Handbooks in Health, Work, and Disability

Robert J. Gatchel
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Christopher T. Ray *Editors*

Handbook of Rehabilitation in Older Adults

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Handbook of Rehabilitation in Older Adults

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We would like to dedicate this Handbook to our loving parents, who instilled in us a great motivation to be honest, to be kind, and to always continue to learn and grow as educated human beings.

Preface

Currently, in the United States, approximately 35 million Americans are age 65 years or older, representing 12.4% of the total population (US Census Bureau, 2001). The US Census Bureau (2000) projects that 20% (72 million) of the population will be 65 years of age or older by 2030. These “gray tsunami”-related population trends contribute to increased concerns about healthcare among older adults, including chronic illnesses, disease and disability prevention, and rehabilitation needs. Indeed, the United States is in the process of what is known as the “longevity revolution” and, as the population of those living longer increases, so will their healthcare needs. As individuals age, they also become more susceptible to injuries, especially falls. About one-third of adults will fall annually, and most will require medical attention as a result. Moreover, falls and fall-related injuries (such as chronic low back pain) are one of the chief origins of morbidity in older adults and are a precursor to functional impairment, disability, fractures, pain, and reduced quality of life. In more severe cases, falls are a significant cause of injury-related death in the older adult population. In addition, other significant chronic illnesses and disabilities associated with aging include musculoskeletal disorders, cardiovascular disease, mental health disorders, neuromuscular and neurological disorders, dementia, and osteoarthritis. Not surprisingly, this situation increases the burden on healthcare providers as more costly invasive interventions are performed and more medications are prescribed to the elderly which, in turn, can also lead to associated protracted recovery, side effects, pain, and disability. This vicious cycle can also strain financial resources, with the monetary burden associated with fall injuries (especially low back pain) projected to reach $32.4 billion by the year 2020. Challenges in meeting the demands of an aging population are not isolated to the United States. Similar statistics about the scope of the sociodemographic and healthcare challenges of an aging population are evident in all Western countries and in Japan.

Addressing the healthcare needs of the aging population is paramount, and yet a paucity of research exists on rehabilitation approaches to reduce the degree of disability in this population and on the maintenance of independence in activities of daily living (ADLs), autonomy in decision-making, and enhancement of quality of life. The present *Handbook* was developed to provide a single, comprehensive, and unique source for a better understanding of these chronic illnesses and disabilities and the associated rehabilitation methods for our aging population. It also provides evidence-informed guidance on how best to assess and manage them. Moreover, implications for future research, policy, and best practices are discussed at the end of each chapter.

In order to accomplish the above, the Handbook is broken down into four separate parts. *Part I*, "Introduction and Overview," provides information on the epidemiology of chronic illnesses in older adults, the modifiability of longevity and quality-of-life predictors, biopsychosocial rehabilitation approaches for older adults, productive aging and work, and the measurement of gait and postural control in aging. *Part II*, "Major Illnesses and Disabilities in the Aging Population," will delineate the most common diseases, illnesses, and disabilities in the aging population (musculoskeletal pain and disability, spinal cord injury, Parkinson's disease, cardiovascular disease, cancer, brain injuries, mental health disorders, and multiple medication issues). *Part III* will expose readers to important clinical, occupational, and functional rehabilitation approaches developed specifically for older adults. Finally, *Part IV* is dedicated to providing future research and practice directions that will be important to know going forward.

We invite our readers for exploration of emerging clinical, occupational, medicolegal, and research issues in rehabilitation of older adults, together with a discussion and dialogue on these issues. Understanding of evidence-informed advances in assessment, as well as clinical and occupational rehabilitation, of older adults will benefit readers from many healthcare and occupational science disciplines. The best rehabilitation practices will be of interest to those healthcare professionals and clinical programs that serve older adults and geriatric patients and inform academic curricula in medicine, physical therapy, occupational therapy, vocational rehabilitation, kinesiology, nursing, gerontology, psychology, and social work. Also, the following professionals will develop enhanced and relevant knowledge in the new rapidly consolidating field of research and practice covered by the contents of our Handbook: human resource professionals, employee and family assistance counselors, union representatives, disability case managers, supervisors/employers, company executives, lawyers, insurers, licensing bodies for safety-sensitive professionals, health policy-makers, and advocacy groups. Furthermore, we encourage clinical researchers and academics to consider future directions for scientific inquiry within the transdisciplinary biopsychosocial model of rehabilitation of older adults.

Finally, we would like to acknowledge all of the authors for their valuable state-of-the-art contributions and for making this *Handbook* come to fruition in a timely manner. We again especially thank Janice Stern of Springer (now retired) who provided us with encouragement and support during our journey. In addition, we thank Pedro Cortes at the University of Texas at Arlington for all his tireless and technical contributions to the development of this *Handbook*.

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Part I

Introduction and Overview

1 Epidemiology of Chronic Illnesses: Associations with the Aging Population and Future Socioeconomic Implications

Robert J. Gatchel, Jin Y. Choi, and Marena Hanna

Overview

At the outset, as noted by Melhorn (2014), "Epidemiology is the study of the distribution and determinants of diseases and injuries in human populations…Disease does not develop randomly, and all individuals are not equally likely to develop a specific disease at a given time…it is a function of his or her personal characteristics (inheritance) and his/her surroundings (environment)" (p. 175). With that in mind, this present chapter will emphasize that, in the United States today, we are in the midst of the "graying of America revolution," with a steady increase in the number of aging adults 60 years or older. Indeed, the "baby boomers" are now in the 51–69 age range and will continue to add to the increasing number of 60+ adults. This is similarly true in many other countries around the world. In the United States, approximately one-half billion people are now over 60 years of age, and it is estimated that, by the year 2050, this number is expected to triple! Unfortunately, one of the inevitable consequences of aging is the increased probability of developing chronic illnesses (due to factors such as the deterioration of organs and the musculoskeletal system). This present chapter will highlight these increasing rates that will have to be frequently managed in the near future, and the prevalence and incidence of these chronic illnesses in aging adults will be reviewed. These rates will also be compared to those in the population as a whole. Other related issues will also be discussed, such as potential methods to help "slow down" the development of these chronic illness problems; how to potentially better manage them when they occur; and how/who will pay for this large chronic illness management crisis?

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Prevalence of Major Chronic Illnesses

An important distinction between *prevalence* and *incidence* needs to be made. *Prevalence* refers to the actual number of people who currently have a known illness (including those just diagnosed in the recent year). It reflects the burden of the illness, taking into account old cases plus new cases. In contrast, *incidence* refers to the number/percentage of new cases reported in a single year.

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Thus, *prevalence* tells us how widespread an illness is in a population, whereas *incidence* tells us the number of new cases of an illness in the population within a specific year. It should also be noted that, although the prevalence among deaths is important in demonstrating a broader picture of all the cases of illnesses for a period of time, the incidence rate of mortality reflects the number of deaths for each illness within a specific 100,000 of the population that arose in that same year. This specified population size makes it easier to compare how fatal each illness is, on the average level, compared to the overall prevalence rate. For example, an illness might be more prevalent in the Hispanic population in a certain region because of some virus which may be a huge "outlier" in the prevalence rate calculated based on the whole population. However, because the incidence rate is strictly based out of (in this case) 100,000 random residents, it reveals a more stable number of cases per illness and thus is more difficult for "outliers" to significantly alter the overall data.

Table 1.1 breaks down the prevalence of chronic illnesses by the "population as a whole" and for those who are "60 years of age and older." As can be seen from the health statistics of the Chronic Disease Center in 2014, the comparative rates are relatively similar, especially in light of two important factors: the absolute number of people in the "population as a whole" is much greater than that of those "60 years of age and older," and there are fewer members in the "60 years of age and older" sample, relative to the "whole population" (National Center for Health Statistics, 2016). Thus, overall, these data document the growing prevalence of chronic illnesses in our aging population.

Table 1.1 Prevalence of chronic illnesses

Population as a whole[a]	60 years and older[b]
Heart disease: 614,348/23.4%	Heart disease: 489,722/22.5%
Malignant neoplasm (cancer): 591,699/22.5%	Malignant neoplasm (cancer): 413,885/21.5%
Chronic lower respiratory disease: 147,101/5.6%	Chronic lower respiratory disease: 124,693/6.5%
Cerebrovascular disease (stroke): 133,103/5.1%	Cerebrovascular disease (stroke): 113,308/5.9%
Alzheimer's disease: 93,541/3.6%	Alzheimer's disease: 92,604/4.8%
Others: 39.8%	Others: 35.8%

[a]Period prevalence in 2014 out of 2,626,418 deaths (CDC, 2016) numbers/percentage
[b]Period prevalence in 2014 out of 1,922,271 deaths (CDC, 2016) numbers/percentage

Incidence of Major Chronic Illnesses

Similar to Table 1.1, Table 1.2 breaks down the incidence of chronic illnesses. As can readily be seen, the incidence rates of chronic illnesses in older adults are, as would be expected, higher in older adults. Other patterns that should be noted are as follows:

- Heart disease and cancer are the number 1 and number 2 illnesses.
- Period prevalence and incidence of death rates are in the same order for the "population as a whole," but not among older adults.
- Surprisingly, Alzheimer's disease is not seen in the top five of incidence rates for older adults.

Review of More Specific Types of Chronic Illnesses

In this section, we will review in greater detail even more specific types of chronic illnesses, as well as brief descriptions of them. It should also be noted, though, that many will be discussed in even much greater detail in subsequent chapters of this handbook.

Table 1.2 Incidence of chronic illnesses

Population as a whole[a]	60 years and older[b]
Heart disease: 167.0	Heart disease: 5,376.3
Malignant neoplasm (cancer): 161.2	Malignant neoplasm (cancer): 3,361.9
Chronic lower respiratory disease: 40.5	Cerebrovascular: 1,269.9
Cerebrovascular disease (stroke): 36.5	COPD: 822.3
Alzheimer's disease: 25.4	HIV: 3.5

[a]Incidence of death rates per 100,000 in 2014 (CDC, 2016)
[b]Incidence of death rates per 100,000 in 2014 (CDC, 2016)

Hypertension

What Is Hypertension (High Blood Pressure)?

High blood pressure causes an increased force exerted by the blood in a "bush/bounce pattern" against the walls of the arteries, which can eventually lead to damage to the heart (MacGill, 2017). Hypertension is known as the "silent killer," because it happens without warning signs. It is most often seen in adults (18+ years; MacGill, 2017). There are two types of hypertension:

- *Primary hypertension* is not due to a specific factor, but, rather, it is caused by multiple variables, such as an imbalance of the hormonal regulation of blood pressure and volume. It is also influenced by environmental factors that include unhealthy lifestyle habits (MacGill, 2017).
- *Secondary hypertension* has a cause leading to it. For example, a hormone disorder may cause an imbalance between sodium and potassium levels, resulting in the elevation of blood pressure (MacGill, 2017).

Prevalence of Hypertension

One-third of adults in the United States (about 75 million people) have hypertension, and only about 54% of the patients have their condition under control (MacGill, 2017). Hypertension also increases the risk for stroke and heart disease – two of the main causes of death in the United States. The prevalence of adults over 60 years is 60–70%. Table 1.3 breaks down this illness by age (MacGill, 2017).

Symptoms and Treatments

Generally speaking, hypertension is asymptomatic (no direct symptoms are directly experienced), but a 180 mmHg (millimeters of mercury) or higher systolic reading and a 110 mmHg or higher diastolic reading are warning signs of hypertension (MacGill, 2017). Normal blood pressure is below 120 systolic and 80 diastolic. Treatments can include medications prescribed by a physician if necessary, such as diuretics (MacGill, 2017). Otherwise, self-care helps lower hypertension (MacGill, 2017). Indeed, hypertension can be stimulated by acute stress, anxiety, excitement, or overly exerting physical activities. Table 1.4 provides a brief summary of some methods that individuals can employ to prevent the sudden development of hypertension (MacGill, 2017).

Table 1.3 Prevalence of hypertension by age

About 6.8% ages 18–39 have hypertension
About 30.4% ages 40–59 have hypertension
About 66.7% ages 60 and older have hypertension

High Blood Cholesterol

What is *hypercholesterolemia* (high blood cholesterol)? Cholesterol is a waxy fat-like substance that the body needs to produce certain hormones, Vitamin D, and other substances for digestion (National Heart, 2013). High blood cholesterol (*hypercholesterolemia*) is the excessive amount of cholesterol in the blood that can build up on the artery walls, which puts one at increased risk for heart disease and stroke, two of the main leading causes of death in the United States (National Heart, 2013). The prevalence of it in older adults ages 55–64 is about 47.8%, and for ages 65–74, it is about 37.2% (National Heart, 2013). There are two types of cholesterol:

- *Low-density lipoprotein (LDL)* or "bad" cholesterol. This type of cholesterol makes up the majority of the cholesterol in the body and is known as "bad" cholesterol because the

Table 1.4 Some methods to prevent the sudden onset of hypertension

Check your blood pressure regularly
Engage in healthy lifestyle habits (e.g., appropriate sleep, exercise, etc.)
Limited/no smoking or drinking
Healthy diet (low in sodium [salt] and saturated fat but high in fibers, vegetables, and fruits)
Exercise (at least three times a week), and remain active

excessive amount of LDL produces the plaque buildup of cholesterol on the artery wall, which then may lead to stroke and heart disease (coronary heart disease). The ideal level of LDL is less than 100 milligrams of cholesterol per deciliter of blood (mg/dl) (National Heart, 2013).

- *High-density lipoprotein (HDL)* or "good" cholesterol. This type is responsible for the absorption of cholesterol and delivers it to the liver, where the cholesterol gets "flushed out" of the body. HDL is known as "good" cholesterol because having an excessive amount of HDL can lower the risk of a person for a stroke and heart disease. The ideal level of HDL is less than 40 mg/dl (National Heart, 2013).

Two other measures relating to LDL and HDL are frequently evaluated when a blood test (lipoprotein panel) is performed:

- *Triglycerides*. This is a type of fat that is used for energy and is found in the blood. The combination of high triglycerides, low HDL, and high LDL increases the risk of heart attack and stroke. A high level of triglycerides is >200 mg/dl (National Heart, 2013).
- *Total cholesterol*. This is the total amount of cholesterol in the whole body, which is composed of the LDL, HDL, and triglycerides levels. The ideal level of total cholesterol is less than 200 mg/dl (National Heart, 2013).

