal, M. A., & Mazzoni, C. F. (1998). Ergonomics intervention for preventing low back pain in industry. Designing for human performance. In *Proceedings of the 30th annual conference of the Human Factors Association of Canada* (pp. 329–332), Mississauga, ON.

McCluskey, S., Burton, A., & Main, C. (2006). The implementation of occupational health guidelines principles for reducing sickness absence due to musculoskeletal disorders. *Occupational Medicine, 56*, 237–242.

Merriam-Webster. (2012). Retrieved from http://www.merriam-webster.com/medlineplus/repetitive+strain+injury

Olkin, R., & Pledger, C. (2003). Can disability studies and psychology join hands? A new model of disability. *American Psychologist, 58*, 296–304.

Panel on Musculoskeletal Disorders and the Workplace-Commission on Behavioral and Social Sciences and Education-National Research Council (NRC) and Institute of Medicine (IOM). (2001a). *Musculoskeletal disorders and the workplace: Low back and upper extremities. Executive Summary, p 3, figure. ES.1. 2001*. Retrieved August 27, 2012, from http://newton.nap.edu/books/0309072840/html/3.html

Panel on Musculoskeletal Disorders and the Workplace-Commission on Behavioral and Social Sciences and Education-National Research Council (NRC) and Institute of Medicine (IOM). (2001b). *Musculoskeletal disorders and the workplace: Low back and upper extremities. Chapter II—Interventions in the workplace* (pp. 301–329). Retrieved August 27, 2012, from http://www.nap.edu/catalog/10032.html#orgs

Pohjonen, T., Punakallio, A., & Louhevaara, V. (1998). Participatory ergonomics for reducing load and strain in home care work. *International Journal of Industrial Ergonomics, 21*(5), 345–352.

Pransky, G., Shaw, W. S., Franche, R., & Clarke, A. (2004). Disability prevention and communication among workers, physicians, employers, and insurers: Current models and opportunities for improvement. *Disability and Rehabilitation, 26*(11), 625–634.

Robinson, J. P., Turk, D. C., & Loeser, J. D. (2004). Pain, impairment, and disability in the AMA guidelines. *The Journal of Law, Medicine & Ethics, 32*(2), 315–326.

Sampere, M., Gimeno, D., Serra, C., Plana, M., López, J. C., Martínez, J. M., et al. (2012). Return to work expectations of workers on long-term non-work-related sick leave. *Journal of Occupational Rehabilitation, 22*, 15–26.

Sandstrom, J., & Esbjornsson, E. (1986). Return to work after rehabilitation. The significance of the patient's own prediction. *Scandinavian Journal of Rehabilitation Medicine, 18*, 29–33.

Schultz, I. Z., Crook, J. M., Berkowitz, J., Meloche, G. R., Milner, R., Zuberbier, O. A., et al. (2002). Biopsychosocial multivariate predictive model of occupational low back disability. *Spine, 27*(23), 2720–2725.

Schultz, I. Z., Crook, J., Fraser, K., & Joy, P. W. (2000). Models of diagnosis and rehabilitation in musculoskeletal pain-related occupational disability. *Journal of Occupational Rehabilitation, 10*(4), 271–293.

Schultz, I. Z., Crook, J., Meloche, G. R., Berkowitz, J., Milner, R., Zuberbier, O. A., et al. (2004). Psychosocial factors predictive of occupational low back disability: Towards development of a return-to-work model. *Pain, 107*, 77–85.

Schultz, I. Z., & Gatchel, R. (Eds.). (2005). *Handbook of complex occupational disability claims: Early risk iden-*

tification, intervention, and prevention. New York: Springer.

Schultz, I. Z., Stowell, A. W., Feuerstein, M., & Gatchel, R. J. (2007). Models of return to work for musculoskeletal disorders. *Journal of Occupational Rehabilitation, 17*(2), 327–352.

Sherman, J. F., & Ohrback, R. (2006). Objective and subjective measurement of pain: Current approaches to forensic applications. In G. Young, A. W. Kane, & K. Nicholson (Eds.), *Psychological knowledge in court: PTSD, pain, and TBI* (pp. 193–214). New York: Springer.

Steiner, W. A., Ryser, L., Huber, E., Uebelhart, D., Aeschlimann, A., & Stucki, G. (2002). Use of the ICF model as a clinical problem-solving tool in physical therapy and rehabilitation medicine. *Physical Therapy, 82*(11), 1098–1107.

Stewart, A. M., Polak, E., Young, R., & Schultz, I. Z. (2012). Injured workers' construction of expectations of return to work with sub-acute back pain: The role of perceived uncertainty. *Journal of Occupational Rehabilitation, 22*, 1–14.

Stowell, A. W., & McGeary, D. D. (2005). Musculoskeletal injury: A three-stage continuum from cause to disability to decision. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk, identification, intervention, and prevention* (pp. 117–139). New York: Springer.

Sullivan, M. J. L., Adams, H., & Ellis, T. (2012). Targeting catastrophic thinking to promote return to work in individuals with fibromyalgia. *Journal of Cognitive Psychotherapy, 2*, 130–142.

Sullivan, M. J. L., Adams, H., Martel, M. O., Scott, W., & Wideman, T. H. (2011). Catastrophizing and perceived injustice. Risk factors for the transition to chronicity following whiplash injury. *Spine, 36*, 244–249.

Sullivan, M. J. L., Davidson, N., Garfinkel, B., & Scott, W. (2009). Perceived injustice is associated with heightened pain behavior and disability in individuals with whiplash injuries. *Psychological Injury and the Law, 2*, 38–47.

Sullivan, M. J. L., Feuerstein, M., Gatchel, R. J., Linton, S. J., & Pransky, G. (2005). Integrating psychosocial and behavioral interventions to achieve optimal rehabilitation outcomes. *Journal of Occupational Rehabilitation, 15*(4), 475–489.

Sullivan, M. J. L., Scott, W., & Trost, Z. (2012). Perceived injustice: A risk factor for problematic pain outcomes. *Clinical Journal of Pain, 28*, 484–488.

Tate, D., & Pledger, C. (2003). An integrative conceptual framework of disability. *American Psychologist, 58*, 289–295.

Tjulin, Å., MacEachen, E., & Ekberg, K. (2010). Exploring workplace actors experiences of the organization of return-to-work. *Journal of Occupational Rehabilitation, 20*, 311–321.

Turk, D. C. (1996). Biopsychosocial perspective on chronic pain. In R. J. Gatchel & D. C. Turk (Eds.), *Psychological approaches to pain management* (pp. 3–32). New York: Guilford Press.

Turk, D. C., & Gatchel, R. J. (2000). Psychosocial assessment of chronic occupational musculoskeletal disorders. In T. M. Mayer, R. J. Gatchel, & P. B. Polatin (Eds.), *Occupational musculoskeletal disorders: Function, outcomes & evidence* (pp. 587–608). Philadelphia: Lippincott, Williams & Wilkins.

Turk, D. C., & Monarch, E. S. (2002). Biopsychosocial perspective on chronic pain. In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed.). New York: Guilford.

Turner, J., Franklin, G., Fulton-Kehoe, D., Sheppard, L., Wickizer, T., Wu, R., et al. (2006). Worker recovery expectations and fear-avoidance predict work disability in a population-based workers' compensation back pain sample. *Spine, 31*(6), 682–689.

U.S. Department of Labor: Bureau of Labor Statistics. (2011). *Non-fatal occupational injuries and illnesses requiring days away from work, 2010* (Publication USDL 11-1612). Washington, DC: U.S. Department of Labor.

Van der Ploeg, H. P., van der Beek, A. J., van der Woude, L. H., & van Mechelen, W. (2004). Physical activity for people with a disability: A conceptual model. *Sports Medicine, 34*(10), 639–649.

Vedder, J., & Carey, E. (2005). A multi-level systems approach for the development of tools, equipment, and work processes for the construction industry. *Applied Ergonomics, 36*, 147–480.

Vink, P., Peeters, M., Gründemann, R. W. M., Smulders, P. G. W., Kompier, M. A. J., & Dul, J. (1995). A participatory ergonomics approach to reduce mental and physical workload. *International Journal of Industrial Ergonomics, 15*, 389–396.

Vink, P., Urlings, I. J. M., & van der Molen, H. F. (1997). A participatory ergonomics approach to redesign work of scaffolders. *Safety Science, 26*, 75–85.

Wickstrom, G., Hyytiainen, K., Laine, M., Pentti, J., & Selonen, R. (1993). A five-year intervention study to reduce low back disorders in the metal industry. *International Journal of Industrial Ergonomics, 12*, 25–33.

Wideman, T. H., & Sullivan, M. J. L. (2011). Reducing catastrophic thinking associated with pain. *Pain Management, 1*, 249–256.

Wideman, T. H., & Sullivan, M. J. L. (2012). Development of a cumulative psychosocial risk factor index for problematic recovery following work related musculoskeletal injuries. *Physical Therapy, 92*, 58–68.

Wilson, J. R. (1995). Solution ownership in participatory redesign: The case of a crane control room. *International Journal of Industrial Ergonomics, 15*, 329–344.

World Health Organization. (2001). *International classification of functioning, disability, and health (ICF): ICF full report*. Geneva, Switzerland: World Health Organization.

World Health Organization. (2002). *Towards a common language for functioning, disability, and health, ICF:*

Full report. Geneva, Switzerland: World Health Organization. Retrieved August 27, 2012, from http://www.who.int/classifications/icf/training/icfbeginnersguide.pdf

World Health Organization International Classification of Functioning, Disability, and Health (ICF). (2012). *Classifications*. Retrieved August 27, 2012, from http://www.who.int/classifications/icf/en/

Wunderlich, G., Rice, D., & Amado, N. (2002). *Dynamics of disability: Measuring and monitoring disability for social security programs*. Washington, DC: The National Academy Press.

Young, A. E., Roessler, R. T., Wasiak, R., McPherson, K. M., Poppel, M. N. M., & Anema, J. R. (2005). A developmental conceptualization of return to work. *Journal of Occupational Rehabilitation, 15*(4), 557–568.

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Vocational Assessment and Training for Patients with Chronic Occupational Musculoskeletal Disorders

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Overview

> Man, through the use of his hands as they are energized by mind and will, can influence the state of his health (Reilly, 1962)

An individual's identity and self-worth is intricately connected to work and/or purposeful activity. The concept to utilize purposeful activity as a means to rehabilitate individuals with injuries or disabilities has been in practice for more than a century. It is a compilation of the work of multiple professions to advocate for, and demonstrate, the efficacy of using work and purposeful activity to treat and enhance the quality of life for individuals with injuries and disabilities.

The American Occupational Therapy Association (AOTA) published its first official position paper entitled "The Role of Occupational Therapy in the Vocational Rehabilitation Process" (Ad Hoc Committee on the Commission on Practice, 1980) in 1980. This position paper described how occupational therapists could practice within vocational rehabilitation. In 1985, the AOTA defined an occupational therapists role in work-based therapy by publishing "work hardening guidelines" (AOTA, 1986). In 1992, the AOTA published an updated position paper about the role of Occupational Therapists in vocational rehabilitation. The position paper reported that the primary goal of an occupational therapy-based work program was "to assist the worker or potential worker to achieve maximal function in the area of performance" (AOTA, 1992). Additionally, the position paper reported several intervention strategies such as body mechanics education and training; job analysis; use of simulated or actual work tasks, and on-the-job training and evaluation (AOTA, 1992). A decade later, similar intervention strategies are in place and backed with peer-reviewed and published research studies.

Ergonomics and the prevention of work-related injuries, including chronic musculoskeletal injuries, have been the focus of vocational rehabilitation programs for the last 10–15 years. Organizations such as the Occupational Safety and Health Administration (OSHA), The National Institute of Occupational Safety and Health (NIOSH), and the US Department of Health and Human Services (DHHS) have been successful at developing formal guidelines for several industries and occupations. In this age of advanced manufacturing and automation, goods are produced

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with a continually increasing demand on efficiency and rate of production. The adverse effect is a rise in chronic work-related injuries. This chapter will discuss four important areas related to vocational assessment and training for patients with chronic musculoskeletal disorders: (1) clinical issues related to musculoskeletal disorders; (2) discussion of evidence-based vocational treatment options; (3) discussion of recommended vocational assessment options; and (4) return-to-work with chronic musculoskeletal disorders.

Clinical Issues Related to Musculoskeletal Disorders

Work-related MSDs impact functional ability in a myriad of ways, resulting in limitations related to job performance. MSDs are generally defined as disorders involving muscles, nerves, tendons, joints, cartilage, or spinal discs. The type of MSD is usually recognized by distinct features that are defined by the anatomical structures and directly related to the location of the injury (Cohen, Gjessling, Pine, Brenard, & McGlothlin, 1997). MSDs are deemed chronic when they occur gradually over a period of time, rather than after a single event or trauma. Chronic MSD injuries may range in severity from mild to debilitating, and they may therefore impact a worker's ability to return to work in the same occupation.

MSDs accounted for 33 % (387,820) of all workplace injuries and illnesses requiring time away from work in 2011 (Bureau of Labor Statistics, 2011 or 2012). Injury incident rates vary by industry and occupation, and the more demanding the industry or occupation, the higher the rate of injury. In 2011, three industries had more than 100,000 incidents: the healthcare and social assistance industry (171,530), the manufacturing industry (129,030), and the retail trade industry (126,500) (Bureau of Labor Statistics, 2012). Because industries comprise occupations, it makes sense that, in 2011, the following six occupations accounted for 26 % of the MSD cases: nursing assistants, laborers, janitors and cleaners, heavy and tractor truck trailer drivers, registered nurses, and stock clerks (Bureau of Labor Statistics, 2012). The statistical rates of incidence for injuries and illnesses "open our eyes" to the prevalence of work-related chronic MSDs. While the incidence of injury in industries and occupations are important to understand, the key measure of the severity of injuries and illnesses is time away from work. The median number of days away from work was 8 days for the fourth consecutive year, and this statistic is regarded as a key measure of the severity of injuries and illnesses (Bureau of Labor Statistics, 2012). The mining industry had the highest overall median number of days spent away from work per case with 28 days (Bureau of Labor Statistics, 2012). Transportation and warehousing followed with 17 median days, construction required 14 median days, utilities required 13 median days, and information required 13 median days (Bureau of Labor Statistics, 2012). In all five of these industries, at least 30 % of the cases required at least 31 days away from work (Bureau of Labor Statistics, 2012). Laborers accounted for the highest proportion of injuries and illnesses in private industry and required a median of 9 days away from work to recuperate (Bureau of Labor Statistics, 2012). The incidence of injury was also compared to the length of time of employment. Injuries and illnesses to private industry workers with 1–5 years of service with an employer accounted for 35 % of the cases, a decrease of 11 % in 2011 (Bureau of Labor Statistics, 2012). However, workers with fewer than 3 months of service saw an increase of 3 % in 2011, and workers with 3–11 months of service saw an increase of 7 % (Bureau of Labor Statistics, 2012).

In 2011, for both the public and private sector, 40 % of the injuries and illness cases requiring days away from work were attributed to three types of events or exposures: falls (on the same level) accounted for 15 %, struck by object or equipment accounted for 13 %, and overexertion in lifting or lowering accounted for 12 % (Bureau of Labor Statistics, 2012).

Overall, the leading event or exposure in 2011 was overexertion and bodily reaction, with 415,800 cases and an incidence rate of 41 cases per 10,000 full-time workers (Bureau of Labor Statistics, 2012). Consequently, overexertion and bodily reaction was the leading event or exposure for four of the five occupations that experienced the highest incident and injury rates: laborers, nursing aides/orderlies/attendants, janitors, heavy/tractor truck trailer drivers, and police/sheriff's patrol (Bureau of Labor Statistics, 2012). Injuries and illnesses incurred from repetitive motion involving microtasks accounted for only 3 % of all the occupational injury and illness cases in 2011 (Bureau of Labor Statistics, 2012). However, workers who sustained injuries or illnesses in this manner required a median of 23 days away from work—nearly three times as many days for all types of injuries and illnesses (Bureau of Labor Statistics, 2012). In 2011, sprains, strains, and tears accounted for 38 % of total injury and illness cases requiring days away from work in all ownerships. Soreness and pain accounted for 12 % of the total cases (Bureau of Labor Statistics, 2011 or 2012). The high incidence and injury rates associated with chronic MSDs, and the significant length of time away from work they require, have given rise to the need and importance for work-based treatment programs and assessments.

Rehabilitation professionals, such as physical and occupational therapists and vocational rehabilitation counselors and evaluators, assess and treat individuals with work-related MSDs that can prevent successful return to work. Many assessment tools are available for use, and determining predictive factors and using a multifaceted approach are emerging trends in the literature (Lydell et al., 2005). The treating rehabilitation professional acts as a "gatekeeper" in many ways and must share information with other medical professionals, the employer, the injured worker, insurance company professionals, case managers, and, where applicable, attorneys and labor unions. Identifying a personalized treatment plan that tailors to the goals of all appropriate parties inherently seems to be the best clinical approach. Work-based or industrial rehabilitation professionals implement work-based therapy programs to address the preventative and return-to-work strategies related to the rising prevalence of MSDs in the workplace. As a result, an increasing number of clinicians are becoming proficient in performing post-offer employment tests, fit-for-duty tests, and functional capacity evaluations (FCEs). Matching workers to jobs, based on the physical abilities of the worker, seems to be an obvious way of trying to prevent an injury before it occurs, by diminishing the effects of overexertion and musculoskeletal injury. By placing an individual who demonstrates the strength necessary to complete a work-related task into a job that matches ability level, it can be assumed that overexertion will not be an issue and the potential for a work-related injury will be minimized. Work-based treatment programs and assessments administered by rehabilitation professionals are proven to maximize successful and safe return to work.

Discussion of Evidence-Based Vocational Treatment Approaches

The shift of vocational rehabilitation from work to all occupational performance areas in the late 1970s opened the doors for a multidisciplinary approach to work rehabilitation. Organizations such as the AOTA and the APTA established practice guidelines, and they continue to demonstrate efficacy for the use of work and purposeful activity in the treatment for individuals with chronic musculoskeletal work injuries. Occupa-tional and physical therapists are in the unique position to combine their knowledge of injury, disability, and impairment, with an ability to create and implement work-related treatment tools, work-hardening and work-conditioning programs, FCEs, job analyses, post-offer employment testing programs, fit-for-duty examinations, and return-to-work programs.

Work Hardening and Work Conditioning

> Work hardening is a highly structured, goal oriented, individualized treatment program designed to maximize the individual's ability to return to work. Work hardening programs, which are interdisciplinary in nature, use real or simulated work activities in conjunction with conditioning tasks that are graded to progressively improve the biomechanical, neuromuscular, cardiovascular/metabolic and psychosocial functions of the individual. Work hardening provides a transition between acute care and return to work while addressing the issues of productivity, safety, physical tolerances and worker behaviors. (Commission on Accreditation of Rehabilitation Facilities, 1988)

The National Advisory Committee's guidelines provide a framework for rehabilitation professionals to establish transitional work-based programs whose primary goal is returning individuals with a work-related illness and injury successfully back to work. These early guidelines provided frames of reference and theories of how to approach and implement work rehabilitation programs, and these same guidelines continue to shape the field of industrial rehabilitation today. Following the acute stage of injury and traditional therapeutic intervention for recovery, the individual may still be unable to perform some occupational job tasks. This may be due to several factors, such as general deconditioning while injured or regaining only partial function but permanent impairment. In these cases, premature return to work may be counterintuitive and may place the individual at risk for re-injury. Addressing the need to shift therapeutic focus from disability to ability, the healthcare team should consider transition to a work-conditioning (WC) or work-hardening (WH) program. WH and WC programs typically begin when the acute treatment of the injury is complete, and the individual's injury is stable enough to withstand a gradual reentry to work-based physical activity. WH and WC are individualized and goal-oriented programs that require constant monitoring and revision by licensed rehabilitation professionals, typically occupational and physical therapists. WC programs focus on restoring generalized fitness (cardiovascular, strength, range of motion, and flexibility) to prepare for work demands. The programs are graded from 3 to 5 days per week and can last 2–3 h per session.