Prevalence of Hypercholesterolemia

Approximately 31.7% (about 73.5 million adults) have high blood cholesterol in the United States. Patients with hypercholesterolemia have twice the risk of developing cardiovascular diseases, relative to people without hypercholesterolemia (National Heart, 2013). Unfortunately, less than one-third of adults (about 29.5%) have their condition under control (National Heart, 2013). Moreover, less than one-half of adults (about 48.1%) who have high low-density lipoprotein (LDL), or "bad" cholesterol, receive treatment for it. Finally, about 31 million adults have a total cholesterol level greater than 240 mg/dl (National Heart, 2013). The prevalence by age is as follows:

- About 88.8% of ages 45–64 have hypercholesterolemia (National Heart, 2013).
- About 94.7% of ages 65 and older have hypercholesterolemia (National Heart, 2013).

Symptoms and Treatments

Hypercholesterolemia is often asymptomatic (i.e., the patient experiences no symptoms). The ideal level of blood cholesterol is less than 200 mg/dl (National Heart, 2013). Treatments may include medications, such as statins, exercise, and a healthy diet (National Heart, 2013). Table 1.5 provides a brief summary of methods that individuals can employ to prevent hypercholesterolemia.

Table 1.5 Summary of methods to prevent hypercholesterolemia

Regularly check blood cholesterol level through the lipoprotein panel blood test
Engage in healthy lifestyle habits (e.g., low-fat diet)
Exercise and remain active
Quit or at least limit smoking or drinking

Upper Respiratory Conditions (Allergies)

Upper respiratory conditions include different pathological conditions that affect other organs, as well as the upper respiratory tract (Langtree, 2015). Their prevalence in older adults is about 13.5%. These respiratory disorders can be classified into four categories: obstructive conditions, such as emphysema, bronchitis, and asthma attacks; restrictive conditions, such as fibrosis, sarcoidosis, alveolar damage, and pleural effusion; vascular diseases, such as pulmonary edema, pulmonary embolism, and pulmonary hypertension; and infectious, environmental, and other diseases, such as pneumonia, tuberculosis, asbestosis, and particular pollutants (Langtree, 2015). Some of the most common respiratory disorders are:

- *Chronic obstructive pulmonary disease (COPD)*. This condition causes irritation to the lungs. COPD also leads to other respiratory disorders, such as asthma and emphysema (Langtree, 2015).

- *Chronic bronchitis***.** When the bronchi and bronchioles are irritated, they will cause an increase in the secretion of mucus (Langtree, 2015).
- *Emphysema.* This condition occurs when the soft/fine walls of the alveoli break down, which causes a reduction in the gas exchange (Langtree, 2015).
- *Asthma*. This condition involves episodes of chest tightness and breathlessness (Langtree, 2015).
- *Pneumonia.* This condition occurs when the alveoli get infected, which then causes problems in breathing, and the patients might need to be put on oxygen (Langtree, 2015).

Prevalence of Upper Respiratory Conditions

About one billion cases of common colds occur each year in the United States (COPD Foundation, 2017). Some other statistics to consider are:

- About 6.8 million emergency department visits for respiratory conditions by individuals under the age of 18 years old occur in the United States (COPD Foundation, 2017).
- Respiratory disorders are most common among children (COPD Foundation, 2017).
- About 24 million Americans suffer from COPD, and it is the fourth leading cause of death in the United States (COPD Foundation, 2017).
- About 5–10% of adults, ages 60 and older, suffer from upper respiratory conditions (allergies) (COPD Foundation, 2017).
- Respiratory disorders can often be inherited (COPD Foundation, 2017).

Symptoms and Treatments

The causes of these conditions vary from one person to the next. However, the most common causes include allergies and other environmental factors (Langtree, 2015). Symptoms can also vary from one condition to another, but most of the common symptoms include coughing with mucus and fever (Langtree, 2015). Finally, below is a brief summary of prevention methods.

- Take medication as prescribed and on time (Langtree, 2015).
- Reduce or eliminate smoking (Langtree, 2015).
- Exercise and remain active (Langtree, 2015).

Arthritis

Arthritis literally means joint inflammation: "joint (arthro) inflammation (itis)." Arthritis is a medical term used to describe 200 rheumatic diseases (Nichols, 2015). Its prevalence in older adults is about 13.0%. The most common form of arthritis is *osteoarthritis* (the degeneration of joint cartilage and the bone underneath) (Nichols, 2015). Other types of arthritis include rheumatoid arthritis, gout, and fibromyalgia. Arthritis is more common in woman than in men, and the risk is increased by age of the person (Nichols, 2015).

Prevalence of Arthritis

About 54.4 million adults in the United States (27.2% annually) have arthritis. An estimated 78 million, which is about 26% of adults (>18) in the United States, will be diagnosed with arthritis by 2040 (Nichols, 2015). A total of 26% of women, and 19.1% of men, have been diagnosed with arthritis, putting women at a higher risk for arthritis than men. Table 1.6 breaks down the prevalence of arthritis by age (Nichols, 2015).

Symptoms and Treatments

The causes of arthritis vary according to the type. Potential causes include injury, abnormal metabolism, genetic makeup, infections, and/or immune

Table 1.6 Prevalence of arthritis by age

From ages 18–44, about 7.1% were diagnosed with arthritis
From ages 45–64, about 29.3% were diagnosed with arthritis
From ages 65 and older, about 49.6% were diagnosed with arthritis

system dysfunction (Nichols, 2015). Symptoms also vary depending on the type of arthritis and may include pain, swelling, stiffness, and difficulty moving the joints. Potential tests conducted also depend on the type of arthritis. Tests that can detect arthritis include joint X-ray, rheumatoid factor, and complete blood count (CBC) (Nichols, 2015). Treatments include medications, such as nonsteroidal anti-inflammatory drugs (NSAIDs), surgery, and physical therapy (Nichols, 2015). Some methods to better manage arthritis include:

- Appropriate physical activities can reduce arthritis pain (Nichols, 2015).
- Maintain a healthy weight (Nichols, 2015).
- Patient education and support (Nichols, 2015).

Asthma

Asthma is a disease that affects the lungs, which causes episodes of chest tightness and breathlessness. The test used to diagnose asthma is called *spirometry*, and this test detects the amount of air and the speed a person can blow it out of the lungs (Rettner, 2014). Symptoms of asthma may include a wheezing sound, coughing, and fast breathing. The main cause of asthma is not completely known, although factors such as genetics, as well as environmental factors (which include air pollution, tobacco smoke, cold air, and food allergies) have been implicated (Rettner, 2014).

Prevalence of Asthma

The prevalence of asthma in older adults is approximately 7.8%. Also, the following statistics should be noted:

- 6.8 million children (about 8.4% of children) have asthma in the United States (Rettner, 2014).
- 18.4 million adults (about 7.6% of adults) have asthma in the United States (Rettner, 2014).
- 7 million out of the 25 million Americans who have asthma are children (Rettner, 2014).
- Greater than 10% of adults, ages 60 and older, suffer from asthma (Rettner, 2014).

Symptoms and Treatments

Treatments for asthma depend on its progression. There are two types of treatments prescribed by physicians, which can be administered by an inhaler with a holding chamber device (Rettner, 2014):

- *Quick relief*. This is an inhaler that should always be carried with the individual in order to treat asthma when it first starts, especially the "noisy part," such as coughing and wheezing.
- *Long-term control*. This type of medicine treats the major part of asthma, such as the inflammation of the airway (it can prevent asthma attacks).

Allergy shots (immunotherapy) can also be used to treat asthma if the trigger of the symptoms is an allergy such as pollen. Table 1.7 provides a summary of ways to prevent asthmatic attacks from occurring (Rettner, 2014).

Vision Problems/Blindness

Vision loss is a condition in which the vision of the eye cannot be corrected with glasses or contact lenses. Vision problems, if left untreated, can lead to blindness (Fries, 2005). Indeed, it should also be noted that, in a recent Lancet Global Health report, it was estimated that there has been a 17.6% increase in blindness (30.6 million in 1990–36.0 million in 2015) due to population growth and the increase in aging adults (Bourne et al., 2017). Approximately 1.4% of older adults now have such a condition. Common conditions that lead to vision problems/blindness (vision loss) include (Fries, 2005):

Table 1.7 Methods to potentially prevent asthmatic attacks

Get influenza and pneumonia vaccines
Know and avoid the triggers of asthma
Take the prescribed medications on time
Observe your breathing as an early sign of an attack

- *Amblyopia*. This condition is known as the "lazy eye," and it is the leading cause of vision loss in children. Amblyopia causes the impairment of vision due to the unusual development of the neural signals between the brain and the eye during childhood.
- *Strabismus*. Strabismus is a misalignment of the eyes, and this condition is the leading cause of amblyopia. The eyes are oriented in a different way, which causes the brain to receive a different visual input, which interferes with depth perception and binocular vision.
- *Refractive Errors*. This condition is one of the most common vision disorders in children. It causes blurred vision due to the unfocused light on the retina. Refractive errors include the following types (Fries, 2005):
  - *Myopia*. This condition is known as "nearsightedness," which enables the eye to see a clear image only for near objects. Therefore, faraway objects appear blurry.
  - *Hyperopia*. This condition is known as "farsightedness," which enables the eye to see a clear image only for faraway objects; therefore, nearby objects appear blurry.
  - *Astigmatism*. This condition is when the cornea or lens that causes the blurred vision is not corrected. Children who have amblyopia or hyperopia usually have astigmatism.

The prevalence of vision problems/blindness is included in Table 1.8.

Table 1.8 Prevalence of vision problems/blindness

About 3% of children, ages under 18 years, are blind or visually impaired
About 2% of children, ages 6–72 months, have *Amblyopia*, which is the leading cause of vision problems in children
About 2–4% of children, ages under 6 years, have strabismus
About 4% of children, ages 6–72 months, and about 9% of children, ages 5–17 years, have *myopia*
About 21% of children, ages 6–72 months, and about 13% of children, ages 5–17 years, have *hyperopia*
About 15–28% of children, ages 5–17 years, have *astigmatism*
About 30% of adults, ages 60 and older, have vision problems

Symptoms and Treatments

The causes of vision problems in children involve factors such as watching TV very closely, squinting the eyes too much, and rubbing the eyes. Vision problems usually cannot be detected by the naked eye of another person (Fries, 2005). Thus, vision screenings can help in detecting vision problems that can potentially lead to blindness. Visible symptoms could include swelling, redness, and white material in the pupil (Fries, 2005). Treatments may include surgery, eye patches, or eye drops, as well as prescription lenses. In terms of prevention, one should get vision tests for the child immediately once you notice any symptoms of vision problems as untreated vision problems can lead to vision loss/blindness. Therefore, seek medical attention immediately (Fries, 2005).

Comorbidity of Physical and Mental Health Illnesses

In the elderly, one major problem in successfully managing chronic illnesses is the fact that there are frequently many comorbid illnesses concurrently present. Moreover, in addition, there are usually comorbid mental health problems that need to be simultaneously managed. This may become a "management nightmare" if not effectively coordinated among healthcare providers. For example, in a recent review by Polatin, Bevers, and Gatchel (2017), these authors highlighted that one type of common comorbidity (chronic pain and depression in adults, which is approximately 50–65% of the population) results in physical and cognitive declines; concurrent multiple health conditions; and complex medication regimens that all add to the unique and complex challenges of effectively treating pain and depression, particularly in geriatric populations. Interdisciplinary physical/mental health interventions and monitoring for psychiatric sequelae (such as depression, cognitive change, and synergistic physical side effects) are necessary. Such interdisciplinary programs are now available for such complex comorbid pain and depression problems (e.g., Gatchel, McGeary, McGeary, & Lippe, 2014).

Mood Disorders

Mood disorders are conditions that affect a person's quality of daily life, especially emotionally. These disorders include depression, mania, bipolar disorder, and depression (MedlinePlus, 2017). Anyone can experience a mood disorder, but they are more prevalent in those with a chronic illness. In older-age adults, the prevalence is about 10.6%. The most common types of mood disorders include (MedlinePlus, 2017):

- *Major depression*. This condition is when one feels sad, cries a lot, and has no interest in activities.
- *Dysthymia*. This condition is a chronic and depressed mood that lasts for at least 2 years.
- *Bipolar disorder*. This condition is when the patient experiences episodes of mood changes that alternately go between depression and mania.
- *Mood disorder related to another health condition*. This refers to other medical illnesses that lead to symptoms of depression.
- *Substance-induced mood disorder*. This condition causes depression due to chronic use of medications.

Prevalence of Mood Disorders

Among the population, aged 18 and older, about one in ten people suffers from a mood disorder. Approximately 20.9 American adults (or 9.5%, ages 18 and older) suffer from mood disorders (MedlinePlus, 2017). Also, disabilities among Americans ages 15–44 are caused by a major depressive disorder. Finally, about 15% of adults, ages 60 and older, suffer from mood disorders (MedlinePlus, 2017).

Symptoms and Treatments

Symptoms of mood disorders include feelings of guilt, worthlessness, recurring thoughts of death or suicide, depression, changes in appetite, and insomnia. Treatments for mood disorders include medications, cognitive-behavioral therapy (CBT), or both if needed, as well as seeking help from a support group (MedlinePlus, 2017). Table 1.9 includes methods for managing mood disorders.

Table 1.9 Methods for managing mood disorders

Follow instructions when taking medication
Exercise, eat healthily, and get enough sleep
Talk with someone if you feel depressed or have a thought about death or suicide
Learn about your illness, and talk to your physician and significant others if something goes wrong, so that they can help you

Attention-Deficit/Hyperactivity Disorder (ADHD)

Attention-deficit/hyperactivity disorder (ADHD) is a condition that decreases individuals' ability to focus, pay attention, and control their behavior. They may also be excessively active and impulsive (WebMD, 2005). ADHD usually begins in childhood and adolescence but can continue into adulthood (WebMD, 2005).

Prevalence of ADHD

- For children 5–17 years of age, about 10.2% were diagnosed with ADHD (between 2012 and 2014) (Centers for Disease Control and Prevention, 2017).
- For boys 5–17 years of age, about 14.1% were diagnosed with ADHD (Centers for Disease Control and Prevention, 2017).
- For girls 5–17 years of age, about 6.2% were diagnosed with ADHD (Centers for Disease Control and Prevention, 2017).
- Boys are two or three times more at risk for ADHD than girls (Centers for Disease Control and Prevention, 2017).
- The number of healthcare visits for patients diagnosed with ADHA is about nine million (Centers for Disease Control and Prevention, 2017).