WH programs were first introduced to therapy practice in the late 1970s in California, with formal guidelines for work-based therapy programs developed by AOTA in 1986 (AOTA, 1986). In March of 1988, the National Advisory Committee on Work Hardening and the Commission on Accreditation of Rehabilitation Facilities (CARF) met to develop guidelines for WH programs. WH programs begin with an evaluation to identify areas of dysfunction and mismatch between the abilities of the worker and the demands of the job/occupation. The WH evaluation should contain a battery of tests that assess active range of motion, neuromuscular strength, flexibility of the injured body areas, a postural tolerance assessment, strength for manual material handing activities (such as lifting, carrying, pushing, and pulling), and simulation of any job-specific activities. In order to accurately assess job-specific postural tolerance or manual material-handling requirements, information about the injured worker's specific job tasks and the physical demands of the essential job functions is critical. If this is not applicable or available, information provided by the injured worker is useful, and the Dictionary of Occupational Titles fourth Edition (US Department of Labor, 1991a) and (O*NET, n.d.) are good references to identify occupation-based work tasks and activities. The WH evaluation process is summarized in a report that is delivered to the professional rehabilitation team, typically consisting of the physical or occupational therapist, the physician, the employer, the case manager or adjuster, and a vocation rehabilitation counselor or evaluator if available. The WH evaluation report will detail the injured worker's abilities and limitations related to return-to-work requirements within a specific job or occupation. Once the abilities and limitations are identified, the therapist and the injured worker will develop goals for the WH program specific to the required physical demands.

WH programs typically range from 4 to 8 weeks in duration, 3–5 days a week for 4–8 h per day. The duration of 4–8 weeks is important because the neuromuscular aspects of rehabilitation required sufficient time to get stronger and demonstrate improvement. As mentioned above, the critical components of a WH program are cardiovascular conditioning, neuromuscular strength and flexibility training, and functional work activity/simulation activities. Cardiovascular conditioning deficits are typically addressed through physical activities, such as walking, climbing, running, or biking. Neuromuscular strength deficits are addressed through progressive resistive exercises, core-strengthening activities, and functional work-simulation activities. Functional activity deficits can be addressed in a variety of customizable work-simulation activities using work samples and materials. Some examples of work-simulation activities include stair/ladder climbing, assembling pipes on a pipe wall, shoveling gravel, manual material handling, and pushing/pulling pallets in a warehouse-type clinic.

Progress in WH or WC programs should be evaluated on a regular or serial basis. This is easily achieved by repeating portions of the initial WH evaluation and comparing the results. The program goals and progress towards the program goals should be reviewed on a regular, weekly basis with the injured worker. Maintaining measurable and attainable goals requires constant monitoring by the rehabilitation professional. Progress in WH and WC programs should be reported to referral source and rehabilitation team on a regular basis. Requests for additional time in WH and WC programs should be seriously considered when the injured worker is continuing to make measurable progress in the program. Multiple studies have verified the efficacy of WH and WC programs. Research demonstrates that WH and WC programs are successful at returning individuals with chronic musculoskeletal injuries back to work. The earliest WH programs reported successful outcomes of 23–50 % (King, 1993). Recent research of a current WH program reports outcomes of 70–80 % (Chapman-Day, Matheson, Schimanski, Leicht, & De Vries, 2011).

Discussion of Recommended Vocational Assessment Options

Vocational assessment of a worker in a clinical setting can assist decision makers when determining if a person can return to work. Workers should be assessed periodically, and functional gains can be highlighted during the course of the treatment process. A functional assessment should include test components that blend the actual job requirements for the individual to be assessed, so matching of the individual's functional abilities or limitations to specific job demands can be objective. The foundation for creating a clinically useful test protocol starts with a detailed physical demand job analysis. From the job analysis, required physical demands can be tested. FCEs are most useful with regard to return to same job or occupation, when the details of the job can be compared to the injured worker's functional abilities. In the event that injured workers do not have a job or occupation to return to, or their injuries are so significant that they cannot return to work in the same job or occupation, the FCE can still be a useful tool. Because an FCE measures several different constructs and abilities of an individual, the FCE can easily and accurately report general abilities of an injured worker. In the event that job demands are (1) not measurable and useful, (2) unavailable, or (3) when post-injury or residual functional abilities of the worker will not match the job, an injury-specific FCE will detail the general functional abilities of the individual.

Post-offer employment testing is a specific assessment used to test physical demands required of job candidates. Employers are able to screen out individuals who may have existing functional limitations and cannot meet the physical demands of the job and therefore will prevent an injury due to inability and also will not "own". Fit-for-duty testing is similar to post-offer employment testing in that it is more tailored and specific to the required physical demands of individual job titles. Fit-for-duty testing is generally used for current employees returning to work after an extended leave or to assess the ability of the current workforce to safely complete job-related essential functions and physical demands.

Job Analysis

The pursuit of work activity analysis is a founding principle in vocational assessment. Whether the goal is to return a disabled person to gainful employment or offer educational services as part of vocational counseling, the objective of knowing the job or occupation is paramount. In the mid-1930s, the US Employment Service recognized this need and developed the Dictionary of Occupational Titles (DOT). The first edition of the DOT was published in 1939, and it provided basic occupational information and a standardized means to examine work. Since this time, the DOT has been republished in response to the changing economy and types of work performed by the American workforce (US Department of Labor, 1991b). The Occupational Network Service (O*NET) was introduced in 1998 with the intent to replace the DOT. However, although it has been found to have utility in assisting professionals in identifying transferrable skills, lost earnings, and job search analyses, the O*NET does not provide the level of detail associated to the physical demands as found within the DOT (Field & Field, 1999). Hence, both the DOT and the O*NET continue to be widely referenced by vocational professionals today. The DOT is a collection of generalized information per occupation, and vocational professionals are encouraged to perform their own job analysis when appropriate. A job analysis is defined as a systematic study to identify the following components of a job: worker functions; work fields; machine tools and work aids; materials, products, subject matter, or services; and worker characteristics. The US Department of Labor published *The Handbook for Analyzing Jobs* as a reference to a standard methodology in collecting and recording job information (US Department of Labor, 1991c). The subsequent use of a job analysis for aiding those with chronic MSDs is often titled as a *physical demands analysis*, with a focus primarily on the physicality of the work performed.

A physical demands analysis may be performed by a number of different professional types, including safety, ergonomists, case management, and rehabilitation professionals including physical and occupational therapists, all with the intent of providing a detailed representation of the human factors associated with a job. Given the medical–legal importance of the services complemented by a physical demands analysis, it is surprising how sorely research is needed in this area (Sanchez & Levine, 2012). One such legal concern is the American Disabilities Act of 1990 (Americans with Disabilities Act, 1990) and the ADAAA of 2008 (ADAAA, 2008), which should entice employers to have physical demands analyses for all jobs. Employment practices in exclusion of having objective analyses are open to challenge with subjective interpretation of the essential functions and associated physical demands. Identifying the essential functions of a job is one of the fundamental components of a physical demands analysis. The essential function is the reason for the position to exist, and the worker in that job title may be one of a few who can perform the function. Essential functions may be presented in the sequential format in which they occur and/or in the duration or percentage of time performed. Rotations, work pace, work rate, and equipment used should also be included within the descriptions of the essential functions. Associating physical demands directly to individual's essential functions is a best practice that allows the employers and vocational professionals to view the job in both its entirety and to a detailed level in which the functions occur. This type of approach can assist preventative services to focus on possible causes of workplace musculoskeletal injuries and then apply ergonomic considerations within a function. Return-to-work programs can be expedited by earlier comparisons of medical restrictions and functional abilities to the separate essential functions.

The methodology of conducting a physical demands analysis should follow a systematic approach of consulting subject-matter experts, observation of biomechanical factors, objective measurement, and a standardized approach to recording of information. The physical demands analysis must be a detailed representation of the actual physical requirements and not construed by the physical capacity of the worker currently performing the job. The impact of environmental factors must also be detailed in each analysis so as to provide the necessary information on possible exposures. Each completed report will offer a means to all professionals involved in the preventative, rehabilitative, claims management, return to work, post-offer testing, and fit-for-duty programs (Trinkoff, Lipscomb, Storr, & Brady, 2003). Given the breadth and importance of its use, the required objectivity of measurement within the physical demands analysis is most easily understood when considering strength requirements. In fact, one of the primary reasons for continued use of the DOT versus the O*NET is the strength classification for occupations. The definitions for each of the five strength classifications as defined by the DOL are provided below:

- *Sedentary work*: Exerting up to 10 lb occasionally or a negligible amount of force frequently to lift, carry, push, pull, or otherwise move objects, including the human body. Sedentary work involves sitting most of the time but may involve walking or standing for brief periods of time. Jobs are Sedentary if walking and standing are required only occasionally and all other Sedentary criteria are met (US Department of Labor, 1991a).
- *Light work*: Exerting up to 20 lb of force occasionally, or up to 10 lb of force frequently, or a negligible amount of force constantly to move objects. Physical demands requirements are in excess of those for Sedentary Work. Even though the weight lifted may be only a negligible amount, a job should be rated Light Work (1) when it requires walking or standing to a significant degree, or (2) when it requires sitting most of the time but entails pushing or pulling of arm or leg controls, or (3) when the job requires working at a production rate pace entailing constant pushing or pulling of materials even though the weight of those materials is negligible (US Department of Labor, 1991a).
- *Medium work*: Exerting 20–50 lb of force occasionally, or 10–25 lb of force frequently, or greater than negligible up to 10 lb of force constantly to move objects. Physical demands requirements are in excess of those for Light Work (US Department of Labor, 1991a).
- *Heavy work*: Exerting 50–100 lb of force occasionally, or 25–50 lb of force frequently, or greater than negligible up to 20 lb of force constantly to move objects. Physical demands requirements are in excess of those for Medium Work (US Department of Labor, 1991a).
- *Very heavy work*: Exerting in excess of 100 lb of force occasionally, or in excess of 50 lb of force frequently, or in excess of 20 lb of force constantly to move objects. Physical demands requirements are in excess of those for heavy work (US Department of Labor, 1991a).

The above strength classification system for occupations offers a broad means of categorization. However, objective measures collected on-site for lift, carry, push, pull, grip, and pinch are best suited for detailed comparisons to functional abilities. Captured parameters for lifting should include the weight, dimensions of the object, vertical distance, horizontal displacement, handedness, coupling used, rate of lifts, and frequency (Waters, Putz-Anderson, & Garg, 1994). Push/pulling requirements need to detail the object moved, distance, required force to overcome inertia, sustained force requirement, height, handedness, coupling, forearm rotation, postural requirements, and the frequency or rate in which it occurs. Similarly, the grip and pinch measures need to detail the handedness, height, type of coupling or pinch, force required, and frequency or rate in which it occurs. The tools used to collect the strength requirements need to be calibrated and verified to ensure the defensibility of the measures. The on-site practitioners collecting data need to also consider the reliability of the measures. In addition, the core positional or postural requirements required for a physical demands analysis include sitting, standing, walking, and driving. Each should be related to the essential function in which it occurs and have a descriptive narrative providing the associated details. The US Department of Labor classifies four frequency ratings as a percentage of a normal workday: never (0 %), occasional (1–33 %), frequent (34–66 %), and constant (67–100 %). Practitioners need to be cognizant of the use of the frequencies to ensure the overall percentages do not exceed 100 % and, as importantly, provide the justification by duration of time (Osborne, Dakos, & Randolph, 2001; US Department of Labor, 1991a).

The advent of technology and production efficiencies lends to the increase in the workplace injuries deemed repetitive-strain type. Repetitive-strain injuries are most typically related to upper extremity job demands. The categorization of upper extremity postural requirements includes reaching, handling, fingering, and feeling. Physical demands analysts must categorize these demands using the same broad frequency classification system by the DOL but also must detail upper extremity parameters of right, left, or bilateral extremity requirements, height ranges, types of prehension used, and details related to work rates. Other postural requirements required in a physical demands analysis include climbing, stooping, kneeling, crouching, and crawling. Overall, the physical demands analysis provides employers and those professionals involved in vocational assessment of workers with chronic musculoskeletal injuries a reliable, objective measure of the human factors associated with a job. The physical demands analysis report is the cornerstone of preventative hiring practices and its use transcends through the continuum of injury prevention, setting rehabilitative goals, and return to work programs. The continued need for setting industry standards for the measurement and reporting of the physical demands will continue to shape vocational programs.

Functional Capacity Evaluation

A FCE is a systematic approach to measure an individual's ability to perform functional and/or job-specific activities on a safe and dependable basis (Matheson, 1996). FCEs comprise a series of standardized tests measuring physical strength, motion, flexibility, sensation, and tolerance to functional work activities (including endurance and the ability to sustain work-related positions and postures) (Isernhagen, 1988). An evaluator skilled in FCEs will structure and select the assessments around key factors, such as the medical diagnosis and/or impairment, the specific referral questions, and essential job functions. The result should be a custom-built test battery that comprises standardized and efficacy-based assessments. According to Matheson, 2003, "professionals who use FCE measures to evaluate work disability must meet criteria for performance tests that are found in professional guidelines, state and federal legislation, and case law" (Matheson, 2003). FCE test selection and administration must meet the demands of the following test hierarchy: safety, reliability, validity, practicality, and utility (Matheson, 1986; Matheson et al., 1995). The hierarchy is described in Table 25.1. Adherence to the test hierarchy guidelines ensures that the FCE will be safe for the individual and provide reliable, valid, and practical results. Most importantly, when the test hierarchy is followed, the results of the FCE will provide useful results to the referral source and rehabilitation team.

Table 25.1 Test factor hierarchy (Matheson et al., 1995)

1.	Safety: When used properly, the test must not be expected to lead to injury
2.	Reliability: The test score must be dependable across evaluators, evaluees, and the date or time of test administration
3.	Validity: The test score must measure what is intended to be measured and must predict or reflect performance in a target task
4.	Practicality: The direct and indirect costs of the test procedure must be reasonable
5.	Utility: The test procedure must meet the needs of the evaluee, referrer, and payer

The US Department of Labor (DOL) in the Revised Handbook for Analyzing Jobs (US Department of Labor, 1991c) provides Physical Demand Factors that are important attributes to measure in the performance of work. The

Table 25.2 Department of Labor Physical Demand Level table (Matheson et al., 1995)

	Occasional	Frequent	Constant	
Physical demand level	0.33 % of the workday	34–66 % of the workday	67–100 % of the workday	Typical energy required
Sedentary	10 lb	Negligible	Negligible	1.5–2.1 METS
Light	20 lb	10 lb and/or walk/stand/ push/pull of arm/leg controls	Negligible and/or push/pull of arm/leg controls while seated	2.2–3.5 METS
Medium	20–50 lb	10–25 lb	10 Ib	3.6–6.3 METS
Heavy	50–100 lb	25–50 lb	10–20 lb	6.4–7.5 METS
Very heavy	Over 100 lb	Over 50 lb	Over 20 lb	Over 7.5 METS

Table 25.3 Department of Labor Frequency guidelines (US Department of Labor, 1991b)

Occasional	>0–33 %	Of the work day
Frequent	34–66 %	Of the work day
Constant	67–100 %	Of the work day

Department of Labor. Dictionary of occupational Titles, 4th Edition, Revised (1991b)

Physical Demand Factors include strength (classified as sedentary, light, medium, heavy, and very heavy), lifting, carrying, pushing, pulling, and the following positions/postures: sitting, standing, walking, climbing, balancing, stooping, reaching, kneeling, crouching, crawling, handling, and fingering. The strength classification levels are described in the Physical Demand Classification for Work chart. Please refer to Table 25.2 for specific details.

Additionally, the US Department of Labor provides frequency classification guidelines for manual material handling and postural tolerances. The DOL frequency guidelines referenced in Table 25.3 are considered to be the “gold standard” for frequency classification. The DOT Physical Demand Factors and frequency classification guidelines are used to classify the physical demands of jobs/occupations and to report the required physical capacities of workers. Because the same factors are utilized to classify jobs and measure a worker’s physical capacity, an easy comparison of job/occupation requirements can be made to an individual’s measured functional capacities (Feuerstein, Menz, Zastowny, & Barron, 1994; Lechner, Jackson, Roth, & Straaton, 1994). Utilizing these guidelines during testing and presenting FCE results in the context of these guidelines allows for an easy comparison of functional data to occupational demands.

FCEs should include the following six evaluation components: a structured-intake interview, condition-specific screening measures, manual material-handling testing, functional activity testing, interpretation of test results, and report generation. In the structured-intake interview, the clinician will obtain self-reported information regarding the worker’s medical history, mechanism of injury and diagnosis, response to treatment, current self-reported abilities for activities of daily living, and functional tolerances. Additionally, the clinician will likely administer one or more self-report measures to identify the worker’s perception of disability and screen for potential performance issues (pain behaviors and depression). A health history questionnaire is also completed. FCEs are most useful (with regard to return to same job or occupation) when the details of the job can be compared to the injured worker’s functional abilities (Feuerstein, Menz, Zastowny, & Barron, 1994; Lechner, Jackson, Roth, & Straaton, 1994). Therefore, the clinician should request a detailed description of the worker’s job demands prior to the scheduled FCE appointment and then spend time during the structured-intake interview to review the job demands with the worker. Lastly, the clinician will review the FCE process, establish goals and expectation of testing, and review the referral questions to be answered in the FCE. Once the structure intake interview is complete, the clinician will obtain vitals (resting heart rate and blood pressure) to ensure the worker is safe to commence functional testing.

Condition-specific screening measures are an essential component of the FCE. Reflecting back to the test hierarchy that was presented above, safety is the foundation of the FCE. Therefore, a formal neuromuscular evaluation measuring active range of motion, strength, and sensation of the injured body part is essential. Because a worker's whole body returns to work or purposeful activity, the FCE must measure whole body functions (Isernhagen, 1988). A screen of active motion, strength, and sensation for the whole body (not just the injured body area) should be administered. In the event that the worker has a brain injury, a cognitive evaluation screen will assess memory, comprehension, ability to follow multistep directions, and attention to task. Condition-specific screening measures will assist the clinician to select appropriate assessments in the FCE and to make necessary recommendations to appropriate referral sources for further assessment and treatment. Once the intake interview is completed and appropriate condition-specific screening measures and the neuromuscular evaluation are complete, then manual material-handling testing can begin. Strength and material-handling testing includes lifting, carrying, pushing, and pulling. Lifting, carrying, pushing, and pulling should be assessed generically, prior to job-specific testing, so that a safe baseline of functional abilities can be established. This is achieved by utilizing a standardized dynamic protocol and beginning with a low weight that is increased incrementally (to ensure safety during the testing process). An example of a dynamic and incremental test of lift capacity is the EPIC Lift Capacity Test (Matheson et al., 1995). Push and pull testing is often measured isometrically via a Chatillon force gauge (or similar) due to space constraints in rehabilitation facilities and the industry's lack of standardized test of dynamic push and pull ability.

The assessment of functional abilities builds upon the generic manual material-handling test results. Physical job analyses that provide information specific to the weight, force, height, coupling, and displacement required on the job should be utilized. Sensitivity to the items lifted, carried, pushed, and pulled and setting up the job-specific tests to match the physical job demands is essential for determining if an injured worker can return to work safely. It is easy to understand that a box of product or bag of concrete is lifted much differently than a 5-gallon bucket of paint. Therefore, utilizing actual work samples, such as 2×4s, sheets of dry wall, bags of sand or concrete, and boxes or cases of product, is preferred when possible. Several computerized functional testing systems exist in the marketplace that allow the therapist to customize job-specific tests to meet the exact parameters of the work site. Unlike the generic manual material-handling testing, job-specific testing should test a worker to the level documented in the job analysis, but not above the job demands requirements or to maximal abilities. If a job description is not provided, occupational references, such as the Dictionary of Occupational Titles, fourth Edition (US Department of Labor, 1991a) or O*NET (O*NET), can provide the clinician with useful information as to the generic material-handling requirements, postural demands, and common job tasks.