- About 4.2% of adults, ages 60 and older, have ADHD (Centers for Disease Control and Prevention, 2017).

Symptoms and Treatments

Some of the symptoms of ADHD include individuals who easily get annoyed, appear angry, do not follow the rules, and cannot handle frustration. This condition could have physical symptoms as well, including a headache, fever, and shaking (WebMD, 2005). Typical treatments include medications such as Ritalin (a long-acting stimulant), as well as functional behavioral assessment tests that can help in detecting behavioral problems and eventually help to control those behaviors (WebMD, 2005). It should also be noted that, in a recent study by Sagar, Miller, and Erdodi (2017), the faking of ADHD in adults may be a significant problem in clinical settings. This may be due to the motivation to acquire academic/work accommodations or access to controlled substances (such as Ritalin) (WebMD, 2005).

Prevention and Early Intervention

If parents/teachers notice any unusual or abnormal behaviors on how an individual is acting, they should seek medical help immediately from a mental health professional (WebMD, 2005). It should also be noted that if this condition is left untreated, it could cause negative short-term and long-term effects, such as fighting, losing one's job, and not being able to maintain a relationship (WebMD, 2005).

Anxiety Disorders

Anxiety is a mental health disorder which makes one feel fearful and worried a great deal of the time, without a particular acute reason. It may eventually get worse and interfere in every aspect of a person's life, which can lead to many symptomatic changes, such as loss of sleep (insomnia) (ADAA, 2017). The most common types of anxiety include the following (ADAA, 2017):

- *Generalized anxiety disorder (GAD)*. This condition is when one feels worried all the time, even when there is nothing to worry about. This disorder is common among teenagers but also affects about 6.8 million adults or 3.1% of the US population. Its prevalence in adults 60-year or older is about 1.7%.
- *Panic disorder* (characterized by anxiety or panic attacks). This condition is characterized by excessive anxiety, which causes one to panic over small matters. This condition affects about six million people (2.7% of the US population).
- *Obsessive-compulsive disorder (OCD)*. A person with this condition (such as continually working one's hands) will struggle to end the same obsessive-compulsive actions repeatedly. This condition affects about 2.2 million people (1.0% of the US population).
- *Phobia*. This condition is characterized by an intense fear of something that should not normally cause fear. This condition affects about 19 million people or 8.7% of the US population.
- *Social anxiety disorder*. This condition is characterized by being afraid to be judged by others and always avoiding crowds/gatherings. This condition affects about 15 million people or 6.8% of the US population.
- *Post-traumatic stress disorder (PTSD)*. This condition is characterized by a feeling of fear and stress when there is not a current danger present. It is the result of being exposed to an intensely traumatic event in the past. This condition affects about 7.7 million people or 3.5% of the US population.

Prevalence of Anxiety Disorders

- Anxiety disorders are more common in women than in men, and it is the most common mental health disorder in the United States (PsychGuides.com, 2017).
- About 18% people who suffer from anxiety will attempt suicide (PsychGuides.com, 2017).
- About 39% people who suffer from anxiety have suicidal thoughts almost daily (PsychGuides.com, 2017).

Table 1.10 Advice for managing anxiety disorders

Seek help immediately when you feel overwhelmed
Exercise on a regular basis and have a healthy diet
Talk to your physician and/or significant other about the anxiety
Attend treatment sessions, as prescribed

- About one-third of people suffering from anxiety seek treatment for it (PsychGuides.com, 2017).
- About 10% of individuals, ages 60 and older, suffer from anxiety (PsychGuides.com, 2017).

Symptoms and Treatments

- Symptoms of anxiety vary from one condition to another. It can be physical (such as stomach cramps) or emotional (such as fear). General symptoms also include insomnia and poor performance at work or school (ADAA, 2017).
- Treatments for anxiety include medications such as antianxiety drugs, as well as cognitive-behavioral therapy (CBT) (ADAA, 2017).

Table 1.10 provides advice for dealing with anxiety disorders.

Some Noteworthy Chronic Illness Patterns

Why Does Heart Disease Have the Leading Prevalence in Both the "Whole Population" and 60+ Adults?

It was already known that heart disease was the leading health problem in America decades ago because the risk factors associated with getting the disease are so easily achievable. The risk factors for chronic heart disease include, but are not limited to, being overweight or physically inactive, having a family history of the disease, eating an unhealthy diet, or just aging in general. However, there were some key historical events that made our nation to start living a more sedentary lifestyle. According to the documentary *The Hidden Epidemic: Heart Disease In America*, the underlying roots that made heart disease even more prevalent were the increasing ownership of cars, the invention of television, change in diet, and a trend toward cigarettes. In the 1920s, cars were a major source of freedom, and the average family increased from having one to two cars. Instead of walking, more and more people started driving to work and visit places that might have been only a few blocks away. A few years later, the television was invented, creating the complete antithesis to exercise. Then, surviving through the depression and World War II changed the mindset of Americans as a well-deserved celebratory period, who began indulging on sweets and fast food (Arledge, 2007). Thus, the trend toward convenient but rich and fatty foods is what the American diet is mostly known for today. Lastly, the government had issued cigarettes to every soldier, who then brought them back home; soon, a great majority of Americans started smoking. These specific events are the root causes of higher blood pressure and cholesterol, as well as an explanation of why heart disease is so common in the present United States.

Why Is There Such a Huge Gap Between Cancer (22.5%) and Chronic Lower Respiratory Disease (CLRD; 5.6%)?

Malignant neoplasm or cancer is a disease in which cells divide rapidly, resulting in tumors that can form anywhere in the body. One of the reasons why the prevalence of cancer may be so high, compared to the next prevalent chronic illness, is because of the many types of cancer that are covered under this "umbrella term," including skin, lungs, breast, prostate, colon/rectum, and the cervix/uterus. Meanwhile, CLRD consists of chronic bronchitis, emphysema, and asthma. Another reason why cancer is so much more prevalent than CLRD is that of the same reason with heart disease – the risk factors are common, such as exposure to sunlight and radiation, obesity, diet, hormones, and alcohol among others. As generations pass, the average life expectancy continues to grow, and the cause of death is from being unhealthy, while, years ago, the majority of people would have died from other weaker illnesses before they even got cancer. CLRD, on the other hand, has a fewer number of risk factors associated with obtaining the illness. The major risk factors are direct smoking, exposure to secondhand smoking, and air pollutants.

Chronic Illness Risk Factors

In general, there are four major behaviors that constitute negative health risks for anyone: little physical activity, poor nutrition, tobacco use, and alcohol consumption (Centers for Disease Control and Prevention, 2016). Chronic illnesses can be frightening because an individual living an unhealthy lifestyle for a long period of time can experience a "domino effect," from something as simple as a bad diet or lack of physical activity to high cholesterol and blood pressure levels to something as deadly as heart disease. Although these behaviors can lead anyone to develop a chronic illness, people with physical and mental health conditions are more likely to be at risk because of the higher possibility of obesity and depression. When observing by social class, the majority of deaths due to noncommunicable diseases come from middle- to low-income families because of the costs of prevention programs that these families cannot afford (Alwan, Armstrong, & Branca, 2015).

Older adults are also at high risk because chronic illnesses increase with age, but, in the very elderly (around 80 years or older), the prevalence declines due to greater mortality within this age group (Kahn et al., 2015). Chronic illness is most common in the 60–80 years of age portion of the population because organs deteriorate over time, as arteries become narrower/clogged or the body may not be producing enough insulin. This can lead to hypertension, heart disease, stroke, and diabetes. The physicality of the body also deteriorates, resulting in arthritis and causing a "chain reaction" of making it difficult for seniors to keep up with a healthy diet, regular sleep routine, and exercise. Lacking these essential healthy lifestyle habits may also put people at greater risk for depression, obesity, and dementia. Finally, in a more comprehensive review of the basic risk factors of the leading causes of death in the United States, Taylor (2015) delineated those presented in Table 1.11.

Table 1.11 The major risk factors for the leading causes of death in the United States

Illness	Risk factors
Heart disease	Tobacco use; obesity; diabetes; high cholesterol and blood pressure levels; physical inactivity; stress
Stroke	Tobacco use; obesity; diabetes; high cholesterol and blood pressure levels; physical inactivity
Cancer	Tobacco use; unhealthy diet; environmental factors
Chronic lung illness	Tobacco use; environmental factors (e.g., pollution, random exposure; asbestos exposure)
Accidental injuries	On the road (failure to wear seat belts); in the home (falls; fire; poisons)

Adapted from (Taylor, 2015)

Taylor (2015) also has discussed the importance of good health habits in order to prevent the development of chronic illnesses, such as eating breakfast every day, not eating between meals, sleeping 7–8 h per night, being no more than 10% overweight, not smoking, not having more than one or two alcoholic drinks each day, and getting regular exercise every day. Methods to reduce these risk factors were also reviewed by Taylor (2015).

Methods to Better Manage Illness Development

There are two major organizations that are working hard to find new methods and implement the ones that work, in order to slow the development of chronic illnesses. The Centers for Disease Control and Prevention (CDC) has a program called the *Four Domains* of CDC that does just that. The *first domain*, epidemiology and surveillance, finds disease patterns by tracking multiple data sources, such as birth and death certificates, as well as cases of cancer death. They also conduct cancer screening and try to spread the message about the ABCS (aspirin use, blood and cholesterol control, and smoking) for heart disease and stroke prevention. Within this *second domain*, environmental policies have been passed for healthier lifestyles, such as smoke-free air laws, banning artificial trans fat and flavored cigarettes, and making unhealthy products more expensive. The *third domain* is all about intervening the healthcare system and improving clinical treatment delivery, whether it was for the Affordable Care Act, the government, or public health organizations. Lastly, community programs are also being linked to clinical services in order to increase self-management programs and try to partner with hospitals for better benefits (the *fourth domain*). There is also an encouragement to seek different types of healthcare workers, whether it is a therapist, dietician, or pharmacist to find the best treatment.

Similarity, the World Health Organization (WHO) tries to tackle the risk factors for chronic illnesses with their four categories. The first category is prevention, in which four departments each focus on different types of noncommunicable diseases (NCD) – risk behaviors. The *Tobacco Free Initiative* has already added tobacco taxation and reduced the public demand for tobacco. *Health Promotion* tries to integrate oral health and educate the public in general. *Surveillance and Population-based Prevention* promotes physical activity, nonalcoholic beverages, and a healthy diet, especially for children. The last category, *mHealth*, uses technology to improve healthy habits. The second category is all about detection, screening, treatment, and palliative care, as well as taking care of health insurance. The third category is *surveillance* to monitor exposures (in other words, look at behavioral factors, physiology, metabolic rate, and social determinants), monitor the outcomes, and work with the health system on infrastructure and other policies. Lastly, the *Global Coordination Mechanism* category raises awareness of the global action plan, shares knowledge based on scientific evidence, and mobilizes resources on an international scale.

Socioeconomic Implications of the "Graying of Societies"

As has been noted by Hartzell and colleagues (Hartzell, Mayer, Neblett, Marquardt, & Gatchel, 2015), besides the enormous economic medical cost burden of managing chronic illnesses in older adults, there are also more far-reaching socioeconomic costs. For example, they cited a unique investigation which was conducted in Australia by Schofield et al. (2011) addressing this socioeconomic issue, using a cross-sectional analysis of the base population of that country. It was found that, for workers (aged 45–64 years) who had to retire early due to a chronic illness (in this case, a spinal disorder), when compared to workers who were fully employed with no illness conditions, these former workers were associated with a significant "economic drain" on the country, in terms of lost income taxation and increased social/medical benefit payments. As more succinctly summarized by Gatchel and Schultz (2014), the following staggering costs were associated with the early retirement individuals:

- They had 79% lower income, relative to those individuals employed (who earned four times more).
- They paid 100% less in taxes.
- They also received 21% more via government welfare support payments.

As further noted by Gatchel and Schultz (2014), the above costs had a major economic impact on Australia as a nation: AU$4.8 billion was lost in annual individual earnings, AU$622 million in additional welfare payments, AU$497 million in taxation revenue for the government, and AU$2.9 billion in gross economic product for the country. To put this in a greater perspective, the above total economic cost for Australia was approximately AU$9 billion (which computed to US$9.4 billion) in a country of only 22 million citizens (or AU$269 per capita; Dagenais & Haldeman, 2012). Finally, as highlighted by Gatchel and Schultz (2014), "If such figures were extrapolated for the USA, the financial costs to the government would be AU$82 billion (US$85 billion)!" (p. 488); and this was only for spinal disorders. If other chronic illnesses were taken into account, they would "break the economy" for future generations in the United States and other countries. With the changing healthcare system still evolving in the United States, it is difficult to imagine how the government will be able to absorb such high financial costs.

In the next section, we will review the financial issues related to some of the major chronic illnesses discussed earlier in this chapter.

Stroke (Cerebrovascular Diseases)

Local health services and social services now assess the level of support needed and provide a support package and financial aid for living in a care home. This is based on an assessment consisting of looking at the patient's income, savings, property, benefits currently being received, and financial assets. Also, the National Health Service (NHS) allows for ongoing payment of home fees and medical care for people needing specialist treatment.

Heart Disease (Cardiovascular Disease)

As noted earlier, the cost of heart disease was about $444 billion in 2010 in the United States (Hoffman, 2017). Helpful programs and resources include:

- *GoodRx*: A discount card used in a pharmacy (Hoffman, 2017).
- *Rx Outreach*: This program provides affordable generic and brand name medications to qualified patients according to their income (Hoffman, 2017).
- *NeedyMeds*: This program is to help patients find assistance programs to help them with their medication costs (Hoffman, 2017).
- *Eldercare Locator Community Assistance for Seniors*: This program provides senior citizens and their caregiver with sources of information, such as medication assistance (Hoffman, 2017).

Chronic Lower Respiratory Disease

The cost of oxygen alone each year is about $3 billion dollars. The cost for patients with COPD, Stage lll, is about $10,812 annually; Stage ll is about $5,037 annually; and Stage l is about $1,681 annually (West Virginia Health Statistics Center, 2006). Thus, the financial burden is quite high. Ways to pay for treatment include:

- *State-sponsored programs*: These programs are created to provide financial assistance or medical care for prescription assistance, medical equipment, medical supplies, disease screening, and other treatments.
- *Medicare information*: This is a federal insurance program for people 65 years of age or older, as well as people with a disability under the age of 65.
- *Medicaid sites*: This program helps low-income citizens by providing them medical care sites.
- *Medicare counseling (SHIP)*: This program provides health insurance counseling to Medicare recipients by providing grants to all 50 states and some territories.
- *Federal poverty guidelines*: This program allows patients to gain extra amounts of federal poverty level (FPL), if the patient's income is less than or equal to a certain percentage of FPL income.
- *Tax return request forms*: Patients who do not file a federal income tax and apply for assistance programs need to fill out and submit Form 4506-T.

Cancer

Who will aid in payment for these illnesses? Many are listed below:

- *Hill-Burton funds*: A federal grant that assists patients who are unable to pay by offering free or low-cost services (Aaron, 2015).
- *Government programs*: This includes state-sponsored children's health insurance programs, veteran and military benefits, and several other financial support programs for women with low incomes and who have breast or cervical cancer (Aaron, 2015).
- *Life insurance loans*: These might provide one with "ready cash" that can be used (Aaron, 2015).
- *Retirement plans*: Most of these plans allow withdrawing of funds early and without penalty (Aaron, 2015).
- *Friends and family*: Fundraisers help in the payment process (Aaron, 2015).
- *Home equity loan*: There is a possibility of taking a line of credit, or a lump sum, to assist in the payment process; but regular payments need to be paid monthly (Aaron, 2015).
- *Personal loans*: Taking a personal loan may also help, but it requires collateral to ensure payment back (Aaron, 2015).
- *Reverse mortgage*: If you are a homeowner and 62 or older, home equity can be converted into cash with the loan that will be repaid in the future. However, there are many disadvantages involved with reverse mortgages (Aaron, 2015).
- *Sale of assets*: One can check with a financial advisor to sell any real estate or investment in order to be qualified for some government-sponsored funding (Aaron, 2015).

Alzheimer's Disease

It should be noted that, according to statistics from the National Center for Health Statistics, the death rate from this disease in the United States is "creeping up." There were slightly more than 31 deaths per 100,000 people in the past year. This is up from 29 deaths per 100,000 people the year before (Ahmad & Bastian, 2017).

The following are the major financial resources for this disease:

- Medicare is the most beneficial for people over 65 years of age.
- Employee benefits available to those in the early stages of Alzheimer's
- Retirement plans, including individual retirement accounts (IRAs) and annuities
- Personal savings, including investments and personal property
- Government assistance through many public programs, such as social security disability income (SSDI), supplemental security income (SSI), veteran benefits, and tax deductions

HIV

The following are some of the potential financial resources available:

- Private insurance plans usually cannot deny coverage because of a pre-existing health condition.
- Medicaid.
- *The Ryan White HIV/AIDS Program* helps those without enough financial resources or coverage.
- *Health Center Program* provides HIV testing and delivery of care.
- Federal Programs for Women and Children, such as the Children's Health Insurance Program (CHIP) and Title V of the Social Security Administration (SSA).

Summary

In addition to the financial resources possibilities/agencies discussed above, it should also be noted that another chapter in the current handbook describes services provided by the *American Association of Retired Persons* (AARP), as well as other nonprofit organizations. Nevertheless, in spite of all these potential financial resources, they still fall short of covering the costs of the many chronic illnesses we have reviewed and discussed. Most governmental social medical programs around the world are under "financial siege" in meeting these monetary needs. For example, in the United States, the ill-fated President Obama's Affordable Care Act plan is now bankrupt, and politicians are still searching for more practical and affordable methods to accommodate these great costs. Moreover, with the "graying of America," things will only get financially more difficult as the "tsunami" of aging adults (with their chronic illnesses) continue to rapidly increase in the years to come.

Summary and Conclusions

America is amidst in a "graying revolution," with an increasing number of people turning 60+, as well as a growing concomitant pandemic of chronic illnesses. This leads to many significant issues, such as high financial costs, more deaths, and raising concerns within families. It is noticeable that the prevalence and incidence of all chronic illnesses are increasing and expected to continue to enormously do so over the next years, especially for the most prevalent diseases seen nationally – heart disease, cancer, chronic lower respiratory diseases, and cerebrovascular diseases. Although these noncommunicable illnesses affect all ages, the elderly are the main targets for most chronic illnesses due to several factors, such as having a weak immune system, possessing a degenerative disease, or living an inactive and unhealthy lifestyle. Indeed, it has been consistently found that adverse lifestyle habits (such as lack of physical activity, poor-quality diet, high body mass index, and smoking) are associated with excess mortality (Macfarlance, Barnish, & Jones, 2017). Thus, it is essential for those coping with one or multiple chronic illnesses, along with their families, to understand what exactly causes the illness, the symptoms, treatments, and where to find support to make their lives easier to manage.

As for how this nationwide increase of chronic illnesses will be paid for, even though there are some specific programs, charities, and local health services that help financially, most are paid through health insurances like Medicare and out of pocket. It is, however, becoming a growing concern of how expensive it will become to take care of someone with a chronic illness, not only because of the treatment but other factors that are often overlooked, such as multiple medications, rehabilitation, care home, and possible needed therapists, dieticians, and a host of other healthcare professionals. However, most government social medical programs around the world are already under "financial siege" to pay for such expenses. For example, in the United States, the ill-conceived President Obama's Affordable Care Act plan is now bankrupt, and politicians are uncertain as to develop a more practical and affordable one to meet both current and future financial demands.

In response to these crises, global organizations, such as the Chronic Disease Center (CDC) and the World Health Organization (WHO), each try to play a major role in the prevention and early intervention through their own programs. For the individual suffering from a chronic illness, four major factors should be kept in mind to reduce risks for worsening of conditions (remembering the acronym NESS): a healthy *n*utritional diet, with limits on tobacco and alcohol consumption; regular *e*xercise; maintaining a regular *s*leep pattern (7–8 h/night); and maintaining regular social *s*upport and interactions with others, which have a physical/mental health benefit. A key incentive to remember is that a healthy lifestyle helps not only physically but also mentally, as well as reduces other comorbid conditions such as anxiety and mood disorders. NESS should also be kept in mind by older adults who do not have a chronic illness, as a means of helping any early onset of one.

With the above in mind, a famous quote come to mind related to issues discussed in the present chapter:

> There were only two things certain in life: death and taxes. (Benjamin Franklin)

Indeed, taxes are inevitable because of the ever-growing economic demands on the government, in this case, healthcare costs for chronic illnesses that the United States still needs to develop a solution for.

Relatedly, the following quote is relevant because death is a certainty for all:

> Don't look back. Something might be gaining on you. (great baseball player Satchel Paige)

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Modifiability of Longevity and Quality-of-Life Predictors of Older Adults

2

Jessica Stephens, Mathew Fiedler, Michelle Lidell, and Robert J. Gatchel

Background

Longevity may be described as the amount of time a person has remaining in their lifespan, often measured in units of years (Rasmussen, Sander, Wewer, & Bohr, 2011). Extending longevity has been a focus of human civilization for thousands of years. Ideas of evading death and experiencing immortality may have been contemplated from the moment human beings established an understanding of their own impermanence.

The fear of eventual death motivated the quest of the central character in humankind's earliest known work of fiction, *The Epic of Gilgamesh*, written in 2000 BCE. Thereafter, the earliest record of an equivalent to the modern day notion of a fountain of youth was written about during the classical period of Greek philosophers. A yarn spun by Greek historian Herodotus in the fifth century (BCE) describes a mysterious spout in a Marcobian city which extended life to 120 years or longer for the lucky nearby inhabitants who encountered and imbibed from it (Zietzer & Hillmeister, 2014). Other early works written on immortality can be found in religious scriptures. Hindu scriptures describe the *atman*, or eternal spirit. Biblical Christian works describe the *soul* as an intangible quality of a person, which transcends matter and death (Edmondson, 2005).

Today, modern medical and scientific advances may result in enhanced healthy lifestyle sustainability and augmented longevity being a tangible reality. New developments are giving practical health promoting opportunities to individuals and communities. This may allow individuals to use novel approaches in taking control of their quality of life and to extend, to some degree, the amount of time they have left to enjoy it. As such, healthy aging and life extension have become increasingly important areas of focus to medical professionals. In the near future, many scientists and citizens alike hope that most people will be living longer lives which promise a higher degree of mental and physical health and well-being than has previously been possible.

This present chapter will present a collection of recent insights gathered from clinical studies, observational works, reviews, and other relevant scientific literature. The main focus of these works is to address the concept and implementation of quality-of-life (QoL) enhancement and longevity modification in the modern and future global society. Indicators of mortality, longevity,

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and wellness in advanced age will be further clarified, including an understanding health and aging: of the growing elderly population, regional influences, quality-of-life predictors, cultural influences, epigenetic studies, and the influence of physical fitness, nutrition and diet, stress, and social affiliation and isolation. Recent clinical studies and individual and national policy recommendations for addressing health in advanced age and recommendations for future directions of research in this area will conclude the chapter.

The Growing Population of Older Adults

At present, whether one is young or old, they can anticipate to live a longer life than did their recent and distant ancestors. For example, a child born in the UK today will likely live until they are 80, which is approximately double the lifespan of a child born in the middle of the nineteenth century who resided in the same area (Pickering & Kiely, 2018). The World Health Organization (WHO, 2015a, 2015b) estimates that the number of people over 60 will more than double by 2050, surpassing the two billion mark. The elderly will then outnumber children under the age of 5 for the first known time in history. By the year 2050, it is expected that the elderly population in poorer countries will be representative of about 22% of all citizens, while those in wealthier and more developed regions will be representative of about 33% of total citizens. These are two-fold increases in the proportion of the elderly than are currently represented within these regions (Rasmussen et al., 2011). These longevity trends may be due to a number of recent technological and accessibility advances in medicine, including reductions in infant mortality, improved prevention and management of acute and chronic illnesses, and other longevity-promoting quality-of-life shifts within local and global societies, such as improved education and technology access (World Health Organization, 2015a, 2015b).

Still, with a reduction in deaths from acute illnesses and an increase in average life expectancy, other health issues have now become concerning. Chronic diseases became the leading cause of death at the midway point of the twentieth century in America, and these types of illnesses are expected to continue to rise alongside average lifespan of elderly citizens (Remington & Brownson, 2011). This makes developing a framework for understanding the underlying mechanisms of healthy aging and quality of life particularly relevant for the growing population of citizens of advanced age. Relatedly, it may be important to understand the key contributors to early mortality. With this, we may better address, how these may be attenuated or prevented in those who are most at risk.

When describing what it means to be of advanced age, it is important to take into account one's disability and disease status, access to healthcare, quantity and quality of work hours, and socioeconomic status (SES). Also, one's lifespan is likely influenced by their culture and geographic area of residence. Therefore, age parameters assigned to distinctive stages of adulthood may depend on the average life expectancy within the region assigning them. Based on these factors, the World Health Organization (WHO, 2015b) describes an *older adult* as, "one who is above the age of 60, considered by their government to be of elderly status, and/or who is retired from their occupation." It should also be noted that the term *elderly* was discussed as being flexibly defined, as it interacts with longevity and general health, and may depend upon SES and regional considerations of its meaning (Beard, Officer, & Cassel, 2016).

The Centers for Disease Control and Prevention, as cited by Remington & Brownson (2011) described the relative contributions of several influences on *mortality*, a term describing the basis of a death. Lifestyle factors were said to contribute to roughly half of the influence on an individual's mortality, playing a bigger role on age of death than any other known element. Lifestyle influences are even estimated to surpass genetic influences by more than 2.5 times. The CDC suggested four key contributors to the most common fatal and chronic illnesses. In descending order, these mortality risk factors were tobacco use, poor diet, lack of exercise/inactivity, and excessive alcohol consumption (Remington & Brownson, 2011).

Regional Determinants of Life Quality and Longevity

As previously discussed, average life expectancy is rising across the world. This describes a broad, rather than narrow, trend, however. There are wide disparities in mental and physical health indicators and life expectancy in different regions and this disparity is further evidenced in the prevalence of disease presence, or *morbidity*.

Andreas et al. (2017) examined older European adult mental health trend variations with a mental health classification of functioning scale, the *European MenDis_ICF65+*. A total of 3142 participants with ages ranging from 65 to 84 years (mean = 73.7) were utilized. There was found to be an uptick for most mental disorders in this population, as compared to previous research findings. The higher prevalence of anxiety, depressive, and substance abuse disorders, the most common disorders reported, was discussed. Anxiety disorders averaged at 17.2% across regions with the highest rates present in England (20.8%). Ranges for depressive disorders varied from 4.7% to 19.7%, being described. The highest rates for depressive disorders were found in Geneva, Switzerland (25.7%), of elderly residents. Substance-abuse-related disorders were the third most present, with a mean of 8.9%, of the various mental health disorders assessed. Older residents of Geneva had the highest averages for substance-related disorders as well, at 12.7%.

In America, it has been recently suggested that there is a continued overall decline in mortality risk in the public (Beard et al., 2016). However, an exploration by Case and Deaton (2017) of data collected by the Centers for Disease Control (CDC; 1989–2013) and National Center for Health Statistics (NCHA; 2014–2015) actually indicates that mortality risk in America has shifted up, with average lifespan lowering in kind. It is possible that this trend is a temporary fluke. Still, the demographic characteristics of those most impacted by this recent development might be worth exploring for potential insight into indications of this regions lifespan shifts.

Case and Deaton (2017) found that male and female Caucasians without college degrees are now dying younger in the USA than in preceding years. This trend was partially explained by previous drops in cardiovascular disease-related deaths halting (and potentially reversing). Also, deaths from suicide, psychoactive substance use, and liver disease began to climb in this population. After analyzing death records and CDC and North Carolina Health Association (NCHA) health and mortality data, Case and Deaton (2017) noted that similar SES circumstances were found within other cultures during this time; however, mortality risk did not rise within these countries. Also, other ethnic groups in America, even those with similar financial backgrounds, experienced falling mortality rates at the same time. It was theorized that it may not simply be education level and income instability that explained increased mortality rates in uneducated whites. Rather, these factors may increasingly exaggerate one's mortality risk over their lifetime. This amassing of collective hindrances was referred to as "cumulative disadvantage." This was said to spark a snowball effect on health outcomes, starting in childhood. Low-SES children were more likely to attend poorly resourced schools, experience stress from poverty and deprivation, lack in safety and proper medical and dental attention, and to experience these and similar effects with increasing intensity over time. Conversely, those from middle class or wealthy backgrounds may continuously *benefit* from the resources and educational advantages that they experience from an early age onward.