After the FCE is complete, the clinician analyzes the test data utilizing clinical reasoning skills and then generates a comprehensive report of the findings. The ability to interpret test results in the context of the worker's injury, clinical presentation, and job distinguishes a professional evaluator from a technician or test administrator (Smith, 1994; Isernhagen & Hart, 1999). "Test results that are provided without the interpretation of the evaluator often are meaningless and can be misleading. The results of the FCE become an integral part of the return-to-work process. It forms a basis for return-to-work conclusions which allow appropriate productivity, with the possibility of identifying physically contraindicated work activities that can be modified to make the activities safe in spite of impairment" (Hart, Isernhagen, & Matheson, 1993). The FCE report should document the objective functional work capacities of the injured worker and support the clinician's clinical reasoning. Clinical reasoning is the clinician's ability to pull all components of the FCE together into an overall statement of performance. The clinician does this by analyzing all available information and specifically the following test components: condition-specific screening results, neuromuscular evaluation results, formal test results, HR analysis and response, quality of movement, subjective reports, self-report measures, pain reports, pain response to activity, and validity-specific test components. Utility of an FCE is achieved when the reliability of the selected test measures determine the validity of the worker's performance resulting in an accurate report of maximum functional abilities.

As discussed above, FCEs are most useful with regard to return to same job or occupation when the details of the job can be compared to the injured worker's functional abilities. In the event that an injured worker does not have a job or occupation to return to, or his or her injuries are so significant that the individual cannot return to work in the same job or occupation, the FCE can still be a useful tool. Because FCEs measure multiple abilities of an individual, the FCE can easily and accurately report general abilities of an injured worker. A general FCE report can be used to compare a worker's abilities to other jobs in the worker's department or employer. In the event that a match is made, the worker can transition to a new job for the same employer. In the event that the injury or disability is too significant for return to work in the same job or for the same employer, a comparison can be made to other similar occupations. In this context, general ability FCEs can act as starting point for vocational exploration. Therefore, the FCE is not only a useful clinical tool but also a baseline for ADA accommodations and/or formal vocational exploration and placement programs that aid to transition a worker from injury to supported employment.

Post-offer of Employment Testing

A useful tool for employers to prevent disability in the workplace is a Post-Offer of Employment Test (POET). Under the ADA guidelines, employers are prohibited to ask questions regarding disability during the interview process. However, following a conditional offer of employment, an employer can request a POET to assess the candidate's ability to safely perform the physical demands of a job. The primary reference for the implementation of a POET program is the Uniform Guidelines on Employee Selection Procedures, issued by the Equal Employment Opportunity Commission in 1978 (EEOC, Uniform guidelines on employee selection procedures, 1978). The US Equal Opportunity Commission is "responsible for enforcing federal laws that make it illegal to discriminate against a job applicant or an employee because of the person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability or genetic information" (EEOC, US Equal Employment Opportunity Commission, 2012). The models to validate a POET program were originally drafted by the American Psychological Association standards for validating educational and psychological tests (American Psychological Association, 1999). An employer who seeks to implement any type of selection procedure, physical or psychological in nature, must be prepared to justify the methods of the program. The Uniform Guidelines reference three types of validity to be considered: content validity, criterion-related validity, and construct validity. *Content validity* means that the test components reflect the physical requirement in the job. *Criterion-related validity* can be defined as two separate types, such as a test component's ability to predict a current capability, or concurrent validity, and a protocol's ability to select candidates who can safely perform the work and reduce an employer's workplace injuries, or predictive validity. *Construct validity* references the statistical means of establishing the relationship of the test components within a protocol and to one or multiple requirements for job performance (Hogdon & Jackson, 2000).

The physical demands job analysis should be the cornerstone of any POET program. Establishing the essential functions with associated physical demands is coupled with an understanding of the hiring and job placement practices of the employer to set up test protocol(s). Test protocols themselves should follow the same functional testing hierarchy referenced with performing FCEs: safety, reliability, validity, practicality, and utility (Matheson et al., 1995). A best practice in

POET protocol design and safe test administration is to follow a progressive loading principle. This consideration of test sequence allows the candidate to maximize performance in lower to higher physical demands requirements. The progressive loading test sequence will also improve the reliability of the data for construct validity analysis. The Uniform Guidelines provide the employer with a reference when validating a POET program, but several key issues must be considered during the setting of cut scores. The primary consideration is adverse impact which occurs when the selection of a group is less than 80 % of the highest selected group, also known as the 4/5ths rule (EEOC, Uniform guidelines on employee selection procedures, 1978). Adverse impact can be justifiable when the physical demands have been validated by on-site job analysis and it is deemed to be a business necessity. Other factors for an employer to consider include workforce demographics, productivity, and injury rates. Ensuring there is a match between the physical requirements of a job and a worker's functional ability is beneficial to both the individual and the employer. The candidate who does not meet the requirements avoids injury and potential loss of future income. The employer does not incur the financial pitfalls related to workplace injuries and maintains productivity with a healthy and capable workforce. A thorough validation study report, including on-site objective job analysis, should be completed and available in response to any potential EEOC inquiries. Given the time elapse that can occur between the onset of a program and any challenge, programs that maintain concurrent validation studies with performance data on all job candidates to date will strengthen defensibility of the program.

Fitness-for-Duty Testing

The purpose of a fitness-for-duty (FFD) test is to determine whether an employee is capable to safely return to work following an extended leave. Similar to a POET and an FCE, the employee's functional abilities are compared to the physical demands associated with the job's essential functions. FFD tests are typically requested by an employer when there is a question of safety, risk of re-injury, or ability to meet productivity requirements. In some instances employers have opted for an FFD test policy with any worker returning from an extended leave. Disability insurance programs and the Family Medical Leave Act (FMLA) often work outside the realm of having an integrated return-to-work plan. Following an extended leave, the question of ability can be in the minds of both the worker and the employer. The request of an FFD test prior to a return to work must include communication between the employer and the employee's personal physician. The employer's request for a referral to have an FFD test is made under the premise of providing the physician with the functional performance data to accurately deem the person safe to return to work or requiring modified duties. Given that the FFD test program is initiated by the employer, the consideration of a higher level of scrutiny should be acknowledged. Ideally, an employer can utilize an existing test protocol from a validated POET program (EEOC, 1978). Employees must only be tested to the requirements of their job, and test components must be representative of the job tasks. Providing a physician with a formal physical demand/job analysis to accompany the results of the FFD test would be considered a best practice.

Return to Work with Chronic Musculoskeletal Disorders

Employers with proactive programs such as job analyses, post-offer employment testing, and FFD policies have several advantages when considering return to work for injured employees. These employers have a preset knowledge of the essential functions, what is physically required to perform the job(s), and a baseline of the worker's abilities at the time of hire. Having standards and testing methodology in place, employers can establish safe parameters for reentry into the workplace. Today's return-to-work practices differ from earlier approaches in vocational rehabilitation with the injured worker remaining or being reintroduced to the workplace prior to full medical recovery (MacEachen, Clarke, Franche, & Irvin, 2006). Despite a growing acceptance of this practice, an understanding of the concept of return to work is confounded by the fact it is both a process and an outcome measured in a variety of ways (Pransky, Gatchel, Linton, & Loisel, 2005; Lydell et al., 2009). It is becoming apparent that employers seeking to adopt disability management programs must base decisions regarding return to work on research evidence (Williams & Westmorland, 2002).

Effective return-to-work programs are multifaceted, shaped by nature of the work performed, type and prevalence of musculoskeletal injuries, and employer experience. Although a standardized solution, or model, remains elusive, there is a growing understanding need of an integrated disability management process (Bultman et al., 2009). The success of an injured worker returning to gainful employment depends largely on how well the employer can collaborate with medical and rehabilitative professionals in order to comprehend their roles, as well as communicate their own goals and objectives (Shaw & Feuerstein, 2004; Williams & Westmorland, 2002). Employers, insurers, and policy makers have often designated the role of the physician as the gatekeeper of many of the return-to-work processes.

Physician's Role

Mindful that early interventions can hasten recovery from musculoskeletal injuries, a physician's evaluation and plan of care is vital to the success of any return to work. However, the challenge of combining traditional clinical care with the assessment of an injury's work relatedness, developing a return-to-work plan, monitoring recovery, and communicating with patients, employers, and the insurer is not well researched (Pransky, Katz, Benjamin, & Himmelstein, 2002; Talmage & Melhorn, 2005; Zeller, 2007). In the United States, the American Medical Association's *Guides to the Evaluation of Permanent Impairment* is the most widely cited reference when assessing and rating a patient's impairments. When deciding on work restrictions, it is recommended that the physician considers three areas:

- Risk—refers to the likelihood of injury exacerbation with returning to specific work activities.
- Capacity—refers to concepts such as strength, flexibility, and endurance.
- Tolerance—refers to the tolerance to sustain work or activity at a given level (Talmage & Melhorn, 2005; Zeller, 2007).

Based on these guidelines, in order to provide meaningful and objective restrictions, it is imperative that the physician have an understanding of the essential functions and physical demands of the pre-injury job. Often, in the absence of an objective job/physical demands analysis, the physician will commence communications setting restrictions and limitations of the patient based solely on the psychophysical approach to tolerance rather than on the capabilities of the worker. This approach is further confounded by the employers' inability to apply the information to accommodate the injured worker in a return-to-work plan. Employers with objective job analyses and explicit organizational strategies in disability management are more apt to allay practitioners' anxieties about considering task limitations, schedule modification, environmental restrictions, medical aids, personal protective equipment, and setting dates for reevaluation (Guzman, Yassi, Cooper, & Khokhar, 2002; Wyman, 1999). One study, by Hiebert, Skovron, Nordin, and Crane (2003), found the most common restrictions provided by physicians included lifting, pushing, or pulling, followed by climbing, walking, and standing (Hiebert et al., 2003). They concluded that there was no evidence to demonstrate that prescribed work restrictions are associated with reduced work disability duration from low back pain in settings where employers have return-to-work policies. It was also concluded that there was evidence that once work restrictions are prescribed, they remain in place longer than required by the physiologic period of healing (Hiebert et al., 2003). Similar to the following the progression of a healing process, experienced pain levels, and/or improvements made in range of motion, a physician would also benefit in having serial functional ability testing.

Value of Functional Capacity Evaluations

Physicians are often requested to provide independent medical examinations (IMEs) as a means to determine the degree of disability and a worker's tolerance. However, beyond "estimating" functional ability, the IME is limited to providing objective measures. Another service often requested to determine musculoskeletal capacity is an FCE. The FCE, as reviewed earlier, is often performed by physical and occupational therapists, rehabilitation professionals that are trained in a function-based model of assessment. The FCE provides a systematic method of evaluating musculoskeletal capacity to perform functional tasks related to work tolerance. When these two types of evaluations are combined, they are often referred to as a "functional IME." This combined service enhances the understanding of the relationship of the musculoskeletal pathology and tolerances for work activity (Clifton, 2006).

Used in conjunction with an IME, or as an independent service, the FCE results have significant implications for further rehabilitation efforts, employment, and compensability determinations. Despite their widespread application in return-to-work decisions, a practical concern is an FCE performed in the absence of a thorough job analysis. Without the job requirements being objectively determined, they are often extrapolated from the job title and broad classifications of work requirements typically associated with the job, derived from the US Department of Labor's O*NET database or its predecessor, the Dictionary of Occupational Titles (Dempsey & Pransky, 2004; US Department of Labor, 1991a) (O*NET). Healthcare providers with a detailed understanding of the job and its employer can play a key role in encouraging a timely and safe return to work for injured workers. Through job-specific functional testing, they can determine appropriate modified work, ergonomic solutions, and recommendations for progression of work activity (Williams & Westmorland, 2002).

Transitional/Modified Duty

The success of a disability management/return-to-work program is contingent on employer participation, ability to provide a supportive work climate, and cooperation between labor and management. Given the number of parties involved in the process, it is imperative that there is an acceptance and understanding of the roles and responsibilities (Shaw & Feuerstein, 2004; Williams & Westmorland, 2002). Research evidence suggests that key factors include:

1. Clinicians' interventions have an established relationship with the workplace.
2. Modified work is available to the injured worker.
3. On-site ergonomic services that incorporate the injured worker.
4. Employer participation in the program.
5. There is a culture of assisting coworkers and promoting safety in the workplace.
6. Understanding the perceptions of the injured worker.
7. Acknowledge the size and resources of the employer in managing return-to-work programs (Williams & Westmorland, 2002).

On-site healthcare providers can facilitate a return-to-work process by providing the necessary level of communication between an employer and consulting physician(s) (MacEachen et al., 2006). Proactive employers have sought healthcare services, including job/physical demands analyses of their positions in preparation of the return-to-work process. The advantage providing a physician with the essential functions and respective physical demands required at time of evaluating the patient negates the reliance on the subjective description by the injured worker. Furthermore, having this level of detail, the physician can better apply the risk, capacity, and tolerance guidelines when setting restrictions and making return-to-work decisions (Talmage & Melhorn, 2005; Zeller, 2007). Modified duty and other accommodations by employers have also been shown to improve the management of musculoskeletal injuries in the workplace (Shaw & Feuerstein, 2004). It is important that the selection of the modified duties be tailored to abilities of the injured workers, with an accepted and understood plan for work recovery. Supervisors can also play a key role in the success of a return to work because of their daily interactions with the worker. Optimum scenarios are experienced when healthcare providers can communicate with supervisors and the injured worker with an understanding of essential functions and productivity requirements of the employer. Fitting the workplace conditions and job demands to the capabilities of the working population is the science of ergonomics (Occupational Safety and Health Administration, 1991; US Department of Labor, 1991a).

Ergonomics

It is generally accepted that the incidence of musculoskeletal injuries increases when the physical demands of the work exceed the abilities of the workers. Employers can utilize ergonomic solutions to reduce the physical demands of the work and then eliminate risk factors to prevent workplace injuries (Garg & Kapellush, 2009; Waters & MacDonald, 2001). Likewise, ergonomic interventions have been found to benefit injured workers to return safely to usual job duties. Ergonomic behavioral changes have been found to be easier to implement and to occur more often than administrative and equipment changes (Bohr, Dale, Evanoff, Grayson, & Wolf, 2005). Behavioral changes or educating the worker through on-site health services, such as "job coaching," benefits the worker by learning proper techniques, working in an efficient manner, and reducing factors that could cause re-injury. The risk factors known to be associated with MSDs include exposure to tasks involving high force demands, high rates of repetition, tasks requiring awkward postures, and tasks that require long duration of static positions (Gallagher & Heberger, 2012). Although these risk factors have been identified, the exact causation of muscle fatigue and discomfort resulting in a disease state or work-related MSD is unknown, and the application of ergonomic principles must be diligent (Gallagher & Heberger, 2012). Several observation-based methods to applying ergonomic principles include the Rapid Entire Body Assessment (REBA), Washington State Ergonomics Checklist, Rapid Upper-Limb Assessment (RULA), and the NIOSH Lifting Equation. While no single tool appears to be superior, professionals applying ergonomics in the workplace are best suited to understand the purpose and outcome from each (Takala et al., 2010).

Clearly, understanding the biomechanics of work activity is an important facet when researching the use of ergonomic tools. Practitioners applying ergonomics need to understand the methods for evaluating workers and the outcomes from applying changes. For example, wrist and upper extremity positioning is one such assessment that is found in both the RULA and REBA. Studies have been designed to assess the effects of upper extremity positioning on grip strength ability (Bhargava, Charu, & Senthil, 2010; Kong, Song, Jung, & Lee, 2011). Similar applications of assessing human performance related to work activity would be beneficial in providing an objective measure for applied changes and consideration for job placement of workers.

Job Rotation

Job rotation is another strategy widely considered as a means to reduce physical exposures to prevent musculoskeletal injuries. The premise of a rotation scheme is to reduce muscle fatigue by having workers perform a different task, alter the duration of the task/rotation, and/or to structure the order of the tasks performed. Although commonly used by employers, there is little empirical research to objectively demonstrate the efficacy of a single strategy (Horton, Nussbaum, & Agnew, 2012; Dickerson, McFall, & Wells, 2010; Dickerson & Raina, 2009). One study found rotation between functionally different tasks, involving grip and pinch requirements, did allow muscle recovery during manual activities (Dickerson et al., 2010). Another study found evidence for the effect of task order on fatigue development, supporting the practical recommendation that starting a work shift with a low-exertion task may reduce fatigue accumulation over the shift (Horton et al., 2012). Employers often have limited options in job rotations while working within the confines of the manufacturing or production requirements. Options for worker placement may be further challenged by any union seniority programs. Ultimately, each employer faces a unique set of circumstances when considering job rotations, and a thorough analysis to validate the rotation program should be performed. This process can only occur with an understanding of the physical demands of the work activity and the functional abilities of the workforce.

Conclusions

The historical foundation of the assessment and treatment of patients with chronic occupational MSDs continues to shape our professional approaches. Our understanding of the need for integrated services in the clinical continuum of care will further advance solutions for reducing workplace injuries and expedite the return-to-work process. Employers' use of proactive services, including on-site healthcare, ergonomics, job analyses, post-offer employment testing, and fit-for-duty policies, will continue to grow with the increasing need for workforce solutions to increase productivity and efficiency. The education and expertise of healthcare professionals involved in the assessment and treatment of MSDs will also increase with the use of technology and the understanding of human performance related to work activity.

References

Ad Hoc Committee on the Commission on Practice. (1980). Position paper: The role of occupational therapy in the vocational rehabilitation process. *American Journal of Occupational Therapy*, 881–883.

American Psychological Association. (1999). *Standards for educational and psychological testing*. Washington, DC: American Educational Research Association.

Americans with Disabilities Act Amendments Act of 2008 (ADAAA). (2008). *Americans with Disabilities Act Amendments Act of 2008; Public law 110–32*. Washington, DC: US Congress.

AOTA. (1986). Work hardening guidelines. *American Journal of Occupational Therapy*, *40*(12), 841–843.

AOTA. (1992). Statement: Occupational therapy services and work practice. *American Journal of Occupational Therapy*, *46*(12), 1086–1088.

Bhargava, A, Charu, E., & Senthil, P. (2010). Grip strength measurements at two different wrist extension positions in chronic lateral epicondylitis comparison of involved vs uninvolved side in athletes and non athletes: a case-control study. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Techology, 2*(22), 1–8.

Bohr, P., Dale, A. M., Evanoff, B., Grayson, D., & Wolf, L. (2005). Ergonomic evaluation: Part of a treatment protocol for musculoskeletal injuries. *American Association of Occupational Health Nurses Journal*, *53*(10), 450–457.

Bultman, U., Sherson, D., Olsen, J., Hansen, C., Lund, T., & Kilsgaard, J. (2009). Coordinated and tailored work rehabilitation: A randomized controlled trial with economic evaluation undertaken with workers on sick leave due to musculoskeletal disorders. *Journal of Occupational Rehabilitation, 19*(1), 81–93.

Bureau of Labor Statistics. (2012, November 8). Economic news release: Non fatal occupational injuries and illnesses requiring days away from work, 2011. Retrieved from www.bls.gov/news.release/osh2.nr0.htm

Chapman-Day, K., Matheson, L., Schimanski, D., Leicht, J., & De Vries, L. (2011). Preparing difficult clients to return to work. *Work*, *40*, 359–367.

Clifton, D. (2006). The functional IME: A linkage of expertise across the disability continuum. *Work*, *26*(3), 281–285.