Relatedly, many other nations, even highly impoverished ones, actually have *lower* mortality and disease prevalence than in America. The University of Michigan School of Medicine and School of Public Health researchers Assari and Lankani (2015) utilized records collected from 44,530 elderly citizens in 15 separate countries. Data collected from the *Research on Early Life and Ageing Trends and Effects* survey, which poses subjective health questions, was compared to a model of regional socioeconomic characteristics. Afterward, this analysis was combined with data on *multi-morbidity* or multiple chronic illnesses reported. *Multi-morbidity* measures were later compared to subjective health and socioeconomic factors. For residents of the USA (a high-income country), it was found that multi-morbidity explained much of the effect of income on self-reported health measures. Furthermore, higher income related to self-reported better health. It was also found that residents of the USA averaged substantially *earlier* mortality than those from the three *lowest*-income countries included in the analysis. US residents averaged about 17 years less in life expectancy than residents in China, about 7 years less longevity than residents of India, and about 9 years less in life expectancy than residents of Ghana, the lowest-income country included in the analysis.

Still, life expectancy in many poorly resourced nations is very low compared to other wealthy nations. In less developed regions, such as West Africa, the average lifespan in Sierra Leone was 46 in 2013. This is in sharp contrast to the average lifespan of many other, more developed regions, such as in Western Europe where, during the same year, the Swiss could expect to live until age 83 (World Health Organization, 2015a, 2015b). This may be related to socioeconomic characteristics being diversely spread across nations. It also may be due to available resources, from those of medicine, such as vaccinations, to those of basic survival, such as clean water access, which some countries possess in abundance and others may find scarce.

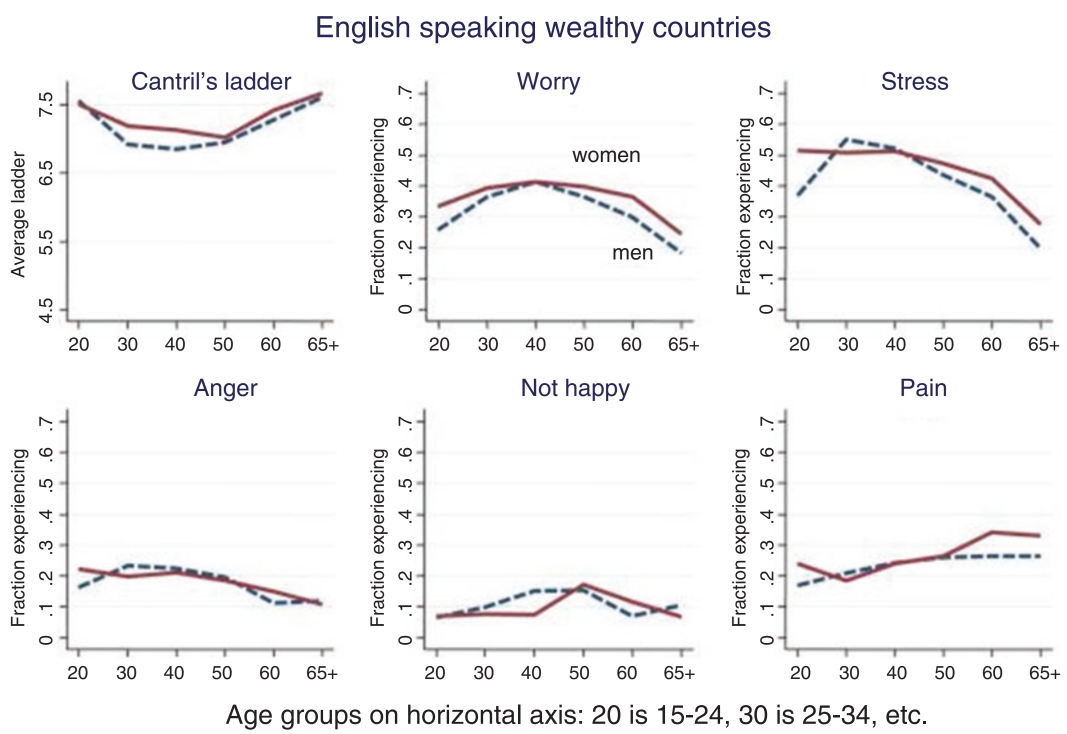
An examination of the World Health Organization's 2007–2010 *Study on Global Ageing and Adult Health* (SAGE) Wave-1 (2007/2010) by Arokiasamy et al. (2015) analyzed data collected on *morbidity* (single disease presence) and *multi-morbidity* (more than one disease present) in 42,236 adults. Single and multiple disease data was assessed in six diverse areas: China, Ghana, India, Mexico, Russia, and South Africa. It was found that the prevalence of overall morbidity in the pooled sample of six countries was 54.2%. Total multi-morbidity prevalence in these nations was found to be roughly 21.9%. Russia was determined to have the highest prevalence of multi-morbidity (34.7%), whereas China was found to have the lowest (20.3%). The likelihood of multi-morbidity was higher in older age groups and was lower in those of high SES.

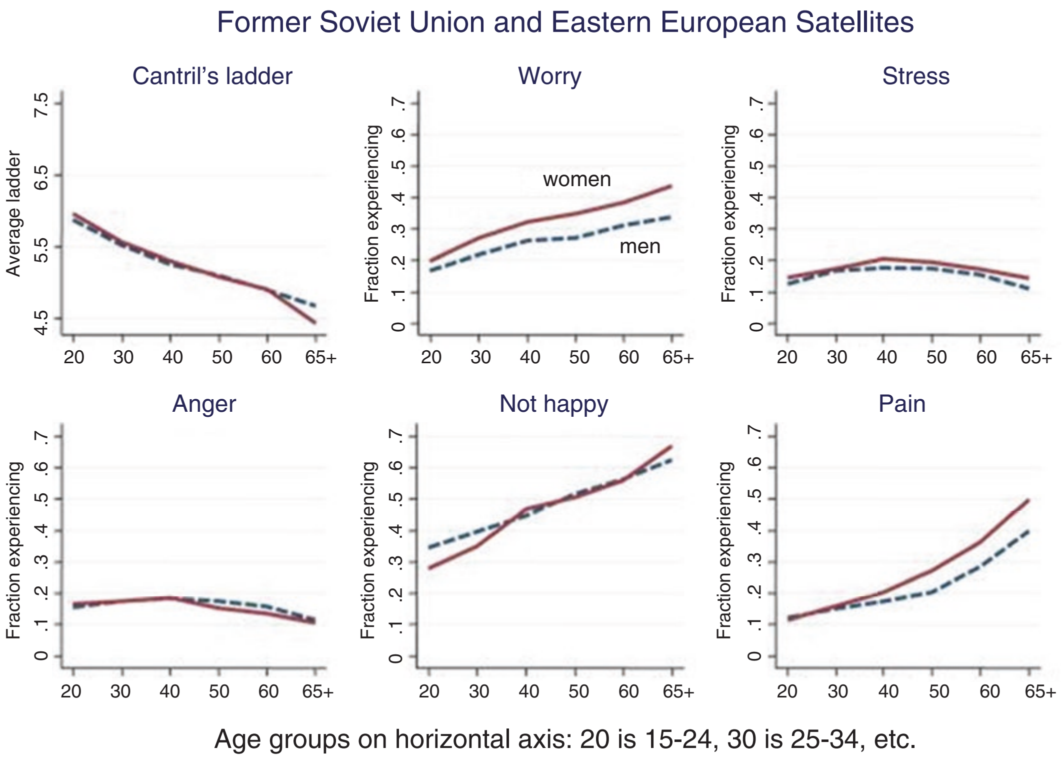
Within the same study, Arokiasamy et al. (2015) also analyzed responses for scales measuring independent functioning limitations, known as activities of daily living (ADL) and quality-of-life (QoL) indicators. These scales were used to assess disability-related limitations to independent functioning prevalence experienced by citizens in these six regions. It was found that, on average, 14% of citizens reported at least one functional ADL limitation, with 5.7% reporting depression, and 11.6% reporting poor health. QoL scores were found to average at 54.4 out of 100. For comparison, the average QoL score for a healthy individual is set at 90 (Burckhardt & Anderson, 2003). The proportion of individuals with depression, self-assessed poor health, and at least one ADL limitation was found to go up as the experience of multiple diseases increased. Conversely, multi-morbidity presence shared an inverse relationship with QoL scores. It was also noted that there was substantial cross-country variation found for all four health measures.

Quality-of-Life Predictors of Healthy Aging

Quality of life (QoL) may be thought of as the general well-being of individuals, including their levels of perceived satisfaction, bonding, enjoyment, and independence (Kobayashi, Beeken, and Meisel (2017). This well-being is typically gauged with scores obtained from self-reported *QoL scales* (i.e., psychometric assessments of personal wellbeing and life satisfaction). QoL scales are often developed in order to measure a person's subjective physical and mental health, relationships, community involvement, and recreation experiences (Burckhardt & Anderson, 2003). QoL scales and studies often also assess measures of physical health. These health measures might include illness experience, medical treatments, and personal biopsychosocial characteristics (i.e., physical functioning, psychological state, stress, and personal resources) so that researchers may gain comprehensive insight into life quality (Michalos, 2017). Taken together, data gathered from QoL research may be used in order to help physicians, patients, and caregivers make educated determinations pertaining to health improvements, disease prevention, and treatment efficacy and enhancement. Examples of the current state of research on QoL for older adults will follow.

Recent trends regarding the interplay of subjective well-being, age, and health were described by Steptoe, Deaton, and Stone (2015) in their review. Health was compared to three facets of wellness in older adults. In one study, Gallup World Polling was administered to about 1000 participants per each of 160 countries. *Evaluative well-being* (EVW*)*, a measure of self-reported satisfaction in life, and *hedonic well-being* (HW), a measure of self-reported pleasure experienced in the preceding day, were assessed. It was found that EVW scores for those from wealthy nations tended to dip in middle age before steadily rising. In poorer nations, the trend was that EVW steadily dropped over the lifetime and into advanced age. HW in predominantly white and developed nations trended toward more positive moods in the previous day. Scores for Cantril's ladder, or worst (score = 0) to best (score = 10) possible life respondent ratings, showed steady increases during and after middle age. Worry, stress, and anger scores tended to steadily fall after middle age. Pain scores tended to steadily rise after middle adulthood. In developing nations, trends differed substantially across distinctive areas. While anger and stress scores saw similar modest declines in older adulthood to those evidenced in wealthier nations. Additionally, 70% of those in developing countries reported no joy experienced in the preceding day. Cantril's ladder scores for worst to best possible life fell steadily over the course of adulthood and into old age. Scores for worry, pain, and unhappiness rose considerably over the course of adulthood in most transitioning countries.





Also reported on by Steptoe et al. (2015) were the findings from the English Longitudinal Study of Ageing (ELSA) on 9,050 adults with an average age of 64.9 years observed in this sample. Scores were obtained for *eudonic well-being* (EUW), a measure of self-reported purpose in life. EUW was found to highly correlate with longevity. 29.3% of individuals who represented the lowest 1/4 of scores for EUW died before the follow-up assessment, 8.5 years after the initial survey. In contrast, only 9.3% of those representing the top 25% of EUW scores had died.

Self-reported well-being scores also tend to relate to scores for certain personality characteristics, such as perceived control. Perceived control (PC) can be thought of as the degree to which an individual believes they direct their own behaviors. Hülür et al. (2017) studied the presence of PC, alongside life satisfaction, in order to assess how these related to health outcomes. The health data of 10,597 German citizens was collected over a 20-year period. Those with higher life satisfaction ratings were typically found to have high levels of PC and a low mortality risk. However, when high levels of PC coincided with low levels of subjective life satisfaction, diminishing effects on positive health outcomes were observed. These effects included reduced mobility and increased likelihood of early mortality. Hülür et al. (2017) also found that adding functioning and relationship scores to age and PC scores predicted health outcomes to an even greater degree. Older individuals were more likely to experience higher PC scores, life satisfaction ratings, and better overall health outcomes. Furthermore, measures of one's current physical ability and social relationship strength displayed moderating effects on PC and mortality. These characteristics, when taken together, were proposed as being potentially useful as comprehensive predictors of lifespan. The predictive ability of all indicators (age, life satisfaction, PC, physical ability, relationship quality, relationship quantity) on mortality risk was up to seven times (16–19%) that of some of the measures when isolated. This suggests that a certain combination of QoL modifiers may be working in concert in predicting greater or reduced life expectancy.

The expectations one has about their own mortality has also been found to influence their health outcomes. Perceived life expectancy (PLE) is a self-reported measure of one's predicted lifespan. It has been associated with personal health motivations, along with psychological, behavioral, and physiological health outcomes. PLE in the elderly may influence their long-term patterns of health behaviors, such as their participation in medical screenings. In a PLE and mortality study conducted by Kobayashi, Beeken, and Meisel (2017), 6,662 adults from England (aged 50 to 79 years) were assessed. Participants rated as having low PLE scores typically averaged the least engagement in physical activities, particularly those thought to cause discomfort. PLE scores were found to be associated within certain populations. Men, smokers, older individuals, and those with cancer or diabetes diagnoses tended to have lower PLE scores. Those who engaged in positive health behaviors, such as healthier diets, regular doctor visits, and greater physical activity tended to have the highest PLE scores. Higher PLE scores were also associated with having strong social status scores and engagement in regular personal fitness routines. Other characteristics were also associated with life expectancy and PLE. Subjective life satisfaction scores, levels of PC, and social standing within one's affiliative circle were positively associated with higher PLE scores and negatively associated with mortality risk. Further exploration of the characteristics related to PLE may be needed for greater insight into their association with healthy aging.

Individuals who live for the greatest amount of time have been found to engage in similar QoL-linked practices that are linked with successful aging. Successful aging may be thought of as physical, mental, and social wellness over the course of advancing age. Research from Araújo, Ribeiro, Teixeira, and Paúl (2015) examined numerous QoL predictors from a group of 80 participants from two Portuguese centenarian studies. The average age of the participants was 101.1 years, and as prerequisite to participation in a study of this kind would tend to be, all were at least 100 years of age. Most participants were women (81.3%) and lived with a spouse or family member (61.2%). Given this, it may be important to note that participants who lived independently (7.5%) were more likely to age successfully. When all QoL data was parsed, factors such as self-efficacy, hope, optimistic outlook, a sense of purpose, and will to live were found to be significant predictors of successful aging. Satisfaction with social support and economic situational factors, distinctive of QoL measures, were also found to be significant predictors of successful aging. Araújo et al. (2015) noted that those who did not experience economic stress and instability were 10.5 times more likely than expected to be centenarians. Men in this group were also more likely to be centenarians, at 3.7 times what would be expected. This study also found that 93.8% of participants stated that the strength of their religious adherence was influential to their lifestyle (Araújo et al., 2015). Religion and spirituality have been identified in other research works as important features of satisfaction in the lives of centenarians, as well. Higher respondent scores for feelings of fulfillment, adaptability, and high-quality coping were found to be related to greater strength of spiritual beliefs and practices in those over 100 years of age (Archer, Brathwaite, & Fraser, 2005).

It may be important to address here that, while these QoL and related health habits may work in concert with one another, many also seem to be have independently. Therefore, it may be important to further isolate and combine various QoL predictors in order to determine their relationship and predictive influence on healthy aging and longevity.

Cultural Influences on Health and Longevity

Cultural norms may also be influential in shaping one's health habits. For example, exercise may be easily accomplished in cultures that highly value active lifestyles. Cycling in most Nordic societies is common practice for young and old alike, and the makeup of many city streets easily accommodates this practice. Such positive health behaviors may be less common or difficult to accomplish in other areas. Many cultures in developed regions are automobile-dependent and are home to populations that are highly sedentary and exposed to high calorie convenience foods.

In a study of 125 rural American adults categorized as being overweight or obese, Sriram, Morgan, Graham, Folta, and Seguin (2018) reported that social norms were highly influential in determining personal health habits. One's conformity to the influence of peers, family members, and cultural norms was found to be highly associated with positive and negative lifestyle and health habits. One's peers and family significantly influenced whether or not one continued or altered poor health habits, such as smoking, poor diet adherence, and exercise participation, for example. Stricter subscription to societal norms and one's expected gender role also significantly related to following similarly risky health behaviors.

An examination of monetary earnings and lifespan has also been undertaken. Chetty and colleagues (2016) of the Johns Hopkins Bloomberg School of Public Health, analyzed the relationship between longevity and income. This was done by analyzing collected data on health, tax, and mortality records of 1.4 billion global citizens between the years of 1999 and 2014. Worldwide, it was found that those with the highest reported annual incomes could be predicted to have the benefit of an increased lifespan over peers who earned less. Also evidenced was a trend in a widening income gap which coincided with a widening longevity gap in America. This gap was most noticeable between the richest and poorest 5% of US citizens. Another noteworthy, was that those in the lowest-income bracket were expected to be *least* influenced by factors of healthcare quality, material surroundings, job circumstances, and salary disparities. These health predictors were less influential on mortality risk for the lowest earners as compared to higher earners, but the question of why this is remains to be answered. According to McGinnis (2016), longevity of the poorest global citizens was highly influenced by culture and community. Education attainment, government spending, and health habits (e.g., tobacco use and obesity rates) were found to be significantly related to mortality risk in various communities. Associations between risky health behaviors, culture, SES, education, and health manifestations, seems to be apparent.

Moe (2018) determined that certain demographic characteristics, such as education level, may serve as useful indicators of health and longevity, at least for the residents of Norway he analyzed. It was reported that those fulfilling greater educational achievement tended to experience a slightly longer lifespan. A Norwegian cross-sectional examination by Moe (2018) of six surveys of elderly adults was concluded with a determination that overall population lifespan increased steadily over the years of 1987–2008. However, longevity gains were more substantial in the higher-educated groups. Men had life expectancies 0.06 years higher and women 0.03 years higher in this uppermost education bracket. It was also reported that gender and sex played a small role in mortality, with men and married women having longer life expectancies than non-married women.

Epigenetic Influences on Aging

It might be intuitive to trust that longevity is highly biologically based. This might be founded in the belief of the strong influence of permanent and fixed genes on health outcomes. It may be the case, though, that genes are less predictive of mortality than one might expect. The genetic influence on the processes of aging and lifespan has been found to be relatively small (~30%), relative to the influence of the environment (~50%), suggesting a substantial role for experiential factors in shaping one's biological health trajectory and outcomes (Adwan-Shekhidem & Atzmon, 2018).

Moreover, environment appears to contribute to health-related gene expression a great deal. Experiential and behavioral factors likely *modify* one's gene expression. This phenomenon is known as *epigenetics*. The study of epigenetics is a field which focuses on the environmental contributions to *phenotypic* (i.e., physically observable) changes in gene expression. Deoxyribonucleic acid (DNA) alteration via epigenetic influence is also accomplished without adding or detracting from the total number of DNA sequences.

Pandey & Pandey (2017) describe the role of epigenetic influences on gene expression well in their overview of the topic. Epigenetic mechanisms have been found to alter gene expression. This is done by way of chemical signaling of transcriptional changes to the genes, with no change to the base sequencing of their compositional DNA. This signal may shift DNA in two ways: (1) transcription initiates a change in the outer structure of a gene; or (2) transcription alters how exposed the woven "thread" of a gene is to the cell which houses it and expresses it. The former is often done through *methylation*. Methylation is the process of adding methyl groups to the sequence of a gene, typically by capping it and silencing its ability to be expressed. The latter epigenetic change results in altering the cell *histone*. A histone is a protein which modifies *chromatin*, the "packager" of DNA material. Chromatin may be signaled to loosen or strengthen the nature of the DNA helical binding within a cell (Pandey & Pandey, 2017). Epigenetic changes to phenotypic gene expression can take place in several ways: Expression of an active gene may be heightened; active gene expression may be dulled; a dormant gene may be turned on; or an expressed gene may be completely silenced.

One focus of epigenetic research centers on DNA methylation and age advancement. Here the question posed might be "How do certain phenomena signal changes in the expression of a gene which leads to premature aging?" or "Might some experiences leave a person more susceptible to chronic illnesses common in the elderly?"

To gain insight into these queries, investigators at the German Cancer Research Center (2016) followed 1863 older individuals (mean age = 62.5) over the course of 12–13 years (2000/2001–2013). The researchers first calculated what was described as the "epigenetic clock." This was determined by estimating the participant's DNA methylation age (i.e., altered DNA characteristics related to one's age) and comparing it to their actual (i.e., chronological) age. Other possible contributing factors to health outcomes, such as age, sex, education level, illness occurrence, blood pressure, tobacco use, weight status, and immunological efficiency, were assessed and controlled for. The team later analyzed information regarding mortality rate and disease presence at death. At the conclusion of the study, 235 deaths related to cancer and 194 deaths related to cardiovascular disease were cited. It was reported that death from any cause was 22% higher in those with a more advanced DNA methylation age than what would be expected of their actual age (Perna et al., 2016).

Other epigenetic studies have focused on specialized *point mutation* of DNA. Sen et al. (2016) reviewed several studies of genetic point mutation, which is a method of changing a single nucleotide pair in a DNA molecule which leads to altered cell activity. Epigenetic point mutation studies typically involve altering genes related to histones or methylation. An example would be taking a segment from a single gene sequence for paired adenine and thymine (A-T) and eliminating it from the DNA strand. Researchers studying point mutation can focus on the phenotypic outcomes that result from altering the DNA responsible for epigenetic mechanisms. If the correct transcriptional gene is modified, there may be a noticeable impact on the health or lifespan of the organism. Point mutations to the gene *C. elegans isp-1* in nematode models isolated it as playing a role in the expression of genes related to oxidative stress. *C. elegans isp-1* altered the mitochondrial respiration system. This related to drastic increases in lifespan, possibly due to a substantial decline in oxygen intake and resulting reductions in oxidative stress.

Similar point mutation studies have looked at gene deletion in yeast models. Yeast organisms lack nervous systems. They are typically used for the purpose of simplicity in studying epigenetic mechanisms. However, yeast lack some important transcriptional genes only found in species with more advanced nervous systems. Yeast models do possess many other genes that are analogous to those in humans. Some of these genes are suggested to influence epigenetically tied processes of aging. It was found that a single deleted gene was related to production quantity of histone proteins. Substantially reduced longevity was evidenced if a histone-*producing* gene was inactivated. Similarly, lifespan was advanced in yeast models where histone *suppressing* genes were inactivated (Sen et al., 2016).

The Role of the Telomere in Health and Longevity Modification

Studies of *telomere*s may also give insight into the role one's life events play in modifying their lifespan on a molecular level. What on earth is a telomere, though? Adwan-Shekhidem & Atzmon (2018) described it well in their extensive chapter covering the telomere's role in aging. A telomere can be thought of as an encasement at the end of a chromosome. A telomere cap preserves the interior of the eukaryotic cell, allowing it to replicate its DNA after division without acquiring any chromosomal damage. Telomeres are present in all human cells and relate to *senescence*, or cell deterioration and atrophy due to advanced age. Telomeres are of great focus to those studying aging mechanisms, as their length and stability appears to partially dictate approximate life expectancy of a host organism.

A telomere is believed to act as a protective shield from the fray and loss of the cell itself. As a cell divides and replicates normally, the length of its telomere typically wears and shortens until, over time, there is nothing left. The natural course of telomere shortening, degradation, and demise is more accelerated in those who are older, typically coinciding with other physiological processes of aging. With the loss of the protective barrier of the cell, the cell itself is no longer capable of dividing and is left exposed. This, as it turns out, is very bad news. Without a shield, the defenseless chromosome becomes easily frayed and damaged, ultimately leading to the death of the cell surrounding it. This occurs gradually over time, until there is a broad death of cells throughout the body due to the cascading loss of telomeres and the unstable genes left in their wake (Adwan-Shekhidem & Atzmon, 2018).

In older individuals in particular, widespread cell loss may be irreparable. When a protective telomere is lost, the DNA of the chromosome is damaged in such a way that the host cell cannot replicate. As cells make up tissues, and tissues make up larger functional parts of the body (such as the organs), losing many similar telomeres has a deleterious effect on the practical units of the body. This may play a crucial role in senescence (deterioration) and mortality related to advanced age.

It has also been found that telomeres are regulated by certain genes. Telomere length and durability, for example, seem to be the responsibilities of the TERT gene. Just so as to not leave a curious reader on the edge of their seat, *TERT* stands for telomerase reverse transcriptase. When telomere enhancing genes are mutated, an unfortunate health event may soon transpire. For instance, a person may be left more susceptible to various forms of cancer, certain illnesses of the liver and heart, and a variety of other chronic diseases (Martinez & Blasco, 2017). These illnesses are sometimes even collectively referred to as telomere-syndromes or telomere-driven diseases.

In their chapter on the relationship between telomeres and aging, Fyhrquist and Saijonmaa (2016) described several lifestyle modifiers of telomere structure and function. Regular use or abstinence from certain drugs, for instance, has been found to influence telomere durability. Alcohol use, if consumed regularly, has been related to shortened telomere length in older adults, thought to be due to it triggering a byproduct buildup which initiates additional oxidative stress. Conversely, the chemical *resveratrol* was found to enhance the sustainability of telomeres and lengthen lifespan in mice models, though to date, studies of its longevity promoting qualities in human subjects has left the research community absent of coinciding supportive results. Stress has been associated with shortened telomeres, as well. This is thought to be caused by prolonged physiological stress responses leading to a the reduction in activity of the telomere repairing enzyme *telomerase*. Healthy lifestyle habits, such being at a proper body weight, having a regular intake of vitamins, taking cholesterol lowering statins, having a calorie restrictive (while meeting nutritional requirements), meat-free, and/or mediterranean diet, and getting regular physical exercise, have all been found to buffer against telomere degradation or otherwise enhance telomere functioning.

Batsis et al. (2018) assessed data gathered from the National Health and Nutrition Examination Survey (NHANES). Afterward, the researchers conducted a follow-up analysis of telomere lengths garnered from DNA samples of subjects. Telomere lengths were then compared to ages and BMI measures. The average age of the 7827 adult subjects was 46.1 years. Obesity and age were evaluated alongside telomere length and mortality. The results indicated that obesity was linked to shorter telomere length. However, the effect of obesity on telomere length tended to lessen by degree with advancing age. In younger subjects in particular, obesity was linked to shorter telomere length.

The Roles of Physical Ability, Sedentary Habits, and Exercise Training on Health and Lifespan

An assortment of experiential factors related to physical activity have been observed to have possible influences on health and mortality outcomes, as well. Personal experiences of frailty, sedentary habits, and physical exercise may alter the course of one's health and life expectancy. *Sedentary habits* may be deemed as engagement in activities which are lowly demanding of energy resources, such as sitting, sleeping, fishing, and slowly walking for extended periods of time. *Frailty* may be understood as being in a state of low levels of nourishment, metabolism, energy output, and muscle mass and strength. Frailty becomes more commonly experienced as a person ages and relates to greater instances of cardiovascular problems, more time spent in medical care, higher disability rates, and increased risk of mortality (Blodgett, Theou, Kirkland, Andreou, & Rockwood, 2014).

Cambridge University researchers Blodgett et al. (2014) investigated frailty associated with moderate vigorous physical activity (MVPA) and sedentary lifestyle. Data was gathered from adults who were aged 50 or older and who took part in the 2003–2006 National Health and Nutrition Examination Survey (NHANES). The results elucidated the relationships between age, frailty, and sedentary and MVPA behaviors. It was found that a typical older adult in 8.5 h of daily time spent engaging in sedentary activity while awake. Higher frailty scores were revealed as related to greater time spent in sedentary activities. The group assessed with the highest frailty score also had the highest mean sedentary activity scores at 9.57 h per day.

In their manual on frailty experiences and the benefits of exercise, Aguirre and Villareal (2015) discussed the problems associated with age-related frailty and meeting one's adequate fitness needs in a review of longitudinal studies on the topic. There were five features that were found to coincide with the experience of frailty: (1) unintentional weight loss, (2) low energy, (3) slow gait, (4) reduced grip strength, and (5) reduced physical activity. Those individuals determined as "frail: also tended to have less ability to exercise, reduced muscle mass, and less endurance. To combat becoming increasingly weaker, frail individuals were encouraged to participate in regular physical exercise. Exertive physical activity was said to involve strengthening of the muscles of the extremities as well as of the heart and other organs. Exercise was also linked with increased oxygen flow throughout the bloodstream and lessened inflammatory responses. These blood oxygen and inflammation outcomes are commonly present in older adults suffering from a musculoskeletal condition, such as arthritis. Other benefits from increased activity levels included heightening of *anabolism*, or the creation of energy for storage in the body, and enhanced muscle protein creation, which may lead to strengthening of the musculature in these adults.