Cohen, A. L., Gjessling, C. C., Pine, L. J., Brenard, B. P., & McGlothlin, J. D. (1997). Elements of ergonomic programs. Cincinnati, OH: US Department of Health and Human Services.

Commission on Accreditation of Rehabilitation Facilities. (1988). *National Advisory Committee Recommendations for Work Hardening Programs*. Tucson, AZ: Commission on Accreditation of Rehabilitation Facilities.

Dempsey, P., & Pransky, G. (2004). Practical aspects of functional capacity evaluations. *Journal of Occupational Rehabilitation, 14*(3), 217–229.

Dickerson, C., McFall, K., & Wells, R. (2010). Task Selection for increased mechanical exposure variation: Relevance to job rotation. *Ergonomics, 53*(3), 314–323.

Dickerson, C., & Raina, S. (2009). The influence of job rotation and task order on muscle fatigue: A deltoid example. *Work, 34*(2), 205–213.

EEOC. (1978). *Uniform guidelines on employee selection proccedures*. Retrieved from www.eeoc.gov; http://www.eeoc.gov/policy/docs/qanda_clarify_procedures.html

EEOC. (2012, October). *US Equal Employment Opportunity Commission*. Retrieved from http://www.eeoc.gov/eeoc/index.cfm

Equal Employment Opportunity Commission. (1978). *Uniform guidelines on employment selection procedure* (p. 43). Washington, DC: Federal Register.

Feuerstein, M., Menz, L., Zastowny, T., & Barron, B. (1994). Chronic back pain and work disability: Vocational outcomes following multidisciplinary rehabilitation. *Journal of Occupational Rehabilitation, 4*, 229–251.

Field, J., & Field, T. (1999). *O*NET reference—COJ 2000 with an O*NET 98 Crosswalk*. Athens, GA: Elliot & Fitzpatrick, Inc.

Gallagher, S., & Heberger, J. (2012). Examining the interaction of force and repetition on musculoskeletal disorder risk: A systematic literature review. *Human Factors: The Journal of Human Factors and Ergonomics Society, 55*(1), 1–17.

Garg, A., & Kapellush, J. (2009). Applications of biomechanics for prevention of work-related musculoskeletal disorders. *Ergonomics, 52*(1), 36–59.

Guzman, J., Yassi, A., Cooper, J. E., & Khokhar, J. (2002). Return to work after occupational injury family physicians' perspectives on soft-tissue injuries. *Canadian Family Physician, 48*, 1912–1919.

Hart, D., Isernhagen, S., & Matheson, L. (1993). Guidelines for functional capacity evaluation of people with medical conditions. *Journal of Spine Physical Therapy, 82*, 682–686.

Hiebert, R., Skovron, M., Nordin, M., & Crane, M. (2003). Work restrictions and outcome of nonspecific low back pain. *Spine, 28*(7), 722–728.

Hogdon, J., & Jackson, A. (2000). Chapter 5: Physical test validation for job selection. In S. Constable & B. Palmer (Eds.), *The process of physical fitness standards development: SOAR* (pp. 139–177). WPAFB, OH: Human Systems 1AC.

Horton, L., Nussbaum, M., & Agnew, M. (2012). Effects of rotation frequency and task order on localized muscle fatigue and performance during repetitive static shoulder exertions. *Ergonomics, 55*(10), 1205–1217.

Isernhagen, S. (1988). Functional capacity evaluation. In S. Isernhagen (Ed.), *Work injury: Management and prevention* (pp. 137–162). Gaithersburg, MD: Aspen.

Isernhagen, S., Hart, D., & Matheson, L. M. (1999). Reliability of independent observer judgments of level of lift effort in a kinesiophysical functional capacity evaluation. *Work, 12*, 145–150.

King, P. (1993). Outcome analysis of work-hardening programs. *Journal of the American Occupational Therapy Association, 47*(7), 595–603.

Kong, Y., Song, Y., Jung, M., & Lee, I. (2011). Effects of hand position on maximum grip strength of discomfort. In *HFESA 47th annual conference 2011*. Ergonomics Australia—Special Edition.

Labor, U. S. (2011, November 9). *Bureau of Labor Statistics Economic News Release*. Nonfatal occupational injuries and illnesses requiring days away from work, 2010. Retrieved from http://www.bls.gov/news.release/osh2.nr0.htm

Labor, U. S. (2012, October 25). *Bureau of Labor Statistics News Release*. Workplace illness and injuries—2011. Retrieved from http://www.bls.gov/news.release/pdf/osh.pdf

Lechner, D., Jackson, J., Roth, D., & Straaton, K. (1994). Reliability and validity of a newly developed test of physical work performance. *Journal of Occupational Medicine, 36*, 997–1004.

Lydell, M., Baigi, A., Marklund, B., & Mansson, J. (2005). Predictive factors for work capacity in patients with musculoskeletal disorders. *Journal of Rehabilitation Medicine, 37*(5), 281–285.

Lydell, M., Grahn, B., Mansson, J., Baigi, A., & Marklund, B. (2009). Predictive factors of sustained return to work for persons with musculoskeletal disorders who participated in rehabilitation. *Work, 33*(3), 317–328.

MacEachen, E., Clarke, J., Franche, R., & Irvin, E. (2006). Systematic review of the qualitative literature on return to work after injury. *Scandinavian Journal of Work Environment Health, 32*(4), 257–269.

Matheson, L. (1986). Evaluation of lifting and lowering capacity. *Vocational Evaluation and Work Adjustment Bulletin*, 107–111.

Matheson, L. (1996). Functional capacity evaluation. In G. Anderson, S. Demeter, & G. Smith (Eds.), *Disability evaluation*. Chicago: Mosby Yearbook.

Matheson, L. (2003). The functional capacity evaluation. In G. Andersson, S. Demeter, & G. Smith (Eds.), *Disability evaluation*. Mosby Yearbook: Chicago, IL.

Matheson, L., Mooney, V., Grant, J., Affleck, M., Hall, H., Melles, T., et al. (1995). A test to measure lift capacity of physically impaired adults. Part 1—Development and reliability testing. *Spine, 20*(19), 2119–2129.

O*NET, N. C. (n.d.). *O*NET online*. Retrieved from http://www.onetonline.org/

Occupational Safety and Health Administration. (1991). *Ergonomics: The study of work*. Washington, DC: US Government Printing Office.

Osborne, P., Dakos, M., & Randolph, D. (2001). Functional testing for positional tolerance by frequency classification. *Disability*, 51–55.

Pransky, G., Gatchel, R., Linton, S., & Loisel, P. (2005). Improving return to work research. *Journal of Occupational Rehabilitation, 15*(4), 453–457.

Pransky, G., Katz, J., Benjamin, K., & Himmelstein. (2002). Improving the physician role in evaluating work ability and managing disability: A survey of primary care practitioners. *Journal of Disability Rehabilitation, 24*(16), 867–874.

Reilly, M. (1962). Occupational therapy can be one of the great ideas of 20th-century medicine: Eleanor Clarke Slagle lecture. *American Journal of Occupational Therapy, 16*, 1–9.

Sanchez, J., & Levine, E. (2012). The rise and fall of job analysis and the future of work analysis. *The Annual Review of Psychology, 63*, 397–425.

Shaw, W., & Feuerstein, M. (2004). Generating workplace accommodations: Lessons learned from the integrated case management study. *Journal of Occupational Rehabilitation, 14*(3), 207–216.

Smith, R. (1994). Therapist's ability to identify safe maximum lifting in low back pain patients during functional capacity evaluation. *The Journal of Orthopaedic and Sports Physical Therapy, 19*, 277–281.

Takala, E., Pehkonenn, I., Forsman, M., Hansson, G., Mathiassen, S., Neumann, W., et al. (2010). Systematic evaluation of observational methods assessing biomechanical exposures at work. *Scandinavian Journal of Work and Environmental Health, 36*(1), 3–24.

Talmage, J., & Melhorn, J. (2005). How to think about work ability and work restrictions: Risk capacity and tolerance. In *A physician's guide to return to work* (1st Ed., pp. 7–17). Chicago, IL: American Medical Association Press.

Trinkoff, A., Lipscomb, J. G.-B., Storr, C., & Brady, B. (2003). Perceived physical demands and reported musculoskeletal problems in registered nurses. *American Journal of Preventative Medicine, 24*(3), 270–275.

US Department of Labor. (1991a). *Dictionary of occupational titles* (4th ed.). Washington, DC: US Department of Labor.

US Department of Labor. (1991b). *Dictionary of occupational titles* (4th Ed. Suppl., pp. 101–102). Washington, DC: US Department of Labor.

US Department of Labor. (1991c). *The revised handbook for analyzing jobs*. Washington, DC: US Department of Labor.

Waters, T., & MacDonald, L. (2001). Ergonomic job design to accommodate and prevent musculoskeletal disabilities. *Assistive Technology: The Official Journal of RESNA, 13*(2), 36–59.

Waters, T., Putz-Anderson, V., & Garg, A. (1994). *Applications manual for the revised NIOSH lifting equation*. Cincinnati, OH: National Institute for Occupational Safety and Health.

Williams, R., & Westmorland, M. (2002). Perspectives on workplace disability management: A review of the literature. *Work, 19*, 87–93.

Wyman, D. (1999). Evaluating patients for return to work. *American Family Physician, 15*(4), 844–848.

Zeller, J. (2007). Assessing disability: JAMA patient page. *The Journal of the American Medical Association, 298*(17), 2096.

Real-Effectiveness Medicine in Musculoskeletal Disorders

26

Antti O.V. Malmivaara

Overview

The effectiveness of clinical work, including diagnostic, treatment and rehabilitation activities, with patients having musculoskeletal disorders is dependent on the clinical expertise and skills of the healthcare personnel. In order to ensure that the treatment is based on the best current evidence, use of up-to-date scientific evidence from clinical guidelines, systematic reviews and randomised controlled trials (RCTs) is needed. However, this is not enough. One has to obtain continuous standardised data on how musculoskeletal patients are diagnosed and treated at healthcare units in order to improve the effectiveness of treatment in ordinary practice. The documentation of the care of patients can be used not only for quality assessment but also for benchmarking with peer units treating similar patients. This chapter will review how the concept of *Real-Effectiveness Medicine* (REM), which pursues the best effectiveness of patient care in the real-world setting, can be applied in the treatment of patients with musculoskeletal disorders. *REM* utilises elements at four levels: (1) good medical expertise and skills, combined with the patient view; (2) up-to-date scientific evidence; (3) continuous documentation of performance in ordinary settings; and (4) benchmarking across providers (Malmivaara, 2013). The REM framework can be used by clinicians, organisations, administrative personnel, policy makers and researchers.

Introduction

Health and the well-being of ordinary patients and the population in general is the ultimate goal for all activities within clinical medicine, whether it is education, clinical work, teaching, administration, policy making or research. In the evidence-based medicine (EBM) framework, the current best evidence, combined with clinical expertise, is utilised to pursue best efficacy in ordinary patient care. However, there is a paucity of information of what actually happens in the healthcare environment. At the level of each healthcare unit, there is a need for performance data: information of what kind of patients are treated, how they are treated, and how do they recover during the treatment episode and at later follow-up. The performance data should be specific to a disease or population and should use the PICO concept: *P*atients, *I*nterventions, *C*ontrol interventions and *O*utcomes. These four items translate into four questions: (1) what is the clinical profile of these patients, (2) how do we treat this condition and what are the costs of the treatment, (3) how do our peers treat this condition and what are the costs of their treatment and

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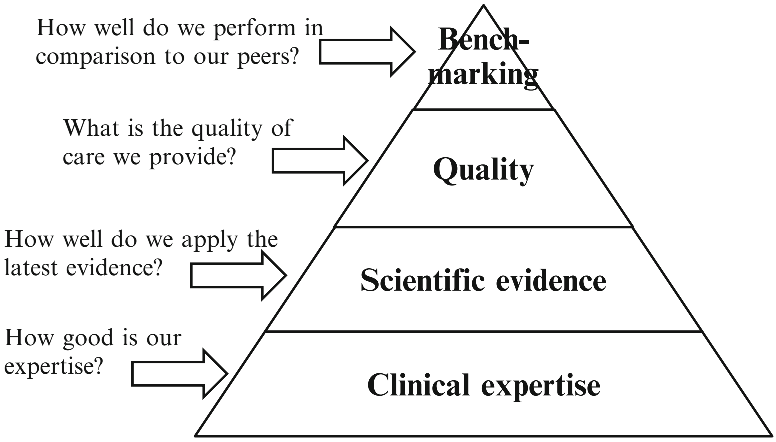

Fig. 26.1 The four levels of Real-Effectiveness Medicine in pursuing the best effectiveness of patient care in the real-world setting are (1) clinical expertise and patients' views, (2) current best scientific evidence, (3) documented data of own unit's or clinical pathways' performance and efforts for quality improvement and (4) benchmarking of own performance with peers

(4) what are the patient-important outcomes at the end of our treatment and during adequate follow-up time. Patient data can be used for assessing the appropriateness of the treatment processes, which can be compared with current scientific evidence (e.g. from systematic reviews or clinical guidelines). Comparisons with peers treating similar patients in real-life circumstances give practical information, and if baseline confounding can be controlled, even estimates of differences in treatment outcomes can be produced. This benchmarking data of changes in time across each treatment unit, or between peer units, can then be used as feedback to improve the quality of patient care.

Real-Effectiveness Medicine (REM) is defined as the principles and practices pursuing the best possible effectiveness of patient care in the ordinary clinical setting by utilising information and activities at four levels (Malmivaara, 2013). The four levels are good medical expertise (knowledge of aetiology, pathogenesis, diagnosis and treatment of diseases combined with practical experience and skills on how to deal with the disease) combined with the patient view, up-to-date scientific evidence, continuous documentation of performance in ordinary settings and quality improvement, and benchmarking across providers. Figure 26.1 presents these four levels of REM and what is the potential of each level in advancing effectiveness of care.

As noted earlier, a major goal of the chapter is to review why there is a need for a new REM paradigm in the treatment of musculoskeletal disorders, what REM is in the context of musculoskeletal disorders, and how to practise it for the advancement of effective and high-value (cost-effective) health care for patients having a musculoskeletal disorder.

Why Is There a Need for a New Paradigm of Real-Effectiveness Medicine?

The most reliable information of effectiveness of medical interventions can be obtained from RCTs, which create the basis for systematic reviews on effectiveness. However, RCTs often exclude patients who are commonly treated in ordinary clinical practice and, thus, the results may not be generalisable to all patients obtaining the studied intervention. In addition, the units and clinicians providing the interventions have usually very good or even exceptional expertise in treating the patients eligible for the trial.

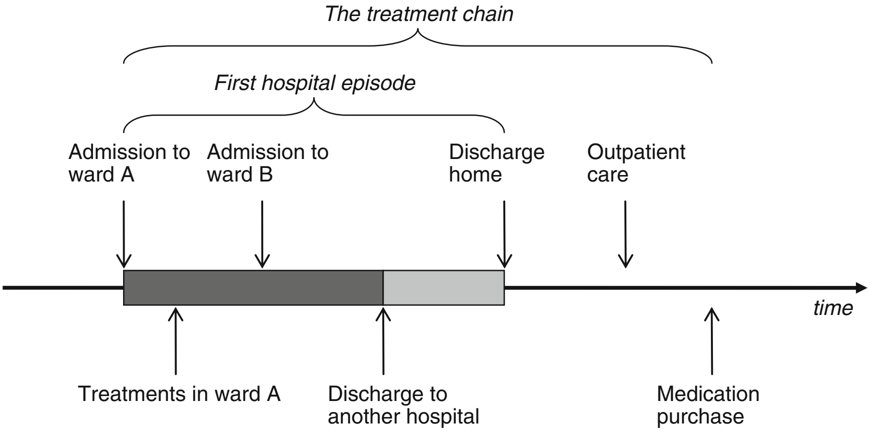

Fig. 26.2 An example of events within an episode of care. (Published with permission from Informa Healthcare (republication from the paper by Peltola et al. 2011))

Thus, the efficacy shown by trials and systematic reviews is often better than the efficacy provided by average healthcare units for average patients. Therefore, the extrapolation of the results to ordinary clinical settings is often uncertain, and there are no formal rules about how to do this; rather one has to rely on one's own clinical expertise (Croft, Malmivaara, & van Tulder, 2011).

The difference between efficacy in RCTs and efficacy in ordinary clinical practice has been demonstrated well in the field of vascular surgery, where clinical documentation for some procedures is most important in order to maintain low-adverse risk events. For example, in two RCTs assessing the perioperative mortality of carotid artery surgery, the mortality was 0.1 % and 0.6 %, respectively. However, clinical follow-up data from real-world circumstances showed that the mortality was much greater compared to that from these two RCTs. In the hospitals participating in the trial, the mortality was 1.4 %, and in other hospitals 1.8 % (Wennberg, Lucas, Birkmeyer, Bredenberg, & Fisher, 1998).

Hypotheses in RCTs are based on a PICO-type research question, which constitutes a clear framework for formulating the aim for these studies. RCT designs enable the most valid assessment of single interventions. However, in the real healthcare clinical practice, the most important question from the patient's perspective is quite rarely based on one single intervention but for the effectiveness of the whole clinical pathway (episode of care). For example, in an RCT, a drug-eluting stent may be compared with a bare metal stent for acute myocardial infarction, but this procedure represents only one part of the treatment process in the hospital taking care of the acute phase. Furthermore, angioplasty with stenting constitutes only a tiny part of the whole clinical pathway consisting of follow-up, treatment and rehabilitation in the hospital and further in the primary care setting. Thus, in the real world of clinical practice, the effectiveness is usually not determined solely by a single intervention, but by how well the whole clinical pathway works. Furthermore, in some cases, RCTs cannot be used for ethical reasons. For these cases, observational studies are the only feasible option to provide data on efficacy (Häkkinen, 2011). In a supplement issue of the PERFECT project on measuring performance of healthcare episodes (clinical pathways), the following definition has been given: “An episode of care refers to the entire treatment pattern from the beginning of the (e.g. acute stage of the) disease to the end of the treatment over any organisatory boundaries to solve the health problem at hand in a specific time frame” (Peltola et al., 2011). An example of a clinical pathway starting from admission to a hospital (e.g. because of a hip fracture) is shown in Fig. 26.2.

To sum up, the knowledge of the efficacy and costs of a single procedure for a particular disease is not enough to evaluate the outcome dependent on the whole clinical pathway. RCTs and systematic reviews will always be unable to answer the question of what the effectiveness of a particular treatment unit is in comparison with other units treating similar patients. Even for single treatments, the assessment of generalisability of the findings from RCTs to ordinary clinical settings is often difficult, and there is no method enabling a quantitative extrapolation of the efficacy data to real-world circumstances. It is obvious that, besides evidence arising from clinical expertise and clinical science, one needs valid data on what happens in ordinary clinical settings. Information from all the four levels of *REM* should be used for advancing effectiveness in the ordinary clinical practice for ordinary patients.

What Is Real-Effectiveness Medicine and How to Practise It?

The questions to ask to improve the performance at the four levels of REM are presented in Fig. 26.3 and clarified further in the text below.

Medical Expertise and Skills

The evidence of effectiveness of interventions in musculoskeletal disorders is primarily based on RCTs. In trial settings, interventions are usually provided by experienced clinicians and multidisciplinary teams. In order to reach similar effectiveness in ordinary clinical practice, very good clinical expertise and skills are needed. Thus, all activities enhancing and maintaining clinical expertise form the basis for REM. It is also noteworthy that, often, the recommendations in clinical guidelines are based on the current views of the most experienced and knowledgeable clinicians, because reliable scientific evidence is not available (Croft et al., 2011).

The first level of REM is composed of good medical expertise and skills, which provides the means for clinical decision making (Fig. 26.1).