Meeting appropriate physical fitness guidelines appears to play an additional role in promoting longevity and offsetting disease risk. In an examination of risks associated with broad and cause-specific mortality outcomes, conducted by Hsu et al. (2017), total physical activity duration and intensity, along with speed of walking were discussed. This study involved 1705 independently living 70-year-old men who took part in the Concord Health and Ageing in Men Project at various points over 7 years. It was found that as scores for the Physical Activity Scale increased, the relative risk of death from any cause went down. Strenuous sports participation and higher rate of walking speed also related to a reduction in the relative risk of death from all-cause mortality. In regard to cause-specific mortality, only strenuous sports engagement could predict lower cancer risk, yet all three physical fitness parameters could significantly predict a reduced risk of developing cardiovascular disease.

Lavie et al. (2015) investigated the role that exercise plays on the health of the cardiovascular system in their wide-ranging review of data collected on the demographics and treatments associated with the topic. One noteworthy trend pertained to cardiovascular outcomes after engagement in aerobic exercise training. Exercise training (ET) and physical fitness were found to be associated with cardiovascular strength. The relationship was such that increases in ET and fitness often related to better overall cardiovascular strength. For example, aerobic ET tended to remodel the heart physically, observedly by physically enhancing the dilation of the vessels and left heart ventricle, and thickening the cardiac wall lining. ET also impacted cardiac function by enhancing the contraction strength and filling ability of the heart chambers. Physical activity level in general, though, was related to health outcomes. Lower levels of physical activity were related to increased prevalence of hypertension, obesity, high blood lipid content, metabolic syndrome, depression, and *Type-2 diabetes*, a disease characterized by abnormally low insulin levels due to pancreatic inefficiency. Higher levels of physical activity were found to reduce the risk of cardiovascular disease in elderly populations, particularly. Muscular fitness (MF) was also found to be particularly beneficial to older populations in this study. MF was inversely related with experiences of frailty and *cachexia*, or illness-linked weakness and muscle wasting. Furthermore, ET was found to enhance MF along with cardiovascular health in older populations. Finally, resistance training was found to be particularly helpful to those suffering from heart failure. This type of exercise was linked with a reduction in the severity of cardiovascular indicators of heart failure and in the risk of heart failure-related death.

Nutrition Quality and Longevity

Nutrition and dietary intake are other potential modifiers of longevity that have been fairly well researched. What exactly constitutes a poor or proper diet, though, might still be an issue of contention among some health researchers. Still, there is a general consensus that the nutritional quality and digestibility of some foods (i.e., foods highly processed, vitamin-deficient, and calorie-dense) are not suitable for maintaining adequate nutrient intake and optimal health. A *poor diet* may consist of a high proportion of daily calories coming from refined and highly processed simple carbohydrates, meat products and meat by-products, and difficult to digest foods, such as artificial ingredients, preservatives, lactose, and artificial sweeteners. Poor diet has been found to be a strong risk factor for *obesity* or an excessive accumulation of body fat resulting in a BMI of 30.0 or greater. Diet and obesity are predictive of coronary artery disease, hypertension, diabetes, cancer, and overall mortality. In fact, obesity has now replaced malnutrition as the most prevalent dietary contributor to poor health worldwide.

Obesity has become a devastating influence on loss of life in America particularly, as it now accounts for more diseases and deaths for citizens there than even smoking (Ahmad et al., 2016).

For those above the age of 65, about 40% of all-cause mortality is believed to be influenced by dietary choices, and almost half of US deaths in 2010 were reportedly from heart disease or a form of cancer, both diet-linked illnesses (Brown, 2016). *Heart disease*, also known as *cardiovascular disease*, is the number one killer of individuals worldwide, leading to 17.7 million, or 31% of total deaths in 2015, most of which are highly preventable through modifications to diet, exercise, and tobacco and alcohol abstinence (World Health Organization, 2017). In America alone, the prevalence of heart failure among adults is approximately 5.7 million (Ahmad et al., 2016).

General guidelines for a proper diet were detailed in a more comprehensive fashion in the textbook *Nutrition through the Life Cycle*, by Judith Brown (2016). An optimal diet was said to consist of daily intake of nutrient-dense foods, such as vitamin-rich fruits and vegetables, sufficient water intake, small, gender dependent, quantities of red wine, and little, if any, saturated or trans fats. Diets of this nature have been associated with lowering the risk of developing common chronic diseases of aging, such as cancer, heart disease, diabetes, and stroke.

It has been further asserted that a diet low or lacking in meat, bleached grains, and simple sugars, while high in colorful, antioxidant-rich vegetation, nuts, legumes, complex and whole grains, omega acids, and olive oil, is conducive to increasing one's longevity and improving one's overall health (Martinez-Gonzalez & Martin-Calvo, 2016). If this diet sounds familiar to you, it is likely because it has become a fairly well-established trend in healthy eating, often referred to as the *Mediterranean diet*.

The quality of nutrition intake which the Mediterranean diet is based upon was first studied closely and popularized in the Seven Countries Study conducted by Ancel Keys in the mid-twentieth century (Hu, 2003). It was found that, while the citizens on the Greek Island of Crete were eating a greater proportion of fat than were those of many other nations, and were drinking a fair amount of wine on a regular basis, they tended to live longer lives than most residing elsewhere. The Crete islanders also tended to have some of the lowest instances of heart disease and cancer, the two long-held greatest causes of total mortality across the world. Diet was believed to play a prominent role in the comparably enhanced health and lifespan of the Greeks; thus, the Mediterranean dietary habits began to be established as consisting of swapping red meat and poultry for fish, drinking regular and small amounts of wine, and eating an abundance of plant-based foods, seeds, and linoleic-rich fats. The practical impact of this diet on health was first studied in the years spanning 1988–1997 for the *Lyon Diet Heart Study.* This influential project was conducted on 605 patients aged at 70 or greater who survived a myocardial infarction or heart attack. Compared to controls, those who took part in the diet had a 73% reduction in heart disease deaths and nonfatal heart attacks (Dalen & Devries, 2014).

Caloric Restriction and Intermittent Fasting

Caloric restriction (CR) has also been suggested as a technique to potentially extend the lifespan. CR diets involve cutting down the proportion of calories (as appropriate for one's size) to around 75% of one's typical intake, while ensuring that adequate nutrients are accounted for (Ravussin et al., 2015). It is believed that, in order to benefit from a CR diet, an individual must be able to sustain the diet long-term, while also beginning the diet by their middle age.

Fontana, Partiridge, and Longo (2010) reviewed the findings of various types of diet restrictive research projects, with CR studies being covered heavily. The CR projects discussed mainly focused on non-human subjects, a practice which began with rat models in the early 20th century. The benefits to substantial, but sustainable cuts to meal quantity were found to be numerous. Typical findings included: reductions in overweight and obesity; enhanced metabolic functioning; reduced experience of neural atrophy and neurodegeneration; reduced instances of various chronic health conditions; and significant increases to longevity. These effects were believed to be due to the CR diets impact on physiological processes. Biological outcome measures in experimental human groups who were administered a reduced calorie diet were also discussed. Physiological changes resulting included enhancement of autonomic function, reduced inflammation, lowered body temperature regulation, and less heart strain. Cellular events resulting from CR diets included increased DNA and chromosomal repair, heightened cell replication, heightened antioxidant activity, greater immunological stress resistance, and enhanced gene and cell durability.

Studies on CR have varied greatly. Rizza, Veronese, and Fontina (2014) reviewed various types of CR diet research projects, including epidemiological studies of chronic illnesses, controlled experimental data, animal models, and human subjects research. Many ultimately indicated that there were key relationships between reduced overall calorie intake and positive health outcomes. Some of the specific outcome measures were as follows: (1) reduced stiffening of the heart muscles; (2) decreased autonomic dysfunction; (3) reversed genetic and age-exacerbated musculoskeletal degeneration; (4) and lowered susceptibility to many diseases, including Type 2 diabetes, heart disease, hypertension, stroke, and various forms of cancer. It was further reported that the most protective intervention against cancer development in radiation-exposed animal models was a CR diet (without malnutrition). This diet halved cancer rates in older monkeys while entirely preventing it in young monkeys. This was in stark contrast to young monkeys fed diets rich in protein and carbohydrates, which were found to experience accelerated tumor growth. The optimal longevity-extending CR diets were said to cut weight-dependent daily calorie intakes by 10–50%, with diets cutting greater intake leading to malnutrition, reproductive and immunological dysregulation, and starvation.

In their study of human subjects, Ravussin et al. (2015) analyzed CR and physiological data collected from 211 healthy adults, aged 21–50 over four time periods spanning 2 years. At the start of the second year, weight loss had plateaued, and the health effects of the CR diet became more prominent. At the end of the second year, a marked reduction in inflammation in areas associated with cardiovascular health was found in the CR group that was not evident in the control group. Further group differences included reduced internal temperatures and reduced thyroid activity, evidenced in CR participants exclusively. Interestingly, while metabolism was reduced in CR participants, it was to a smaller degree than was their core body temperature regulation. These findings may further support the idea that a CR diet reduces energy expenditure within the body, which contributes to a slowed aging process, without substantially cutting one's metabolic rate in the process.

Those who practice intermittent fasting may be aiming for a similar longevity-extending goal as those who practice CR diets. These two methods differ slightly in their approach. *Intermittent fasting* (IF), also called *periodic fasting*, involves reducing the number of caloric ingestion periods over the course of the day or week (in the case of alternate-day fasting). The goal of IF is typically to decrease energy consumption to fewer intervals over the course of a certain period of time. While both CR and IF diets typically reduce overall calorie intake, intermittent fasting does not do so by design. In fact, IF diets may actually result in the same or greater overall caloric intake than was the case before their implementation. This is because one typically has the option to consume any quantity of calories they so choose during meal periods. Those practicing IF diets may choose from various meal time windows to fast within. These windows may be over the course of a day (hours of fasting), week (days of fasting), or month (weeks of fasting). IF diets are thought to potentially have many of the same benefits of CR diets, although extensive empirical results are still lacking (Horne, Muhlestein, & Anderson 2015).

In an analysis of three randomized and controlled clinical studies of IF diets, Horne et al. (2015) reported on health outcomes observed in human subjects. It was found that IF diets significantly induced weight loss (−6.5%) in the first study. In the second clinical trial, mood improvements, such as reduced depression, were found along with better health outcomes to blood pressure, cholesterol, body mass, and DNA repair. The third clinical trial found higher red blood cell counts, lower triglycerides, and increases to *human growth hormone*, an endogenous endocrine chemical related to enhanced energy, mood, metabolic function, and muscle and bone strength. The results from all three clinical studies suggest that IF diets may result in improvements to metabolic optimization, blood glucose regulation, weight management, and cardiovascular performance.

In their review of the effects of fasting on chronic disease outcomes, Mattson, Longo, and Harvey (2017) analyzed clinical research projects comparing the health outcomes of IF and periodic fasting (PF) practice. *Periodic fasting* was described as the form of IF in which one extends the window of time between meals from 2 days to as much as 3 weeks. In this review, IF meal gaps were measured as between 16 and 48 h. Animal model studies on IF diets support that reduced weight, resting heart rate, blood pressure, inflammation, insulin, tissue damage, diabetes symptoms, and stress reactance result from the practice. Alzheimer's disease, Parkinson's disease, and Huntington's disease symptoms were also found to be offset. This was supported by observing a diminished progression of neural degeneration and dysfunction compared to regular diet matched controls. Taken together, these findings support the possibility that IF diets in humans can significantly shield them from the development of diabetes, heart disease, metabolic syndrome, overweight and obesity, and chronic conditions of advanced age.

The Health Implications of Chronic Stress and Stress Reactions

There may be a reason why we tend to feel exhausted and are left vulnerable to illness after a stressful life event, such as dealing with interpersonal or occupational challenges. Stress has long been associated with experience of sickness and earlier mortality. Hans Selye (1950) popularized the link between stress and health in his early works, such as *Stress and the General Adaptation Syndrome*, wherein the association between human experiences of stress and resulting universal adaptive immune responses are detailed. *Stress* has been loosely defined as the experience of an event or events which are appraised as being threatening or challenging by the individual facing them (Maniam, Antoniadis, & Morris, 2014).

When someone is in the process of experiencing a *stressor*, or stressful event, the brain and body arouse energy that prepares a person to respond to the challenge, called the *stress reaction*. The stress reaction involves psychosocial and physiological components which are thought to bolster survival chances and the immune system response in times of an acute crisis. However, the inverse effect may result from a prolonged stressful experience. When stress is chronic or experienced repeatedly, the typically adaptive immune response can have deleterious effects on a health, "wearing away" at the resources necessary to maintain proper pathogenic defenses (Dhabhar, 2014).

Short-term stress reactions are initiated and maintained by the sympathetic adrenomedullary system (SAM), also called the *sympathetic activation system*. Long-term stress activates the hypothalamic-pituitary-adrenal (HPA) axis, a major neuroendocrine system. Both the SAM system and the HPA axis can be thought of as complexes for physiological stress responses. For the SAM activation system, the initial sensory input from a stressor travels to the cerebral cortex, which labels what is occurring, and that information is transmitted to the hypothalamus, which activates the sympathetic nervous system. Sympathetic arousal stimulates the medulla of the adrenal glands to secrete *epinephrine* and *norepinephrine*. Epinephrine and norepinephrine initiate several physiological reactions in the body, such as increased blood pressure, increased heart rate, increased sweating, and the constriction of peripheral blood vessels (Nicolaides, Kyratzi, Lamprokostopoulou, Chrousos, & Charmandari, 2015).

Many of the effects of recurring SAM-activated stress activity are based upon elevated levels of epinephrine and norepinephrine. These effects might include suppression of immune system functioning, hypertension, heart and ventricular arrhythmias, neurochemical imbalances, and suppressed liver function leading to a buildup of lipids and fatty acids in the bloodstream. The latter is one of the foundations of *atherosclerosis*, or accumulated fatty deposits on the arterial walls of the heart. Atherosclerosis, alongside the similarly pronounced, but distinct *arteriosclerosis*, a disease characterized by a weakening of the lining of the arteries, form the foundation of the number one killer of individuals the world over; heart disease (Lagraauw, Kuiper, & Bot, 2015).