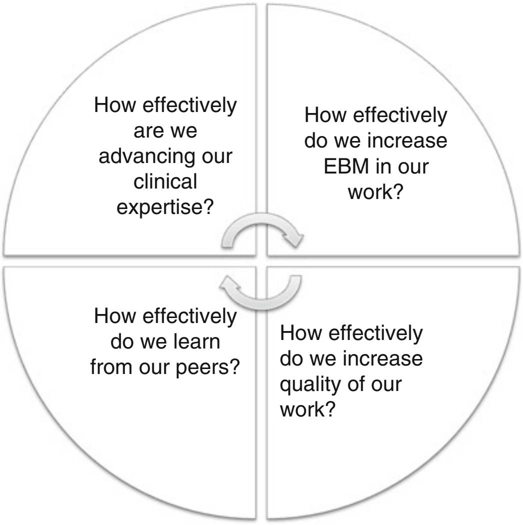

Fig. 26.3 The four levels of Real-Effectiveness Medicine (clinical expertise, scientific evidence, quality, benchmarking) are all needed to promote the best effectiveness in the care of ordinary patients. Answers to the four questions clarify how well Real-Effectiveness Medicine has been advanced at the healthcare units. The levels interact with each other, e.g. feedback from actual performance and that of peers in other units or organisations increases the clinical expertise of practitioners

In order to select effective treatments, one has to consider both clinical and other patient characteristics, including comorbid conditions before deciding upon the best treatment option. The same PICO concept which is recommended for clinical trials and systematic reviews can be used in clinical reasoning (Malmivaara, Koes, Bouter, & van Tulder, 2006). Using PICO makes it also easier to consider the generalisability of evidence of effectiveness from RCTs to clinical conditions.

The *Royal College of Physicians and Surgeons of Canada* started a *CanMeds* initiative in the early 1990s aiming to advance the abilities that a physician needs in order to reach optimal patient outcomes. The *CanMeds* framework is intended for medical students, as well as for clinicians for lifelong learning. Although intended primarily for physicians, the framework can also be used amongst other healthcare professionals. The framework includes seven key roles (Jarvis-Selinger, Hameed, & Bloom, 2011). The roles are the following: medical expert, communicator, collaborator, manager, health advocate, scholar and professional.

The role of a *medical expert* includes the following abilities: to function effectively as a consultant in order to provide optimal, ethical and patient-centred medical care; to establish and maintain clinical knowledge, skills and attitudes appropriate to practise; to perform a complete and appropriate assessment to one's practice; to use preventative and therapeutic interventions effectively; to demonstrate appropriate use of procedural skills, both diagnostic and therapeutic; and to seek appropriate consultation from other healthcare professionals and recognising the limits of their expertise.

The *communicative role* is also defined in detail, and it extends to patients and their families, colleagues and other professionals. The *collaborative role* includes the ability to participate and work effectively in an interpersonal team and with other healthcare professionals. The *managerial role* includes activities contributing to the effectiveness of healthcare organisations, including appropriate allocation of finite healthcare resources. The *health advocate's* role includes the ability to respond to the healthcare needs of individual patients, communities and populations in order to promote health. The *role of a scholar* includes ongoing learning; critical evaluation of information and its appropriate application; facilitation of learning by patients, healthcare personnel and the general public; as well as contribution of new medical knowledge and practices. Finally, the *role of a professional* includes a commitment to patients, the healthcare profession and society.

The *CanMeds* initiative has undertaken systematic reviews of the evidence on the advancement of clinical expertise. One systematic review assessed the impact of early experience in clinical and community settings for learning clinical expertise (Dornan et al., 2006). It was concluded that early experience helps medical students socialise to their chosen profession, helps them to acquire a range of subject matter and makes their learning more real and relevant. In another systematic review, it was found that early experience helps medical students to learn, helps them to develop appropriate attitudes towards their studies and future practice and orients medical curricula towards society's needs (Littlewood et al., 2005). One systematic review found that evidence of effectiveness of case-based learning is inconclusive, as compared with other types of learning (Thistlethwaite et al., 2012). Teachers consider that case-based learning motivates the students and seems to aid learning in small groups, although the impact of the group learning effect remains unclear.

One systematic review assessed the effectiveness of different methods for teaching musculoskeletal clinical skills to medical trainees and physicians (O'Dunn-Orto, Hartling, Campbell, & Oswald, 2012). Of the 24 studies, 18 focused on undergraduate medical education, 5 of 6 studies favoured patient educator and 5 of 6 studies interactive small groups, 2 of 4 studies favoured computer-assisted learning and 2 of 2 studies favoured peer learning. On the basis of these findings, the authors concluded that it is effective to use different instructional methods that engage learners and provide meaningful learning contexts. The majority of the studies support use of patient educators and interactive small group teaching.

An international group of individuals, universities and professional organisations have formed the *Best Evidence Medical Education* (*BEME*) *Collaboration* (http://www.bemecollaboration.org/), which is committed to the development of evidence-informed education in the medical and health professions. This is pursued through three activities: dissemination of information which allows teachers and stakeholders in the medical and healthcare professions to make decisions on the basis of the best evidence available; production of systematic reviews that present the best available evidence and meet the needs of the user; and the creation of a culture of best-evidence education amongst individuals, institutions and national bodies. The BEME Collaboration was established in 1999 because of the need to move from opinion-based education to evidence-based education. The BEME Collaboration has published over 20 systematic reviews, along with guidance books based on these reviews.

Up-to-Date Scientific Evidence

Excellent clinical expertise of musculoskeletal disorders already includes knowledge of the scientific evidence. However, the emergence of new evidence should be keenly followed and lead to a change in practice if considered valid and applicable to one's own clinical practice setting. Well-planned processes at the healthcare unit level, ensuring early appraisal of new evidence, are probably more powerful in leading to adoption of new evidence than just reliance on individual clinicians' abilities to follow the literature.

The second level of REM consists of the utilisation of the most up-to-date scientific evidence, particularly from RCTs and systematic reviews, as well as health technology assessment (HTA) reports and clinical guidelines. Also, other scientific- and patient-based information (such as scientific data on diagnostic tests and patients' values and preferences) according to the concept of EBM should be considered. It should also be emphasised that when summarising all the available evidence in systematic reviews, the quality of evidence in the original studies should be based on the degree of internal validity of each study and the reproducibility (consistency) of the findings across clinically homogenous and methodologically high-quality studies. Meticulous assessment of internal validity of the original studies, and placing emphasis on the studies having very low risk of bias, is an appropriate basis for the quality of evidence assessments in systematic reviews. In case there are more than one methodologically high-quality study on the same research question, reproducibility of findings between the different studies should be considered when assessing the quality of evidence.

EBM has greatly advanced systematic reviews of RCTs as a tool for valid synthesis of current evidence of relevant clinical questions. EBM has also promoted clinical work based on explicit and judicious assessment of the underlying evidence (Sackett, 1995). The *Cochrane Collaboration* has produced and maintained systematic reviews of musculoskeletal disorders, especially on back and neck pain, osteoarthritis, rheumatoid arthritis and soft tissue disorders, including shoulder pain and upper extremity pain (http://www.thecochranelibrary.com).

Table 26.1 Summary of common recommendations between national guidelines for treatment of low back pain (Koes et al., 2010)

Acute or subacute pain
✓ Reassure patients (favourable prognosis)
✓ Advise to stay active
✓ Prescribe medication if necessary (preferably time contingent): first line is paracetamol; second line is nonsteroidal anti-inflammatory drugs; consider muscle relaxants, opioids or antidepressant and anticonvulsive medication (as co-medication for pain relief)
✓ Discourage bed rest
✓ Do not advise a supervised exercise programme
Chronic pain
✓ Discourage use of modalities (such as ultrasound, electrotherapy)
✓ Short-term use of medication/manipulation
✓ Supervised exercise therapy
✓ Cognitive behavioural therapy
✓ Multidisciplinary treatment

From Koes, B. W., van Tulder, M., Lin, C. W., Macedo, L. G., McAuley, J., & Maher, C. (2010). An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *European Spine Journal*, *19*(12), 2075–2094

Nationally produced clinical guidelines take into consideration the local treatment practices and preferences, as well as the available resources. The methodology for producing guidelines may be similar within one country and the healthcare providers familiar with how the level of evidence has been assessed and rated (e.g. from A = strong evidence to D = very weak evidence). For these reasons, national guidelines are needed. However, comparison of several national low back pain guidelines, including also European guidelines, indicated that the main recommendations were rather similar across the various guidelines (Koes et al., 2010) (Table 26.1).

Performance of Healthcare Units and Quality Improvement

There is evidence that many patients do not receive appropriate care, as revealed by RCTs and systematic reviews (Grol & Grimshaw, 2003). Implementation of new evidence or clinical guidelines into practice has been shown to be resource demanding and, even then, seems to succeed only partially (Grol & Grimshaw, 2003). Furthermore, due to the limited resources in health care, one must also question the effectiveness in relation to the invested resources—i.e. cost-effectiveness. Translating cost-effectiveness data in a valid way from an RCT to another setting, especially to another country, presents substantial problems. So far, only first studies have been published on determining in which cases this translation is justifiable (Knies, Ament, Evers, & Severens, 2009; Welte, Feenstra, Jager, & Leidl, 2004). For these reasons, it seems evident that there is a need to gather performance data at the ordinary healthcare level.

The third level of REM consists of standardised documentation of the performance of healthcare units and continuous quality improvement measures based on the performance data. The aim of the performance assessment is to increase effectiveness and cost-effectiveness of care in routine clinical practice. Increasing cost-effectiveness means that resources are allocated to those patient groups and interventions which show the best effectiveness, as the resources always have their limits. Kaiser-Permanente in the United States provides a good example of a healthcare provider, which continuously documents the performance of its services (https://healthy.kaiserpermanente.org). In Canada the state of Saskatchewan has implemented in the year 2011 a clinical pathway for low back pain patients. The spine pathway describes assessment and treatment processes for improving the performance of family physicians and other health providers and to expedite the care and specialist referral for the patients. A standardised form has been developed for primary care practitioners to be filled when referring patients with low back pain to a Spine Pathway Clinic (http://www.health.gov.sk.ca/back-pain). Also national register-based methods have been developed for performance assessment—the PERFECT project will be described in this chapter.

It would be optimal to assess the performance of the whole clinical pathway covering primary, secondary and tertiary care. If feasible, the performance indicators should be those for which there is scientific evidence that a change in the care process leads to improved outcomes, the indicators capture whether the process is indeed provided, the process indicator is sufficiently near the important outcomes, and there is low or no risk of inducing adverse consequences (Chassin, Loeb, Schmaltz, & Wachter, 2010). However, ideal documentation of patients, processes and outcomes is rarely possible. Thus, the documentation of performance should be started with the best available indicators; increasing such quality is not a project but a continuing process.

Information of accessibility of care, patient characteristics, diagnostic procedures and treatments, and treatment outcomes can be used for assessments of the performance of an individual unit by comparing changes in time or by making comparisons to other units that are treating similar patients. However, valid comparisons—especially for outcomes—necessitate that confounding factors at baseline can be adequately adjusted for. If possible, all the relevant outcomes for patients, and also adverse effects, should be documented. Obtaining a quality certification based on fulfilment of established criteria is a mark of quality and increases the transparency of the treatment processes: e.g. a status of a designated stroke centre warrants that internationally defined requirements for stroke care are fulfilled (Xian et al., 2011). Implementation science has produced evidence of the effective ways to promote the uptake of research findings into routine health care, and this evidence should be utilised (Rubenstein & Pugh, 2006).

Developing National Health Service Quality Indicators for Occupational Health

The National Health Service (NHS) in the United Kingdom is currently developing a national occupational health registry, known as MOHAWK (Management of Health At Work Knowledge; http://www.mohawk.nhshealthatwork.co.uk/). In order to form the basis of the performance indicators used later in the MOHAWK registry, a systematic review (Stilz R, Baker A, Madan I, published in the Internet July 2012) was carried out to choose clinical indicators for the six core services: prevention, timely intervention, rehabilitation, health assessments for work, promotion of health and well-being and for teaching and training. Many of the chosen occupational health quality indicators are focused on the musculoskeletal disorders. Exercise and activity should be encouraged as a primary prevention approach for back pain. For patients with new back pain, the quality indicators include advice for activity and early return to work, consideration of the "red" and "yellow" flags (Tables 26.2 and 26.3), recording of clinical examination and patient information and appropriate communication of appropriate workplace adjustments. In case sickness leave is more than 4 weeks, liaison with the general practitioner and referral for active rehabilitation (education, reassurance, exercise, pain management, work) should be initiated. If the absence from work is for more than 8 weeks, the occupational health practitioner and the treating physician should liaison with the employee. For workers with chronic back pain, a referral for an intensive back school programme should be offered. For each of the NHS quality indicators, a review criterion is presented as well as the target standard, which maybe, for example, that 90 % of patients with the particular indication will obtain the preferred intervention.

Utilising Register Data for Performance Assessment

The Centre for Health and Social Economics in Finland has created a register-based database for follow-up of patients on an individual level throughout the treatment chain in the so-called PERFECT project (Häkkinen, 2011). The disease-oriented approach has been developed for eight major diseases or health problems, including total hip and knee endoprosthesis and hip fracture. The utilisation of the PERFECT project in assessing adoption of clinical guideline recommendations, as well as in benchmarking, is described in more detail below. It should also be noted that, besides national registries based usually on administrative data, clinical registries are also needed. Clinical registers may contain more detailed information about patients, treatments and outcomes. This augments a rigorous baseline

Table 26.2 Signs or factors that suggest a serious disease, the "red flags"

✓ Weakness, sensory loss or numbness appears in the lower extremities
✓ Urination is not possible or there is faecal incontinence
✓ Back pain is not alleviated by rest
✓ Back pain is associated with fever
✓ General condition is deteriorated or pain grows gradually more severe
✓ Back pain is associated with severe abdominal pain
✓ Patient has a history of malignant disease
✓ Weakness, sensory loss or numbness appears in the lower extremities

From Malmivaara A, Seitsalo S. Low back pain. In: Evidence-Based Medicine Guidelines [online]. Helsinki: Duodecim Medical Publications Ltd, *2010* [Updated 24.11.2010]. Available from Internet (password required): http://ebmg.wiley.com/ebmg/

Table 26.3 Factors suggesting an increased risk for chronicity of back pain, the "yellow flags"

✓ Belief that pain and physical activity are harmful
✓ Inappropriate illness behaviour (e.g. prolonged bed rest)
✓ Depressed mood, negativity and social withdrawal
✓ Seeking for many different therapies
✓ Physically strenuous work
✓ Problems at the workplace and dissatisfaction with the work
✓ Overprotective family or lack of support
✓ Complaints, litigations and compensation claims

From Malmivaara A, Seitsalo S. Low back pain. In: Evidence-Based Medicine Guidelines [online]. Helsinki: Duodecim Medical Publications Ltd, *2010* [Updated 24.11.2010]. Available from Internet (password required): http://ebmg.wiley.com/ebmg/

adjustment and inclusion of patient-relevant outcome measures (e.g. of pain and subjective disability). For example, in Sweden, a national quality register for spine surgery, SweSpine, accounts for about 95 % of departments at which spine surgery is carried out in the country (Stromqvist, Fritzell, Hagg, Jonsson, & Swedish Society of Spinal Surgeons, 2009).

Assessing How Well the Clinical Guidelines Have Been Followed

It is most important to assess whether treatments suggested by evidence-based guidelines are actually implemented in ordinary clinical practice. For example, in a study utilising the population-based South London Stroke Register, the appropriateness of treatment had improved considerably from 1995 to 2009, but the implementation of evidence-based care was still not optimal, and there were inequalities between socioeconomic groups (Addo et al., 2011). In a Swedish register study, the prescription of statin and anticoagulant therapy was associated with reduced risk of death, but it seemed to be underused for elderly patients (Asberg et al., 2010). In Finland, the national PERFECT project routinely provides information on how well the Finnish Current Care guidelines for treating hip fracture patients are followed in health care (Sund et al., 2011). Around 60 statements in the guideline were found suitable for indicators of the quality of hip fracture treatment. Some of the indicators were directly equivalent to those included in PERFECT and provided relevant data on patient populations, surgical and medical interventions, costs and outcomes. Some recommendations (e.g. surgery without delay for these patients) have been better implemented after publication of the guideline. During these years, mortality rates have decreased, and the proportion of people returning home after hip fracture has increased, but there are still large differences in clinical care practices across different areas in Finland. The existing register-based indicators from the PERFECT project appear to provide suitable measures for the evaluation of clinical care practices and may help to develop local practices and implementation of the Current Care guideline. Indeed, the national registers and guideline recommendations should be integrated so that adherence to the recommendations can be readily monitored. Guideline-based quality indicator development activities should be supported (Kötter, Blozik, & Scherer, 2012).

Implementing Clinical Guidelines by Creating Treatment Pathways

Implementation of national clinical guidelines can be augmented by locally created treatment pathways for specific indications. Local treatment pathways are based on the clinical guidelines but are more succinct and present an agreement on how the primary and secondary healthcare work together in order to ensure appropriate treatment for individual patients. For example, in hip and knee osteoarthrosis, the topics could include primary and secondary prevention, diagnosis and differential diagnosis and conservative treatment in the primary healthcare setting. Also, instructions are needed when to send patients for assessment of a potential operative treatment, as well as instructions on prior radiological examinations and what information should be included in the referral letter. There is also a need for instructions on postoperative rehabilitation and patient follow-up, as well as on assessment of disability and working ability, and on indications for vocational rehabilitation. An example of a local treatment pathway for low back pain is provided in Table 26.4.

The local treatment pathways need to be created by a multidisciplinary team consisting of professionals working in primary care and secondary healthcare settings. The goal of the treatment pathways is to standardise the way patients are diagnosed and how conservative care and operative care and rehabilitation are arranged through all the stages of treatment. The goal is to ensure the best possible working ability for those in their work-life and the ability to stay at home for the elderly people.

Table 26.4 Local treatment pathway for treating adults having low back pain, an example from the Lappeenranta health and social care district, Finland

Issues	Description of content
Aim of the treatment pathway	Clarify tasks of different professionals and promote multidisciplinary cooperation
Professionals targeted by the pathway	Professionals at primary and secondary healthcare treating low back pain patients
Team responsible for the pathway	Names of persons who have created the pathway
Diagnosis and treatment at the primary care	Tasks of nurses, physiotherapists and physicians
When to refer to the secondary (hospital) care	Indications for urgent referral to orthopaedic surgeon. Indications for nonurgent referral to orthopaedic surgeon or physiatrist
Information in the referral letter to the hospital care	History, clinical findings, degree of disability, work conditions, imaging findings
Responsibilities of primary and secondary care	Tasks of each professional in primary and secondary care defined in a general way
Treatment at the hospital	Tasks related to orthopaedic or conservative treatment, assessment of disability, rehabilitation
Information in the feedback letter to the primary care	Treatment plan including rehabilitation
Treatment at the primary care	Patient information, pain management, guidance for activity, assessment of work ability (preferably at occupational health care)
Other pathway issues	Vocational rehabilitation, help from patient organisations
Date for updating the pathway	Will be updated every year on October

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Benchmarking: Learning from the Peers

The fourth level of REM includes benchmarking (i.e. learning from the best practices of peers) across treatment providers. Again, simultaneous information of patient characteristics, diagnostic procedures and treatments and of the outcomes is needed for the comparisons across healthcare providers and for comparisons over time. If baseline imbalances between patients treated by different providers can be satisfactorily adjusted for, comparisons of treatment outcomes can also be made (Peltola et al., 2011). If feasible, all clinically important patient-relevant outcomes should be documented. The term “effectiveness” in REM covers both favourable and adverse effects produced by the healthcare units. Once there is comparable data to allow valid comparisons across health service providers of treatment processes, use of resources, outcomes and costs for a particular disease, the analyses should be extended to evaluate factors that determine the differences at the healthcare unit or regional level. The reasons for differences in outcomes can be assessed based on data on baseline patient characteristics and treatment processes, but this often needs to be supported by clinical reasoning of the probable determinants of favourable or unfavourable outcomes. Methods for statistical analyses have been developed and utilised for these comparisons (Peltola et al., 2011). Auditing of the services in the units may also be needed to get further information of the differences in the treatment processes. For example, in Finland, rather large differences in mortality rates of very low-weight infants were found between university hospitals providing tertiary care and central hospitals providing secondary care (Rautava et al., 2007). The mortality of infants born during the day time did not differ but, during nighttime, the central hospitals’ performance was weaker. The main reason for this difference was considered to be the relatively small nighttime expert resources for paediatric intensive care in the central hospitals. Based on these findings, centralisation of very small babies to university hospitals has increased in Finland during the last 5 years.

The benchmarking can be extended to international comparisons as well, which must again be done within specific indications that have been pre-defined to create sufficiently homogenous patient populations. In the recently launched EuroHOPE programme, which includes five indications (stroke, acute myocardial infarction, breast cancer, very low birth weight infants and hip fracture), the benchmarking will occur between seven European countries (http://eurohope.info/). EuroHOPE programme makes it possible to learn also from hospitals abroad and to compare performance of very big hospitals in various countries.

A valid comparison across different healthcare units requires appropriate eligibility criteria for the patients as well as risk adjustment for confounding factors at baseline. For example, the eligibility criteria for cases of myocardial infarction might be restricted to new episodes (e.g. patients have not been hospitalised for myocardial infarction during the previous year) and for those patients who have not been institutionalised before hospital admission. Risk adjustment for age, gender, comorbidity and other confounding factors should be made, using information from the treatment units and when available also from registers (Peltola et al., 2011). Moreover, in order to obtain valid benchmarking data through the whole clinical pathway, the possibility of linking different registers and combining information from different sources is needed. Unique personal identification numbers and legislation allowing data linkage on individual level make this feasible. Unfortunately, this is not achievable in all countries. However, it is always possible to compare the performance of individual healthcare units treating similar patients by documenting patient characteristics, treatments, costs and outcomes in a standardised way. Finally, the primary aim of benchmarking is, through continuous improvement of processes (based on the probable reasons between provider differences), to improve effectiveness of ordinary patient care by learning from the best practices.

How to Promote Real-Effectiveness Medicine?

The levels three and four of REM include use of observational data. The risk of bias of observational studies is usually much higher than that of RCTs, and up-to-date methodological knowledge and methods should be utilised to judge the validity of observational data for comparative research on intended effects (Norris et al., 2011). The most unbiased data can be obtained when the allocation of patients to a particular unit is unrelated to the outcome (Vandenbroucke, 2004). In some cases, unbiased analysis can be aided by an instrumental variable, which determines treatment allocation but is not related to outcome. For example, in a study assessing the ability of designated stroke centres to decrease mortality of stroke patients, in comparison with non-designated stroke centres, an instrumental variable based on difference in distance to the two treatment sites was employed (Xian et al., 2011). Researchers made additional analyses to ensure the validity of the results, particularly a sensitivity analysis on subgroups of stroke patients and a specificity analysis on mortality for two other life-threatening conditions in the hospitals having or not having a designated stroke centre. Furthermore, validation work needs to be carried out in order to ascertain the risk of bias and comparability of register data often aimed for mainly administrative purposes, such as data from the inpatient register and the cause-of-death register (Appelros & Terent, 2011). Lack of statistical power for assessment of relative differences in effectiveness between treatment providers may also limit possibilities to extend benchmarking to outcome indicators.

As the validity of the observational data is crucial, health service research should be promoted. In those cases when observational data cannot provide unbiased comparisons of treatment outcomes, descriptive data on how well patients have been treated according to current scientific evidence provides some valuable information. For example, as there is evidence on effectiveness of stroke centres, the primary aim of the hospitals treating stroke patients could be quality improvement and reaching a status of a designated stroke centre.

Electronic patient record systems are bringing new opportunities for REM. Development of patient record systems needs, however, carefully planned definitions and classifications of indications, interventions, use of resources and outcomes. Researchers and clinicians should be involved in this work of establishing standardised documentation of healthcare units' performance on various disease indications, as well as in the work aiming to improve the quality of existing registers. A special concern is the lack of, or poor quality of, data on primary healthcare services (Häkkinen, Malmivaara, & Sund, 2011). There should also be a considerable investment in the assessment and follow-up of what actually happens in health care. Only by doing so can one guarantee that the limited resources are used for treatments that really offer benefit. The healthcare units should routinely document essential information of patients, diagnostic procedures and treatments, costs and outcomes in a standardised way. This documentation makes it possible to improve quality, preferably together with peers treating similar patients.

Conclusions

The REM approach adds to the use of clinical expertise and up-to-date scientific evidence the levels three and four: the documentation of actual performance of a particular healthcare unit (or a hospital or a hospital district) and benchmarking based on this documentation. The "effectiveness" in REM is not limited to single interventions but to the entity of processes in patient care and preferably to those of the whole clinical pathway. Thus, the comparison is between two or more healthcare units or clinical pathways, not solely between specific treatments or pre-planned treatment algorithms as in RCTs. In musculoskeletal disorders that present special challenges, the question is usually not whether or not to use a single intervention, but rather how the patient can be taken care of through the whole process of recovery. Multidisciplinary treatment is usually needed in order to reach the best possible functional state.

According to the REM concept, all four elements are needed in order to increase effectiveness of care of musculoskeletal disorders. Good clinical expertise and skills form the basis for effective interventions. Use of current scientific evidence according to the EBM approach is also mandatory for effective patient care. Sound assessment of healthcare units' performance and benchmarking with peer units produces data that supports decision making and is helpful for clinicians, healthcare directors and policy makers. Clinicians are able to compare their own performance by using data on patient characteristics, process indicators, costs and outcomes. How well the treatment units have succeeded in advancing REM can also be assessed in a descriptive way by documenting the activities that have been taken to advance clinical expertise, EBM and documentation of performance and quality improvement including that through benchmarking with peers. The eventual aim of REM is to produce as much good and as little harm as possible for each patient, with reasonable costs to the society. REM also extends the prioritisation of alternatives from one single intervention to the whole clinical pathway (Malmivaara, 2013).

The advancement of real-world effectiveness should be based on combining, and continuously developing, the four elements: good medical expertise and skills combined with the patient view, scientific evidence, quality improvement and documentation of performance in ordinary clinical settings and benchmarking between providers. The new framework is suggested for clinicians, educators, developers, researchers, healthcare leaders and policy makers.

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References

Addo, J., Bhalla, A., Crichton, S., Rudd, A. G., McKevitt, C., & Wolfe, C. D. (2011). Provision of acute stroke care and associated factors in a multiethnic population: Prospective study with the south London stroke register. *BMJ, 342*, d744. doi:10.1136/bmj.d744.

Appelros, P., & Terent, A. (2011). Validation of the Swedish inpatient and cause-of-death registers in the context of stroke. *Acta Neurologica Scandinavica, 123*(4), 289–293. doi:10.1111/j.1600-0404.2010.01402.x.

Asberg, S., Henriksson, K. M., Farahmand, B., Asplund, K., Norrving, B., Appelros, P., et al. (2010). Ischemic stroke and secondary prevention in clinical practice: A cohort study of 14,529 patients in the Swedish stroke register. *Stroke, 41*(7), 1338–1342. doi:10.1161/STROKEAHA.110.580209.

Chassin, M. R., Loeb, J. M., Schmaltz, S. P., & Wachter, R. M. (2010). Accountability measures—Using measurement to promote quality improvement. *New England Journal of Medicine, 363*(7), 683–688. doi:10.1056/NEJMsb1002320.

Croft, P., Malmivaara, A., & van Tulder, M. (2011). The pros and cons of evidence-based medicine. *Spine, 36*(17), E1121–E1125. doi:10.1097/BRS.0b013e318223ae4c.

Dornan, T., Littlewood, S., Margolis, S. A., Scherpbier, A., Spencer, J., & Ypinazar, V. (2006). How can experience in clinical and community settings contribute to early medical education? A BEME systematic review. *Medical Teacher, 28*(1), 3–18. doi:10.1080/01421590500410971.

Grol, R., & Grimshaw, J. (2003). From best evidence to best practice: Effective implementation of change in patients' care. *Lancet, 362*(9391), 1225–1230. doi:10.1016/S0140-6736(03)14546-1.

Häkkinen, U. (2011). The PERFECT project: Measuring performance of health care episodes. *Annals of Medicine, 43*, S1–S3. doi:10.3109/07853890.2011.586901.

Häkkinen, U., Malmivaara, A., & Sund, R. (2011). PERFECT—Conclusions and future developments. *Annals of Medicine, 43*, S54–S57. doi:10.3109/07853890.2011.586904.

Jarvis-Selinger, S., Hameed, M., & Bloom, S. W. (2011). A matrix for comprehensive surgical education. *Canadian Journal of Surgery, 54*(5), 296–299. doi:10.1503/cjs.036110.

Knies, S., Ament, A. J. H. A., Evers, S. M. A. A., & Severens, J. L. (2009). The transferability of economic evaluations: Testing the model of Welte. *Value in Health, 12*(5), 730–738. doi:10.1111/j.1524-4733.2009.00525.x.

Koes, B. W., van Tulder, M., Lin, C. W., Macedo, L. G., McAuley, J., & Maher, C. (2010). An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *European Spine Journal, 19*(12), 2075–2094. doi:10.1007/s00586-010-1502-y.

Kötter, T., Blozik, E., & Scherer, M. (2012). Methods for the guideline-based development of quality indicators—A systematic review. *Implementation Science: IS, 7*, 21. doi:10.1186/1748-5908-7-21.

Littlewood, S., Ypinazar, V., Margolis, S. A., Scherpbier, A., Spencer, J., & Dornan, T. (2005). Early practical experience and the social responsiveness of clinical education: Systematic review. *BMJ, 331*(7513), 387–391. doi:10.1136/bmj.331.7513.387.

Malmivaara, A. (2013). Real-effectiveness medicine-pursuing the best effectiveness in the ordinary care of patients. *Annals of Medicine, 45*(2), 103–106. doi:10.3109/07853890.2011.653394.

Malmivaara, A., Koes, B., Bouter, L., & van Tulder, M. (2006). Applicability and clinical relevance of results in randomized controlled trials—The Cochrane review on exercise therapy for low back pain as an example. *Spine, 31*(13), 1405–1409. doi:10.1097/01.brs.0000219868.30427.66.

Norris, S. L., Atkins, D., Bruening, W., Fox, S., Johnson, E., Kane, R., et al. (2011). Observational studies in systemic reviews of comparative effectiveness: AHRQ and the effective health care program. *Journal of Clinical Epidemiology, 64*(11), 1178–1186. doi:10.1016/j.jclinepi.2010.04.027.

O'Dunn-Orto, A., Hartling, L., Campbell, S., & Oswald, A. E. (2012). Teaching musculoskeletal clinical skills to medical trainees and physicians: A best evidence in medical education systematic review of strategies and their effectiveness: BEME guide no. 18. *Medical Teacher, 34*(2), 93–102. doi:10.3109/0142159X.2011.613961.

Peltola, M., Juntunen, M., Häkkinen, U., Rosenqvist, G., Seppälä, T. T., & Sund, R. (2011). A methodological approach for register-based evaluation of cost and outcomes in health care. *Annals of Medicine, 43*, S4–S13. doi:10.3109/07853890.2011.586364.

Rautava, L., Lehtonen, L., Peltola, M., Korvenranta, E., Korvenranta, H., Linna, M., et al. (2007). The effect of birth in secondary- or tertiary-level hospitals in Finland on mortality in very preterm infants: A birth-register study. *Pediatrics, 119*(1), E257–E263. doi:10.1542/peds.2006-1964.

Rubenstein, L., & Pugh, J. (2006). Strategies for promoting organizational and practice change by advancing implementation research. *Journal of General Internal Medicine, 21*, S58–S64. doi:10.1111/j.1525-1497.2006.00364.x.

Sackett, D. (1995). Evidence-based medicine. *Lancet, 346*(8983), 1171. doi:10.1016/S0140-6736(95)91850-7.

Stromqvist, B., Fritzell, P., Hagg, O., Jonsson, B., & Swedish Society of Spinal Surgeons. (2009). The Swedish spine register: Development, design and utility. *European Spine Journal, 18*(Suppl. 3), 294–304. doi:10.1007/s00586-009-1043-4.

Sund, R., Sipilä, R., Malmivaara, A., Forsström, J., Ketola, E., & Huusko, T. (2011). Paljastavatko rekisteritiedot miten lonkkamurtuman hoitosuositukset toteutuvat? *Suomen Lääkärilehti—Finlands Läkartidning, 66*(20), 1655–1662. Retrieved from http://www.fimnet.fi/cgi-cug/brs/artikkeli.cgi?docn=000035824

Thistlethwaite, J. E., Davies, D., Ekeocha, S., Kidd, J. M., MacDougall, C., Matthews, P., et al. (2012). The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME guide no. 23. *Medical Teacher, 34*(6), e421–e444. doi:10.3109/0142159X.2012.680939.

Vandenbroucke, J. (2004). When are observational studies as credible as randomised trials? *Lancet, 363*(9422), 1728–1731. doi:10.1016/S0140-6736(04)16261-2.

Welte, R., Feenstra, T., Jager, H., & Leidl, R. (2004). A decision chart for assessing and improving the transferability of economic evaluation results between countries

RID B-7209-2009. *PharmacoEconomics, 22*(13), 857–876. doi:10.2165/00019053-200422130-00004.

Wennberg, D. E., Lucas, F. L., Birkmeyer, J. D., Bredenberg, C. E., & Fisher, E. S. (1998). Variation in carotid endarterectomy mortality in the Medicare population: Trial hospitals, volume, and patient characteristics. *JAMA, 279*(16), 1278–1281.

Xian, Y., Holloway, R. G., Chan, P. S., Noyes, K., Shah, M. N., Ting, H. H., et al. (2011). Association between stroke center hospitalization for acute ischemic stroke and mortality. *JAMA, 305*(4), 373–380. doi:10.1001/jama.2011.22.

Future Research Directions for Preventing and Treating Occupational Musculoskeletal Disorders

27

Robert J. Gatchel and Izabela Z. Schultz

Overview

As discussed in the first chapter of this handbook, musculoskeletal disorders are the single largest category of work-related illnesses in industrialized countries today. They are also the most common cause of short- and long-term occupational disability (Melhorn, Lazarovic, & Roehl, 2005). Moreover, they are a great economic burden to society, with estimates of approximately $100 billion spent annually in the USA on healthcare utilization costs and concomitant work productivity losses associated with just two of the most commonly cited occupational musculoskeletal disorders alone—neck and back pain conditions (Research and Markets, 2009). Subsequent chapters provided comprehensive overviews of the various types of prevalent occupational musculoskeletal disorders: back pain disorders, cervical pain disorders, upper and lower extremity disorders, chronic widespread pain disorders, and whiplash injuries.

As was discussed in a number of chapters in this handbook, it is extremely important to effectively treat musculoskeletal disorders in the acute phase before they develop into more costly and disabling chronic disorders. Some of the key factors found to play a dominant role in developing chronic disability problems after a musculoskeletal injury, including the degree of inactivity and resultant progressive physical deconditioning (such as loss of mobility, strength, and endurance that becomes more severe in the injured area), psychosocial factors (such as fear avoidance, depression, substance abuse), and occupational factors (such as job dissatisfaction, the availability of a job to go back to, and financial secondary gain for remaining disabled; Howard, Mayer, & Gatchel, 2012). In terms of psychosocial factors alone, they often significantly exacerbate the musculoskeletal pain condition and, therefore, must be managed on multiple levels. Indeed, in a recent meta-analysis, psychosocial factors were identified as the predominant research for the development of chronic disability for any musculoskeletal injury, irrespective of physical site of involvement (Chou & Shekelle, 2010). Thus, any potentially effective prevention or intervention strategy will need to embrace a comprehensive biopsychosocial approach to the assessment and treatment of occupational musculoskeletal disorders, as highlighted in Chap. 1 of this handbook.

Even though there has been an increase in clinical and basic research directed at better

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understanding risk factors for developing musculoskeletal disorders, as well as how to best prevent and treat them, the epidemic crisis of these disorders have not abated. Indeed, the urgent need for a more comprehensive approach to them, as earlier noted almost a decade ago by Schultz and Gatchel (2005), is still relevant today:

> The last two decades have seen a proliferation of basic science and clinically based research on these conditions. Despite these efforts, the knowledge generated by this research has not yet been integrated and translated into clinical and case management practice, policy and new paradigms of service delivery. There is no overarching conceptual framework for diagnosis, risk identification, early intervention, return to work and prevention. Rehabilitation and compensation systems, and professionals working within them, together with employers, are challenged by the pressing need to develop effective clinical and occupational interventions, as well as management and prevention approaches for these complex yet still elusive disabilities… The absence of evidence-informed paradigms, guidelines and strategies for early identification, intervention and management of these claims (for use in compensation, occupational and clinical settings) results in multi-billion dollar disability-related economic losses across industrialized countries. (p. ix).

The remainder of this chapter will review those areas that show greatest promise for helping to curb the rising prevalence and costs of occupational musculoskeletal disorders.

Identification of Risk Factors for Developing Occupational Musculoskeletal Disorders

Hernandez and Peterson (2013) have provided a comprehensive review of biomechanical, occupational, psychosocial, and various other individual risk factors associated with occupational musculoskeletal disorders. However, as they have appropriately noted, with people living longer (and the average age of the US work force also increasing), clinical research on the impact of this aging process on all work-related variables (e.g., biomechanical tolerance of work-related lifting and tolerance, psychosocial stress) will need to be constantly updated. These authors have provided examples of such "moving target" changes, as delineated below:

- In the past, highly repetitive and heavy lifting jobs were a mainstay of most work environments, such as the assembly line production process. However, with more mechanized equipment being utilized, high weight-force demands are decreasing and are being replaced by more frequent, repetitive motions. We will need to develop a more updated understanding of whether these new ergonomics produce greater risk for injury, relative to the earlier biomechanical/ergonomic risk factors, as well as the various types of exposure.
- Relatedly, the development of quantification metrics for these potentially new risk factors will need to be developed. Reliance on self-reported measures is not sufficiently reliable.
- With the changing demographics of the work force, more updated epidemiological research will be needed to evaluate the potentially complex interactions among biomechanical/ergonomic, psychosocial, and individual difference factors and their pathways to musculoskeletal injuries.

Thus, the ever-changing landscape of the work environment will have to be continuously monitored, and the resultant changes in risk factors modified accordingly. This will be no easy task and will rely on a continual "surveillance system" to document such changes.

Early Prevention and Intervention Programs

As Linton (2005) appropriately pointed out in discussing the importance of the early identification of patients who are at risk for developing persistent chronic musculoskeletal pain and disability disorders, an equally important issue arises: Is there an effective intervention available once these at-risk patients are identified? Thus, early identification of at-risk patients has little inherent worth if it is not directly tied to some positive action, in this case effective early intervention. In the earlier chapter by Gatchel, Kishino, and Schultz in this handbook, examples of such comprehensive early identification and intervention programs for "high-risk" patients were reviewed for two very prevalent and costly musculoskeletal disorders—low back pain and temporomandibular joint and muscle disorder (TMJMD). The clinical research conducted yielded very positive results in demonstrating the treatment and cost-effectiveness of these programs, as well as their ability to prevent the development of more costly and disabling chronic conditions. What is still needed, though, are comparable early identification/intervention programs for the various other occupational musculoskeletal disorders reviewed in this handbook. Indeed, the empirical "framework" for how to accomplish this has been developed on the basis of the work with low back pain and TMJMD. It is now important to use this framework for other prevalent and costly disorders.

However, even with the above empirical framework, this will not be an easy task. A number of obstacles will have to be overcome, as delineated below:

- Funding for such clinical research studies will be required. Fortunately, such funding from the National Institutes of Health (NIH) was successfully applied for and granted to Gatchel and colleagues for conducting the low back pain and TMJMD studies. Unfortunately, there have been major cutbacks in NIH funding over the past few years, so that alternative sources of funding will need to be found (e.g., State or private industry funding).
- Access to appropriate clinical populations is often difficult to obtain. One needs to develop a clinical referral source for patients to enroll in the study. Often, a great deal of "public relations" and marketing efforts is needed to motivate physicians to refer their patients to you for a study and to relieve their fears that you may "steal them away" from their practices.
- Finally, once patients are referred to the study, it is often difficult to motivate patients to remain in it. One often needs to come up with incentives that will prompt the full cooperation and participation of patients to fully complete the study.

For a more thorough review of these potential obstacles, the reader is referred to an article by Pulliam, Gatchel, and Robinson (2003), which more comprehensively discusses the major challenges related to such early prevention and intervention clinical research.

The Overlooked Indirect Personal and National Costs of Early Retirement Due to Occupational Musculoskeletal Disorders

Throughout this handbook, we have reviewed the current prevalence and costs of the major occupational musculoskeletal disorders. However, an equally important issue related to these disorders concerns the potentially long-term negative effects on the government and the economy in general. A recent study by Schofield et al. (2012) was one of the first to address such issues for workers with spinal disorders. In their investigation, these authors conducted a cross-sectional analysis of the base population in Australia, using a microsimulation model (which was developed on data from that country's Bureau of Statistics' Survey of Disability, Aging and Careers), as well as an income and savings microsimulation model. The goals of the study were to quantify the personal cost of lost income of patients who had to retire early because of spinal disorders; the cost to the country due to lost income taxation, and increased benefit payments, to these former workers; and the related loss in gross domestic product (GDP).

The results of this unique study were quite striking. These findings can be summarized as follows for workers (aged 45–64 years) who had to retire early because of spinal disorders, relative to those who were employed full time with no health conditions:

- They had 79 % lower incomes (only AU$310, relative to those employed full time who earned four times more).
- They paid 100 % less in taxes.
- They received 21 % more on government welfare support payments.

The above also had a large economic impact on Australia: AU$4.8 billion lost in annual individual earnings; AU$622 million in additional welfare payments; AU$497 million lost in taxation revenue for the government; and AU$2.9 billion in lost GDP! These costs were all attributable to patients with spinal disorders who were lost to their labor force participation. As the investigators appropriately note, even though the injured worker has to bear the emotional suffering and lost income due to the occupational injury, the country (Australia) itself also experiences many losses, such as the loss of productivity from reduced work force participation, lost of taxation revenues, and increased government welfare support payments. In an accompanying article, Dagenais and Haldeman (2012) noted that this total economic cost was nearly AU$9 billion (US$9.4 billion) for a country with only 22 million people or AU$269 per capita. If such figures were extrapolated for the USA, the financial costs to the government would be AU$82 billion (US$85 billion)!

These above findings are even more alarming because they represent costs related to only one musculoskeletal disorder. However, in the USA, disabling occupational spinal disorders are the primary cause of federally compensated disability and is a leading cause of disability for those over the age of 45 (e.g., Melhorn & Kennedy, 2005). Thus, such personal and national costs would be expected to be even higher in the USA, as suggested by Dagenais and Haldeman (2012). It will also be of great interest to conduct such economic analyses for the wide range of musculoskeletal disorders in other countries, such as the USA. Such costs may "break the national banks" for future generations of citizens. Data such as these will make it of paramount importance to further develop and implement early identification and intervention programs, such as those reviewed in the previous section of this chapter. Such programs have great potential for decreasing the development of chronic musculoskeletal disorders that can lead to early retirement and associated high financial costs that the government will need to absorb.

Cost of Opioids in the Treatment of Occupational Musculoskeletal Disorders

Another very high-cost time when treating occupational musculoskeletal disorders is related to the increased use of opioids. Indeed, opioid medications are often prescribed for such patients who are experiencing chronic pain (Kornick, Santiago-Palma, Moryl, Payne, & Obbens, 2003). In fact, between 1980 and 2000, there was an increase from 8 to 10 % in the number of patients receiving opioid medications for the treatment of occupational musculoskeletal disorder pain (Webster, Verma, & Gatchel, 2007). Of course, there is no question that patients with chronic nonmalignant pain will derive some pain reduction for opioid treatment, with studies suggesting that about 50 % of patients who receive appropriately managed chronic opioid treatment report a 30–40 % reduction in pain (Turk, 2002). However, as highlighted by Kidner, Mayer, and Gatchel (2009):

> …not much is known regarding the rates of improvement in terms of physical and emotional functioning that accompany the analgesic effects derived from opioids… the use of opioids for the treatment of chronic, nonmalignant pain is surrounded by controversy because of concerns about the potential for abuse and addiction, organ damage, demotivation, and questions regarding long-term effectiveness… Additionally, the debate over the use of opioids for the treatment of chronic nonmalignant pain has been heightened by evidence that chronic opioid use alters pain modulary systems, possibly increasing pain sensitivity (hyperalgesia) and aggrevating the underlying pain condition. (p. 920)

Indeed, the very influential Institute of Medicine's (IOM) Report, *Relieving Pain in America*, has recognized the serious problem of diversion and abuse of opioid drugs, as well as having questions about their usefulness long term. Relatedly, it has been found that high opioid doses are associated with poorer functional improvement in patients with chronic disabling occupational musculoskeletal disorders (Kidner et al., 2009), as well as poorer overall outcomes in patients with chronic disabling spinal disorders (Dersh, Mayer, Gatchel, Polatin, & Theodore, 2008). Combined with such discouraging outcome results is the documented high cost of such medications (Gatchel & Okifuji, 2006). For example, more than 312 million prescriptions for analgesics (137 million for opioids) are written each year, resulting in a total estimated cost as high as $62.5 billion annually. Thus, the high costs of opioids, combined with the poorer treatment outcomes associated with them, strongly argue for more careful scrutiny of opioid treatment for occupational musculoskeletal disorders. However, as noted by Bernacki, Yuspeh, Lavin, and Tao (2012), there have been increases in the use and cost of opioids in treating both acute and chronic pain in injured workers (these investigators evaluated such data from 1999 to 2009). They also noted that the proportionate and absolute rates of opioids used for treating occupational injuries vary considerably from one State to another. For example, New York State rates the highest in such use, and Louisiana rates second.

In a related study by the above research team, Tao, Lavin, Yuspeh, and Bernacki (2012) evaluated the relative costs associated with spine surgical procedures, opioid treatment, and combined surgery and opioid treatment in workers' compensation cases in Louisiana. They found that in terms of the odds ratios (ORs) for a resulting catastrophic claim (defined as an individual case costing more than $100,000), such claims for short-acting and long-acting opioids (versus no opioids) were 4.28 and 12.19 times greater, respectively. Moreover, the OR for catastrophic claims associated with a spinal fusion surgery (versus no surgery) was 11.40 times greater. Finally, and more dramatically, the OR for a spinal fusion surgery *plus* long-acting opioids rose to 138.96 times greater for a catastrophic claim.

Not only is there a tremendous cost associated with opioid treatment, but there is an escalating public health problem of abuse of prescription opioids, with such abuse increasing 71 % between 1997 and 2002 (Turk, Swanson, & Gatchel, 2008). Indeed, data from the Substance Abuse and Mental Health Services Administration's 2003 national survey on drug use and health reported that 31.2 million people, aged 12 or older (which represented 13 % of the population), had used prescription pain relievers nonmedically at least once in their lifetime, and 4.7 million in the past month. This was more than misuse of prescription tranquilizers, stimulants, and sedatives combined (U.S. Department of Health and Human Services, 2003). Moreover, as summarized by Dersh et al. (2008), this national survey also found the following:

- The number of new opioid users increased from 573,000 in 1990 to 2.5 million in 2000.
- In 2002, prescription opioids were the most prescribed drugs of all controlled substances (representing 153 of 234 million total prescriptions).
- These opioid prescriptions represented a 22 % increase in the absolute number of opioid prescriptions during a 10-year period.

These above statistics are very clear in demonstrating the widespread use of opioids in medical treatment. As was pointed out earlier in the study by Kidner et al. (2009), there is still not much known regarding the rates of improvement in terms of physical and emotional functioning that accompany the analgesic effects of opioids and some evidence to indicate poorer functional improvement in patients with chronic disabling occupational musculoskeletal disorders who are on high doses of opioids. Although some early proponents of long-term opioid use in the population contend that most patients with stable pathophysiological-related pain can achieve satisfactory analgesia by using non-escalating doses of opioids while remaining functional, with minimal risk of addiction or serious side effects (e.g., Portenoy & Savage, 1997), others have argued that their use is frequently associated with serious problems, such as oversedation, cognitive impairment, and hormonal changes (e.g., Ballantyne & Mao, 2003). Moreover, Schofferman (1993) has long contended that long-term opioid use often leads to a "downward spiral" characterized by a loss of active functional capacity at the workplace and a corresponding increase in depressed mood.

Unfortunately, there have been no high-quality research studies addressing the important issue of the long-term efficacy and risk for developing opioid addiction (Dersh et al., 2008).

Moreover, there is a paucity of clinical research regarding predictor variables that can identify those patients who are at risk for opioid misuse and abuse (Turk et al., 2008). Because of this, coupled with the earlier cited data on potential misuse of opioids, there has been an attempt to control this problem. Prescribing physicians are now legally required in the USA to comprehensively justify the medical use of the pain medication drug, as well as keep accurate records of prescribing practices in each patient's chart (Gatchel, 2010). These medical charts are subject to a Drug Enforcement Agency (DEA) audit at any time. Indeed, medical licenses have been revoked for failure to adhere to these regulations (Gatchel, 2010). As a result, many physicians have developed *opiophobia*, a term originally coined by the pharmacologist John Morgan in 1986. *Opiophobia* is defined as "a fear of opiate prescribing, with an inherent prejudice against these types of drugs regardless of their appropriate utility" (Gatchel, 2010), p. 638). As a consequence, many patients may be undertreated for their chronic pain condition. This creates a great conundrum for the practicing physician who does not want the risk of overprescribing such medications, especially for those patients who are at risk for abusing them. What is now needed is a reliable and valid method for evaluating patients who are at risk for the misuse of prescription medications. Gatchel and colleagues have made a significant stride in this area by developing the Pain Medication Questionnaire (PMQ; Adams et al., 2004; Buelow, Haggard, & Gatchel, 2009; Dowling, Gatchel, Adams, Stowell, & Bernstein, 2007; Holmes et al., 2006). The PMQ has shown good reliability and validity in identifying those patients who are at risk for potential medication misuse. It can be used by physicians to "flag" those patients who will need to be closely monitored, and possibly urine-tested, to be certain that they are not taking higher levels of opioids than those prescribed. Instruments such as the PMQ should allow physicians to overcome their fear of prescribing pain medication by alerting them to more precautions in treating patients with opioids. As summarized by Dersh et al. (2008):

> …clinicians who prescribe opioids should become familiar with…behaviors indicative of high risk of problematic opioid use…The use of screening instruments to identify those at risk for opioid dependence may be considered as part of standard clinical care…Once risk factors and problematic behaviors are identified in a particular patient, effective management procedures can balance the dual roles of analgesia and avoidance of iatrogenic ODD… Explicit limit setting, in the form of opioid agreements, have been found to be effective in these circumstances. Some patients will require treatment of addictive disease before pain management can be effectively addressed (p. 2224).

Finally, this major problem of the use of opioid analgesics for managing pain, with no well-validated and objective method for reliably identifying patients who are likely to experience good analgesia without troublesome side effects, as well as those patients who may be at risk for abuse prior to initiating opioid therapy, is continuing to receive a great deal of attention. For example, Bruehl et al. (2013) have recently proposed the possibility of developing a data-based personalized prescription methodology in the future. This "personalized medicine" approach would attempt to optimize medication types, as well as dosages, for individual patients based upon genetic and biomedical markers and other patient-related factors. However, as these authors note, such an approach is still many years away because many randomized controlled trials are still needed for documenting analgesic efficacy, as well as additional research which can develop appropriate algorithms based upon the most valid and reliable genetic and biomedical markers and patient-related factors. Nevertheless, in the long run, this may be the only way to control the problem of opioid use and abuse in the future.

The Major Paradigm Shift from the Biomedical Approach to the Biopsychosocial Approach to Occupational Musculoskeletal Pain and Disability

There can be no doubt that the *biopsychosocial approach* to occupational musculoskeletal pain and disability is the most heuristic one to embrace, relative to the outdated and overly simplistic biomedical approach (e.g., Gatchel, 2006;

Schultz & Gatchel, 2005). As reviewed in the first chapter of this handbook, this biopsychosocial model focuses on the complex interaction among biologic, psychosocial, and medicolegal variables that patients encounter when coping with persistent and distressing occupational musculoskeletal disorders. This complex interaction may perpetuate or even worsen the patient's medical condition and negatively affect various aspects of the patient's life. This approach is in striking contrast to the formerly embraced *biomedical reductionist approach*, which mistakenly assumed that most medical/musculoskeletal disorders can be separated into distinct, independent physical and psychosocial components. However, clinical research and experience has shown that every patient experiences a musculoskeletal injury uniquely, and the complexity of an injury can be especially evident when it persists over time, as a host of psychological, social/occupational, and economic factors come into play. These factors interact with the physical pathology to modulate the patient's discomfort and disability. Individual patients differ significantly in the frequency with which they report physical symptoms, their tendency to visit a physician for identical symptoms, and their response to identical treatment approaches (e.g., Gatchel, Kishino, & Strezak, 2006). As a consequence, the nature of a patient's response to treatment often has little to do with his or her objective physical condition. An especially significant contribution of the biopsychosocial model has been its use in developing effective interdisciplinary assessment and treatment methods (Gatchel, 2004, 2005). Such interdisciplinary care has been found to be extremely efficacious and cost-effective for treating patients with various occupational musculoskeletal pain and disability disorders (Gatchel, 2005; Gatchel & Okifuji, 2006; Wright & Gatchel, 2002).

In striking contrast to interdisciplinary pain management programs, traditional unimodal medical treatment, embracing an overly simplistic biomedical approach to these musculoskeletal disorders, has not been shown to be consistently therapeutic or cost-effective. Indeed, as comprehensively reviewed by Gatchel and Okifuji (2006), interdisciplinary programs such as functional restoration (based on the biopsychosocial model of pain and disability) have been shown to be effective not only for self-reported measures of pain and disability but also for more objective measures of function, such as range of motion, strength, and aerobic capacity. Even as important has been the significant positive effects it has had on important socioeconomic outcomes, such as return to work, subsequent healthcare utilization, surgery rates, and case closure, relative to conventional medical treatment approaches. Even with the accumulating evidence for the heuristic value of the biopsychosocial model, though, there have still been some misguided attempts to discredit it. For example, an article by Weiner (2008) questioned its utility in the area of spine care. However, in a rebuttal to this article, Gatchel and Turk (2008) provided a rebuttal in a separate article entitled *Criticisms of the Biopsychosocial Model in Spine Care: Creating and Then Attacking a Straw Person*. What follows is a brief summary of each of the concerns raised by Weiner (2008), accompanied by the rebuttal provided by Gatchel and Turk (2008):

- Concerns about the reliance on self-report of outcomes (Weiner). Gatchel and Turk: "There is nothing inherent in the biopsychosocial model that limits outcome assessment to self-report…By definition, the 'bio' 'psycho' 'social' underscores the important contributions of factors in each of the 3 defining domains…In fact, a substantial number of authors have emphasized repeatedly that there are 3 broad categories of measures—physical, psychosocial (including interpretations, affective state, behavior and coping resources), and socioeconomic (including workplace factors, contextual demands, availability of wage replacement)—that should all be used to assess patients, in treatment planning, and as outcomes of clinical trials of spinal disorder patients…" (p. 2831).
- The disconnection between physical pathology and self-report (Weiner). Weiner attempts to caution us that "the history of medicine is filled with tales of diseases with insufficiently understood etiologic pathology and poor

outcomes of treatment being inappropriately correlated (in its worst forms, etiologically/causally) with psychosocial phenomena" (p. 2832). He then asserts that this biopsychosocial approach will actually hamper the development of a more complete understanding of the etiology of many diseases and indicates that the Type A behavior pattern has impeded our understanding and treatment of coronary artery disease.Gatchel and Turk: "…quite to the contrary, the identification of the Type A behavior pattern and its relationship to stress opened up whole new pathways of investigation that unequivocally demonstrated that the psychosocial construct of 'stress' was a major risk factor for certain forms of coronary heart disease, albeit not necessarily all forms. There are now even textbooks that focus on such important psychosocial factors in the field of cardiology…" (pp. 2832–2833).

- Concerns about the scientific status of the biopsychosocial model (Weiner). Weiner indicated that the biomedical model is more effective in experimentally testing and objectively documenting whether certain somatic pathophysiological events may be responsible for low back pain.Gatchel and Turk: Although this is possible, it has been well documented that a significant amount of variance in the progression and maintenance of pain and disability after a low back injury is related to psychosocial factors (more than can be accounted for by physical variables). These data have also documented that the biopsychosocial model is very testable one. Moreover, the biopsychosocial model has stimulated the development of a very effective interdisciplinary approach to the treatment of chronic low back pain, in contrast to previously biomedical-based approaches that emphasized only monotherapies, such as pharmacotherapy, surgery, and other invasive procedures.
- "Philosophers have fretted for millennia over mind/body interaction and implementing models based on debatable premises must itself be subjected to debate" (Weiner, p. 2833).Gatchel and Turk: "Contrary to Weiner's statement… the status of the biopsychosocial model has progressed past the overly simplistic mind/body dichotomy that was the major underpinning of the reductionist biomedical approach. The fact that a biopsychosocial model requires a better understanding of the complex interaction of a number of factors does not make it untenable. To the contrary, the fact that a complex goal is difficult to achieve should not prompt us to abandon the pursuit of that goal for the seduction of a more immediate, albeit 'quick fix,' one that is only minimally effective" (pp. 2833–2834).
- The outcomes of treatments for persistent spinal pain based on the biopsychosocial model are just now being studied, and there is conflicting evidence to date of their effectiveness in decreasing pain and improving function (Weiner).Gatchel and Turk: Quite to the contrary, "…the review of the pain literature has unequivocally demonstrated the therapeutic effectiveness of the interdisciplinary approach to chronic pain. In fact, there is an extensive literature demonstrating the therapeutic effectiveness of a biopsychosocial model-based functional restoration program for chronic low back pain. The results of such programs…have demonstrated significant positive socioeconomic outcomes (such as return-to-work, decreased surgical rates, resolution of outstanding legal and medical issues) in chronically disabled patients in both 1-year and 2-year follow-up studies…" (p. 2834).
- Concern about the ubiquity of biopsychosocial "pathology" (Weiner). Weiner raises the fact that, in a recent study of nonpatients, 49 % of the "healthy" individuals demonstrated biopsychosocial dysfunction on standardized questionnaires.Gatchel and Turk: This concern "…reinforces the notion that many patients 'bring with them' unique characteristics that often need to be considered in assessment and treatment…The 49% figure cited does not necessarily mean that all these people are in urgent need of any form of treatment…as proposed by many, 'biopsychosocial dysfunctions' or 'psychopathology' may be significant for some individuals and

not others…it emphasizes that the chronic problem may represent a complex interaction between physical factors and psychosocioeconomic variables that all need to be effectively managed to ensure therapeutic success" (p. 2834).

- The biopsychosocial model encourages the further medicalization of the patients (Weiner).Gatchel and Turk: "As we have reviewed… an illness such as intractable chronic low back pain is not conceptualized as purely a nociceptive problem that simply requires a structural 'fix of some broken part,' but one that results from the interactive of biopsychosocial factors that need to be carefully assessed in order to then 'customize' treatment to the specific needs of the patient—physical, psychosocial, and behavioral" (pp. 2834–2835).

The purpose of presenting the above discourse is to highlight the fact that even though the biopsychosocial approach has been repeatedly demonstrated to be the most heuristic for the assessment and treatment of musculoskeletal disorders, there are still some physicians who cling to the outdated biomedical model. This is especially puzzling because Engel (1977), a physician, was the first to introduce the biopsychosocial model as a more effective one to use in assessing and treating chronic medical illnesses.

Translating Evidence-Based Prevention and Early Intervention Approaches to the "Real World" of the Current Epidemic of Occupational Musculoskeletal Pain and Disability Disorders

As earlier noted by Schultz and Gatchel (2005), even though we now know that the biopsychosocial approach is the optimal clinical research paradigm to use for the prediction and early intervention with occupational musculoskeletal disorders, the process of implementing it in the "real world" can be quite costly and labor-intensive (as was briefly discussed earlier in this chapter). It also requires a great deal of collaboration among multiple stakeholders who may have conflicting interests. This is no easy task and is still problematic today. In fact, the previously referenced IOM Report, *Relieving Pain in America*, has highlighted many of these problematic barriers, to be discussed next. As can be seen in Fig. 27.1, there are a number of stakeholder barriers/layers that all may converge to ultimately determine the care provided to occupationally injured workers. Before reviewing these barriers/layers, we should again remind the reader of the three important constructs of *pain*, *disability*, and *impairment* that were each discussed in the first chapter by Gatchel, Kishino, and Strizak of this handbook. *Pain* is a psychophysiologic construct based primarily on an experiential or subjective evaluation by the patient that some sort of bodily injury has occurred. *Impairment* is a physical/medical term that refers to an alteration of the injured workers' usual health status (i.e., some objective anatomical or pathological abnormality) that is evaluated by physical and medical means. This evaluation of impairment has traditionally been a medical responsibility in which there is an attempt to objectively evaluate structural limitations, through techniques such as

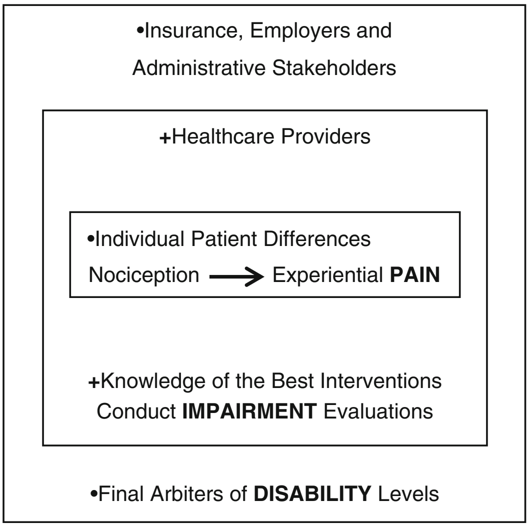

Fig. 27.1 Different stakeholder barriers/layers that converge to ultimately determine the level of care provided to injured workers

a thorough medical examination and imaging results. Unfortunately, current technology does not automatically allow a totally accurate or objective physical impairment evaluation. It relies on methods that many not have good validity, as well as not being completely reliable, and sometimes subject to examiner bias. Finally, *disability* has traditionally been an administrative term that refers to the diminished capacity or inability to perform certain activities of everyday living. It is the resulting loss of function due to impairment. Disability evaluations, too, are often not totally reliable and are subject to various examiner and patient response biases (e.g., Gatchel, 2005). The assessment of disability is usually based on subjective self-report measures of restrictions on activities of daily living, such as walking, work and recreational activities, and sleep. Because pain, physical impairment, and disability are separately assessed, they are often not highly correlated with one another. Thus, for example, one patient may verbally report a significant amount of pain but show little impairment that can be objectively evaluated, with disability perhaps lying somewhere between the two in severity. In contrast, another patient may report little pain but displays great disability and some impairment. As a result, this can create a legal/bureaucratic "nightmare" in terms of determining how much impairment and disability resulted from an occupational injury and, thus, the amount of workers' compensation that is paid to the injured employee. This, in turn, can create an adversarial and emotional distressing interaction between the injured worker and his or her employer and company.

Patient-Level Barriers

It has been well documented that there are often significant individual differences in how patients may respond to the same pain-nociception event, due to genetic factors, past learning experiences, sociocultural factors, etc. (e.g., Gatchel, 2005; Gatchel, Peng, Peters, Fuchs, & Turk, 2007). Thus, at this level, if a patient is perceived by others (e.g., clinicians, family members, and employers) as complaining too much about his or her pain, then there may be some suspicion raised that this is a way of gaining extra sympathy, avoiding certain unpleasant activities, or "gaming the system" to receive monetary compensation for the injury. On the other hand, if the patient receives a great deal of sympathy and is allowed to avoid certain activities, then this may reinforce and further increase such pain behavior. Obviously, because pain is a theoretical *construct* which cannot be objectively seen or quantified, but only *inferred* from certain behaviors (e.g., self-report of pain, pain behaviors such as grimacing, and bracing), the true intensity of pain can never be fully quantified (even with high-technology devices). This has always been a major conundrum in attempts to reliably assess and understand experiential pain—what is experienced as extremely high or intolerable pain by one person may be experienced as only moderate but tolerable pain by another. As a result, injured workers are often put in the position of having to "prove to others" that they have significant "real" pain which interferes with their ability to work and be fully productive.

Healthcare Provider-Level Barriers

As highlighted in the IOM Report (Institute of Medicine of the National Academy of Science, 2011), although a great deal of acute and chronic pain can be reduced with appropriate treatment by a single clinician, or by an interdisciplinary team of clinicians with different specialties (e.g., psychiatrists, psychologists, nurses, physical therapists, occupational therapists), many healthcare providers will routinely face numerous barriers to provide the most appropriate care, as delineated below:

- Well-validated, evidence-based assessment and treatment guidelines have not yet been developed for many pain conditions.
- Even if such guidelines have been developed, they are not uniformly followed by all healthcare providers.
- Healthcare providers are frequently not well educated or fully informed about emerging best practices in pain prevention, assessment, and treatment.

- Relatedly, primary care physicians who usually are the first to encounter acute pain patients are usually not well trained in pain assessment and management and may not know what specific other practitioners to refer these patients to.
- Restrictions of insurance coverage/payment policies, including those of workers' compensation system plans, can significantly limit the ability of a healthcare provider to offer the potentially best assessment and treatment program for all patients.
- All of the above can have a major impact on the quality and validity of the medical impairment given to a patient, which is determined by the treating physician.

System-Level Barriers

As earlier discussed by Schultz and Gatchel (2005), there are multiple factors that can come into play and that can significantly mediate the relationships among injured workers and their self-reports of *pain*, the treating physician's responsibility of determining the patient's medical *impairment* caused by the injury, and the ultimate final determination of physical *disability*, which is an administrative process involving multiple possible stakeholders in an injury claim, such as third-party insurance payors, different workers' compensation systems (that may differ from one State to another in the USA), the federal social security disability system, and employer insurance policies. This frequently results in uncoordinated or poorly coordinated policies and practices across these different stakeholders. Moreover, there is often an adversarial relationship that develops across these different stakeholders, the injured worker, as well as the lawyers representing the injured worker. As can be seen in Fig. 27.1, this may result in the patient being "squeezed" by the different layers of the healthcare system/agencies involved in his or her care and the perception of helplessness caused by this "piling on." What makes this an even more troublesome predicament is the fact that throughout the layers of this system (starting with patients themselves and extending to the healthcare providers, employers, third-party payors, and state/federal system administrative regulators), there is frequently a basic lack of understanding of the importance of pain management and early intervention techniques to minimize patient-reported pain and the resultant impairment and disability determinations. Rather than having an appropriate degree of synergy in developing the best assessment/treatment plan for an injured worker, the present state of affairs usually leads to an uncoordinated and less than adequate assessment/treatment plan. Today, there is still a great need for improvement in order to provide the best care for injured workers.

Summary and Conclusions

Presently, there is no doubt that we are continuing to experience an epidemic of occupational musculoskeletal disorders that create a great deal of unnecessary worker suffering and a significant socioeconomic toll on society as a whole. Indeed, these disorders are the single largest categories of work-related illnesses in industrialized countries today. A common theme in many of the chapters in this handbook is the urgent need to effectively treat these occupational musculoskeletal disorders in the early, acute stage before they develop into more costly and disabling chronic disorders. The good news is that clinical research has isolated some key factors found to play a dominant role in developing chronic disability problems following a musculoskeletal injury. These include physical factors (such as the degree of inactivity and the resultant progressive physical deconditioning that hampers the rehabilitation process), psychosocial factors (such as fear avoidance, depression, substance abuse), and occupational factors (such as job dissatisfaction and the availability of a job to go back to). Unfortunately, even with the identification of these risk factors, and the subsequent successful development of early intervention programs to prevent the development of chronicity, such findings have not been easy to widely translate/apply to "real-world" occupational settings.

The various barriers encountered in attempting to do this were reviewed. Relatedly, another important and frequently overlooked consequence of occupational musculoskeletal disorders that was discussed relates to indirect personal and national costs of early retirement due to these disorders. Recent studies have highlighted the large economic impact such early retirement has on an available work force, individual income, as well as federal financial costs that greatly affect GNP figures. Again, such data make it even more imperative to develop early identification and prevention programs to "slow down" these early retirement rates.

There have been estimates that nearly $100 billion is spent annually in the USA on healthcare utilization costs and concomitant work productivity losses associated with just two of the most common occupational musculoskeletal disorders alone—neck and back pain conditions. One of the "high-price" drivers of these costs is related to the increased use of opioids in treating such disorders. As was pointed out, in the USA, more than 312 million prescriptions for analgesics (137 million for opioids) are written each year, resulting in a total estimated cost as high as $62.5 billion annually. This high use and cost of opioids, moreover, are often associated with poorer treatment outcomes. Thus, more scrutiny is needed for opioid prescription patterns and in the identification of what patients will respond best or poorly to them.

We have emphasized that great strides have been made in "shedding" the outdated and overly simplistic biomedical approach to pain and disability and replacing it with the more heuristic biopsychosocial approach. This latter approach appropriately recognizes the complexity of pain and disability problems, especially when they persist over time, with the need to take into account the unique interactions among biological, psychosocial, and economic factors. Such a model has led to the development of effective interdisciplinary pain assessment and intervention programs. Finally, we need to again emphasize translating what we have learned about evidence-based prevention and early intervention approaches to the "real world" of the occupational setting for producing the best therapeutic results. However, a number of barriers to this translation process—patient level, healthcare provider level, and system level—still must need to be overcome. This will not be an easy feat to accomplish. Because of the different stakeholders at each barrier level, the next major task facing this field is the best way of developing cooperative synergy among the stakeholders. Without such synergy, one cannot expect to solve our current epidemic crisis of occupational musculoskeletal pain and disability disorders.

References

Adams, L. L., Gatchel, R. J., Robinson, R. C., Polatin, P. P., Gajraj, N., Deschner, M., et al. (2004). Development of a self-report screening instrument for assessing potential opioid medication misuse in chronic pain patients. *Journal of Pain and Symptom Management, 27*(5), 440–459.

Ballantyne, J. C., & Mao, J. (2003). Opioid therapy for chronic pain. *New England Journal of Medicine, 349*, 1943–1953.

Bernacki, E. J., Yuspeh, L., Lavin, R., & Tao, X. G. (2012). Increases in the use and cost of opioids to treat acute and chronic pain in injured workers, 1999 to 2009. *Journal of Occupational and Environmental Medicine, 54*(2), 216–223.

Bruehl, S., Apkarian, A. V., Ballantyne, J. C., Berger, A., Borsook, D., Chen, W. G., et al. (2013). Personalized medicine and opioid analgesic prescribing for chronic pain: Opportunities and challenges. *The Journal of Pain, 14*(2), 103–113. doi:http://dx.doi.org/10.1016/j.jpain.2012.10.016.

Buelow, A. K., Haggard, R., & Gatchel, R. J. (2009). Additional validation of the Pain Medication Questionnaire in a heterogeneous sample of chronic pain patients. *Pain Practice, 9*, 428–434.

Chou, R., & Shekelle, P. (2010). Will this patient develop persistent disabling low back pain? *JAMA: The Journal of the American Medical Association, 303*(13), 1295–1302.

Dagenais, S., & Haldeman, S. (2012). Commentary: Laboring to understand the economic impact of spinal disorders. *The Spine Journal, 12*(12), 1119–1121. doi:http://dx.doi.org/10.1016/j.spinee.2012.11.023.

Dersh, J., Mayer, T. G., Gatchel, R. J., Polatin, P. B., & Theodore, B. (2008). Prescription opioid dependence is associated with poorer outcomes in disabling spinal disorders. *Spine, 33*, 2218–2227.

Dowling, L. S., Gatchel, R. J., Adams, L. L., Stowell, A. W., & Bernstein, D. (2007). An evaluation of the predictive validity of the Pain Medication Questionnaire with a heterogeneous group of patients with chronic pain. *Journal of Opioid Management, 3*, 257–266.

Engel, G. L. (1977). The need for a new medical model: A challenge for biomedicine. *Science, 196*(4286), 129–136.

Gatchel, R. J. (2004). Comorbidity of chronic mental and physical health disorders: The biopsychosocial perspective. *American Psychologist, 59*, 792–805.

Gatchel, R. J. (2005). *Clinical essentials of pain management*. Washington, DC: American Psychological Association.

Gatchel, R. J. (Ed.). (2006). *Compendium of outcome instruments* (2nd ed.). LeGrange, IL: North American Spine Society.

Gatchel, R. J. (2010). Biopsychosocial screening before surgical intervention or opioid therapy for patients with chronic pain. In D. C. Turk & R. Melzack (Eds.), *Handbook of pain assessment* (3rd ed.). New York: Guilford Press.

Gatchel, R. J., Kishino, N. D., & Strezak, A. (2006). The importance of outcome assessment in orthopaedics: An overview. In J. M. Spivak & P. J. Connolly (Eds.), *Orthopaedic knowledge update: Spine* (3rd ed., pp. 95–102). Chicago: American Academy of Orthopaedic Surgeons.

Gatchel, R. J., & Okifuji, A. (2006). Evidence-based scientific data documenting the treatment and cost-effectiveness of comprehensive pain programs for chronic nonmalignant pain [Journal Peer Reviewed Journal]. *The Journal of Pain, 7*(11), 779–793. doi:http://dx.doi.org/10.1016/j.jpain.2006.08.005.

Gatchel, R. J., Peng, Y., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin, 133*, 581–624.

Gatchel, R. J., & Turk, D. C. (2008). Criticisms of the biopsychosocial model in spine care: Creating and then attacking a straw person. *Spine, 33*(25), 2831–2836.

Hernandez, A. M., & Peterson, A. L. (2013). Work-related musculoskeletal disorders and pain. In R. J. Gatchel & I. Z. Schultz (Eds.), *Handbook of occupational health and wellness*. New York: Springer.

Holmes, C. P., Gatchel, R. J., Adams, L. L., Stowell, A. W., Hatten, A., Noe, C., et al. (2006). An opioid screening instrument: Long-term evaluation of the utility of the Pain Medication Questionnaire. *Pain Practice, 6*(2), 74–88.

Howard, K. J., Mayer, T. G., & Gatchel, R. J. (2012). Comparison of chronic occupational upper extremity vs. lumbar disorders for differential disability-related outcomes and prediction variables. *Journal of Occupational and Environmental Medicine, 54*, 1002–1009.

Institute of Medicine of the National Academy of Science. (2011). *Relieving pain in America: A blueprint for transforming prevention, care, education, and research* (p. 5). Washington, DC: Institute of Medicine.

Kidner, C. L., Mayer, T. G., & Gatchel, R. J. (2009). Higher opioid doses predict poorer functional outcome in chronic disabling occupational musculoskeletal disorders. *Journal of Bone and Joint Surgery—American Volume, 91*, 919–927.

Kornick, C. A., Santiago-Palma, J., Moryl, N., Payne, R., & Obbens, E. A. (2003). Benefit-risk assessment of transdermal fentanyl for the treatment of chronic pain. *Drug Safety: An International Journal of Medical Toxicology and Drug Experience, 26*(13), 951–973.

Linton, S. J. (2005). Early interventions for "at risk" patients with spinal pain. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention*. New York: Springer.

Melhorn, J. M., & Kennedy, E. M. (2005). Musculoskeletal disorders, disability and return-to-work. In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention*. New York: Springer.

Melhorn, J. M., Lazarovic, J., & Roehl, W. K. (2005). Do we have a disability epidemic? In I. Z. Schultz & R. J. Gatchel (Eds.), *Handbook of complex occupational disability claims: Early risk identification, intervention and prevention*. New York: Springer.

Portenoy, R. K., & Savage, S. R. (1997). Clinical realities and economic considerations: Special therapeutic issues in intrathecal therapy—Tolerance and addiction. *Journal of Pain and Symptom Management, 14*(3 Suppl.), S27–S35.

Pulliam, C. B., Gatchel, R. J., & Robinson, R. C. (2003). Challenges to early prevention and intervention: Personal experiences with adherence [Journal Peer Reviewed Journal]. *Clinical Journal of Pain, 19*(2), 114–120. doi:http://dx.doi.org/10.1097/00002508-200303000-00006.

Research and Markets. (2009). *Back pain report 2008*. Retrieved May 30, 2012, from http://www.researchandmarkets.com/reports/706585/back_pain_report_2008

Schofferman, J. (1993). Long-term use of opioid analgesics for the treatment of chronic pain of nonmalignant origin. *Journal of Pain and Symptom Management, 8*, 279–288.

Schofield, D. J., Shrestha, R. N., Percival, R., Passey, M. E., Callander, E. J., & Kelly, S. J. (2012). The personal and national costs of early retirement because of spinal disorders: Impacts on income, taxes, and government support payments. *The Spine Journal, 12*(12), 1111–1118. doi:http://dx.doi.org/10.1016/j.spinee.2012.09.036.

Schultz, I., & Gatchel, R. (Eds.). (2005). *Handbook of complex occupational disability claims*. New York: Springer.

Tao, X. G., Lavin, R. A., Yuspeh, L., & Bernacki, E. J. (2012). Impact of the combined use of opioids and surgical procedures on workers' compensation cost among a cohort of injured workers in the state of Louisiana. *Journal of Occupational and Environmental Medicine, 54*(12), 1513–1519.

Turk, D. C. (2002). Clinical effectiveness and cost effectiveness of treatment for patients with chronic pain. *Clinical Journal of Pain, 18*(6), 355–365.

Turk, D. C., Swanson, D. C., & Gatchel, R. J. (2008). Predicting opioid misuse by chronic pain patients:

A systematic review and literature synthesis. *Clinical Journal of Pain, 24*, 487–508.

U.S. Department of Health and Human Services. (2003). *National survey on drug use and health 2005*. Retrieved from http://www.oas.samhsa.gov/nhsda.htm#NHSDAinfo

Webster, B., Verma, S., & Gatchel, R. J. (2007). Relationship between early opioid prescribing for acute occupational low back pain and disability duration, medical costs, subsequent surgery and late opioid use. *Spine, 32*(19), 2127–2132.

Weiner, B. K. (2008). The biopsychosocial model and spine care. *Spine, 33*(2), 219–223.

Wright, A. R., & Gatchel, R. J. (2002). Occupational musculoskeletal pain and disability. In D. C. Turk & R. J. Gatchel (Eds.), *Psychological approaches to pain management: A practitioner's handbook* (2nd ed., pp. 349–364). New York: Guilford Press.

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