The HPA axis directly influences the output of the stress hormone cortisol. The three component of the HPA axis are (1) the hypothalamus (a medial brain region just behind the thalamus), (2) the pituitary gland (a pea-shaped structure located below the hypothalamus), and (3) the adrenal glands (small, conical organs on top of the kidneys). Initially, the hypothalamus secretes corticotropin-releasing factor (CRF). CRF signals the pituitary gland to secrete adrenocorticotropic hormone (ACTH). Following this, the adrenal cortex is stimulated to release *glucocorticoids*, such as *cortisol*.

HPA axis stress reactions have been shown to have deleterious effects on brain mass and the neurons of the hippocampus, a region of the brain responsible for memory and attentional focus. In very young children who experience stressful instances of abuse, an abnormal reduction in overall brain size is often observed once they have matured. This reduction in brain mass is also typically proportional to the age of their trauma onset. In calf models, early maternal separation stress was linked with reduced hippocampal synapses. This deficit was later found to be partially protected against when the calf models were introduced to and nurtured by a surrogate (Maniam et al., 2014). Long-term HPA activation may also lead to consequences that are directly related to elevated cortisol levels.

After prolonged stress, both an abnormally high and abnormally low cortical stress response has been observed to occur, though the former is more common (Gaffey, Bergeman, Clark, & Wirth, 2016). Due to this, long-term stress-induced cortical activity may have several consequences. For one, irregularly high cortisol levels increase inflammatory responses. Additionally, corticosteroid activity influences carbohydrate energy conversion, with higher levels of cortisol increasing the amount of carbohydrates, such as insulin, that are stored as fat. This is often evidenced as visceral fat of the abdomen, which has been associated with the onset of *metabolic syndrome*, or the series of early symptoms associated with the onset of cardiovascular diseases. Amassing belly fat after stress occurs, mostly, from a reduced efficiency to metabolize sugars and fats in the bloodstream. An increase in high-energy eating, common during times of stress, certainly does not help in this matter. In terms of evolutionary reasons for lipid retention, intake of high quantities of caloric energy may have helped humans with alleviating the stress of starvation and in overcoming physical challenges (Maniam et al., 2014).

Stress, and the associated negative emotions corresponding with it, seems also to relate to nutrition intake and food *choices* (Kate, Deshmukh, Datir, & Rao, 2017). Higher levels of stress experiences relate to higher levels of unease and worry, which are associated with elevated cortisol. Individuals have a tendency to be drawn to sugary foods when stressed, as these positively impact serotonin and glucose levels. This may relate to making impulsive dietary choices in order to give one's self a mood boost.

Sarafino and Smith (2014) found that carbohydrate-rich foods impact the brain differently than other food types, as described in their chapter on the impact of dietary composition on mood and weight. The so-called "good mood foods" might include highly starchy and calorie rich sweet and savory offerings, such as chips, baked goods, candy, and the like. Such foods are known to increase a person's likelihood of experiencing overweight and obesity. Foods that are high in carbohydrates have been reported to give individuals insulin boosts, mood enhancement, and feelings of calmness even hours after being consumed. No such findings were observed in protein-rich diets, even those that were calorie matched. Also, the more the individual filled-up on these offerings, the fewer nutrient-dense grains, fruits, and vegetables they tended to consume. Other consequences of heavy starch intake included an inclination to eat later into the evening, to skip a morning meal, and to consume more snack foods than usual.

Exercise, however, may help to offset some negative stress responses. Maniam et al. (2014) reviewed literature on immunological functioning as a consequence of stress and exercise. Physical fitness and regular exercise were determined to increase resiliency against negative health effects of stress. Exercise was also found to protect against elevated corticosteroid levels and other heightened HPA axis activity. Greater amounts of exercise related to a reversal of both the stress-related reductions to immune system functioning and the related heightened inflammatory response. Certain illnesses, such as posttraumatic stress disorder and hypertension, were linked with prolonged high levels of cortisol. It is possible, therefore, that exercise may play a role in alleviating symptoms of both. The conclusions drawn implicated chronic stress as a major culprit in the development of various disease and poor health risks; however, using exercise as a *buffer* may reduce these risks.

Stress buffers modify how stress is experienced and attenuate a multitude of effects that stress has on an individual. Emotional regulation has been studied by de Frias and Whyne (2015) as a potential buffer against stress and resultant ill health and reduced mortality. *Emotional regulation* was described as how a person guides their own emotional experiences by using intrapersonal affective comprehension, evaluation, delay, manipulation, and/or expression. As we aged, our ability to regulate our own emotions was found to increase, on average. Conversely, the experience of negative emotions (especially those of an extreme nature) tended to decline. Older adults, therefore, may be better capable of enacting a resiliency against experiences of stress. It was found that older adults who were better at, and who more often utilized, emotional regulation were less likely to experience the deleterious immunological effects of stressors. These *optimal emotional regulators* also recovered from heightened stress effects more quickly.

The Roles of Social Affiliation and Isolation on Stress and Longevity

Interpersonal bonds and social isolation may play important roles in how an individual experiences stress, health, and longevity. *Social support* may be understood as receiving an indication from others that one is cared for, has assistance when needed, and has enduring ties to others through communication and mutually beneficial obligations (Moore et al., 2015).

Social isolation may be best understood as lacking affiliative connection and adequate meaningful communication with others (Franck, Molyneux, & Parkinson, 2016). Social isolation may be one of the best predictors of poor health outcomes. It has been associated with increased inflammatory output, which has been related to chronic experiences of stress, tumor growth, hypertension, cardiovascular pathologies, and even neurodegeneration (Yang et al., 2016).

In contrast, strong social ties have been described as one of the best understood and most researched indicators of positive health outcomes (Robles, Slatcher, Trombello, & McGinn, 2014). Strong social supports appear to be amongst the strongest buffers against stress and related health deterioration. Social ties have even been found to provide a heightened sense of subjective well-being. Strong and positive affiliative relationships have further been related to higher productivity at school and work, greater creative expression, better mental health, and lessened disease and mortality risks (Kansky & Diener, 2017).

The "buffering hypothesis" explains the use of social affiliation to reduce stress and enhance overall health (Praharso, Tear, & Cruwys, 2017). Strong and supportive ties to intimate partners, friends, and community have been related to physical, knowledge-based, intuitive, and emotional gains from these relationships. Such buffers provide a type of "cushioning" against aversive consequences of stress. These social buffers may reduce the physiological effects related to stress experienced by individuals as well. Specifically, social supports have been related to improved immunological functioning, attenuation of tumor growth and metastasis, fewer chronic illnesses, and increases to lifespan (Hinzey, Gaudier-Diaz, Lustberg, & DeVries, 2016).

Animal models may give insight into how social relationships are linked with stress and mortality. In their review of the association, McFarland et al. (2017) assessed strength of social ties in baboon models. It was found that many monkey populations show increases in physical activity and fitness that were related to increases in socialization. In most populations, active maintenance of a few, strong, long-lasting monkey "friendships" appeared to have the strongest positive effect on physical activity and fitness. The reason for this might be that these friends were more likely to travel to visit each other over visiting an "acquaintance." These effects were stronger in female monkeys than males, interestingly. Strong social bonds predicted higher birth rates and weak social bonds predicted greater infant mortality in the population assessed.

It appears that there may be other factors that can impact the effect that social relationships have on longevity. In a review of behavioral data, Thompson and Cords (2018) explored the relationship between strong social bonds and longevity in 83 female primates in 8 social groups. It was determined that monkeys who experienced the highest rate of relational turnover (broken ties) in their close relationships experienced reduced longevity duration. Put another way, these break-up prone monkeys tended to have higher incidences of early mortality as compared to monkeys with stable year-to-year close relationships. Even monkeys with fewer and poorer relationships tended to out live those with many broken social bonds. While partnership changeover was predictive of longevity, hierarchical rank and age of first reproduction were actually not linked with mortality in this group, a finding that upsets much of the previous research on the mortality influence of these variables.

Research on elderly participants also supports the theory that social relationships can enhance health and reduce stress consequences. Moore et al. (2015) studied the interplay between health, aging, social support, and stress in the elderly. Scales of self-rated successful aging (SRSA), physical and mental health, perceived stress, and social support were completed by 1,006 adults, averaging an age of 77 years. The results indicated that higher scores for stress lowered the scores for the interaction of physical and mental wellness and successful aging. Those who reported the strongest social supports also tended to experience the greatest buffering effect against perceived stress. Put another way, physical and mental health and healthy aging outcomes were less influenced by perceived stress when one's social relationship strength improved.

Research Implications for Modifying Longevity and Quality of Life from Intervention Studies

The many decades of research centering on issues facing the growing elderly population have led to several important new insights. Studies of this kind may prove useful in spawning future research projects geared toward enhancing QoL and wellness. The findings of several intervention studies aimed at making key improvements to the mental and physical health of the elderly are presented in the following section.

Mindfulness programs have been evaluated for their use in enhancing the QoL of older individuals. Franco, Amutio, Mañas, Gázquez, and Pérez-Fuentes (2017) implemented an intervention-based study wherein a mindfulness-based stress reduction (MBSR) program was assigned to a group of elderly volunteers, ranging from 66 to 82 years of age. The aim of the program was to reduce levels of measured stress and stress-related traits. After 7 weekly sessions, post-completion results indicated that the experimental group in the study rendered significantly reduced scores for depression, anxiety, trait worry, and *meta-worry*, or worrying about one's own worrying.

A systematic review completed by Franck et al. (2016) presented several studies highlighting the role of therapeutic interventions in improving QoL predictors of health. In one, Chiang et al. (2010) used group-based reminiscence therapy as a method to reduce depression and loneliness in participants. It was reported by Chiang et al. (2010) that depression was present in the majority of older citizens in some countries, with 78% of elderly Chinese residents found to be sufferers, for example.

The reminiscence therapy analyzed by Chiang et al. (2010) is often used as a tool for improving feelings of self-worth and reducing the severity of depression in older and isolated adults. This type of therapy centers on the belief that long-term memories tend to be resistant against age-related memory decline. Those implementing this study initially evaluated 47 Taiwanese men who were an average of 77 years of age. Each week for eight total sessions, small groups would meet for 90 min and talk about their memories with an expert in this form of therapy administration serving as a facilitator. There was found to be a significant improvement in all mental health parameters assessed. Feelings of isolation improved from moderate to mild. Depression, feelings of achievement, and psychological well-being were similarly evidenced with significant improvements. A short-term follow-up at 3 months upheld the significant positive results to mood and loneliness. Improvements to overall positive feelings have also been upheld in similar research conducted on reminiscence therapy that was administered to elderly Iranian women (Yousefi, Sharifi, Tagharrobi, & Akbari, 2015).

Game play as a potential enhancer of QoL was examined by Kalhbaugh et al. (2011) on elderly subjects averaging 78 years of age. For 1 h a week for 10 weeks, the same research assistant would play a Nintendo Wii game of the patient's choice. There were two alternative procedures: watching TV with a research assistant and a true control group of patients that just completed an initial and final assessment without intervention. The Wii group saw a significant decrease in loneliness compared to the true control. It was also found that lower levels of loneliness in these participants were predictive of future scores on mood and physical activity levels. Interestingly, the group assigned to simply watch television actually scored higher on levels of loneliness at the termination of the study.

Overall life satisfaction, feelings of isolation, social relationships, and physical activity were the focus of a gardening study for older Hong Kong citizens. Tse (2010) created an indoor gardening program which lasted for 8 weeks and focused on education of gardening practices and administering these practices on personal florae. Participants, averaging an age of 83 years, also made a planting journal that they shared with other participants in a conclusion ceremony. A control group completed an initial and final assessment without the activities. The gardening group saw a significant reduction in loneliness and significant improvements in life satisfaction and social network size at the conclusion of the gardening program. Despite the intervention, there was not a significant measured difference in physical activity, though many participants did *report* feeling that their physical activity did improve. Other common self-reported improvements included feeling more socially involved and connected, heightened accountability, and greater overall feelings of joy and positivity.

Gleibs et al. (2011) investigated the therapeutic efficacy of gender-based social clubs in UK nursing home residents. These organizations involved team meetings and group activities led by a staff member of the same gender from the group's nursing facility. Club events included going to museums, movies, and lunches every 2 weeks over the course of 3 months. Depression and anxiety scores decreased while self-reported life satisfaction increased in partnered men. However, there was no significant finding on these measures in female participants. Strength of personal identity, though, was found to significantly improve in both sexes.

In two intervention studies conducted by Travers and Bartlett (2010, 2011), Australian retirement home residents listened to an hour-long radio broadcast every day for 3 months and journaled about their experiences. There were 113 participants: 80 females and 33 males with an average age of 79.9. Music and radio shows from the 1920s–1950s were played daily for 1 h segments over the course of 3 months. Depression significantly decreased at the conclusion of the study, especially in patients with dementia, while QoL scores of life satisfaction increased. Caregivers reported that patients were friendlier, had improved well-being, were visibly more relaxed, and exhibited better behavior after the broadcasts. Other discussed positives to this design included the low cost of the programs and the ability to broadcast them over a wide area.

A review by Cohen-Mansfield and Perach (2015) focused on 34 clinically based studies conducted over a 15-year span which analyzed the relationship between loneliness and socialization. These social group interventions aimed to improve overall measures of loneliness and social interaction in elderly participants. It was found that the 12 most effective studies tended to utilize information-based techniques, such as improving knowledge of social skills and bonding. The most beneficial programs also tended to offer direct guidance from a trained researcher on how to connect with others and cement relationships. Those who were taught to enhance social skills and improve relationship upkeep were the most likely to experience reduced feelings of loneliness.

In their analysis Johnson et al. (2016) reviewed 19 studies on how knowledge and attitudes surrounding health relate to actual health behaviors. Also studied were the utility of habit-changing interventions, such as nutrition and fitness games. It was found that personal biases and other attitudes surrounding health and wellness tended to motivate how one cared for their health. The intervention programs were found to be rather successful in altering these attitudes and behaviors, though. Most individuals (59%) reported a significant and positive effect of introducing health-promoting games and introducing positive health habits, such as fitness and dietary changes. This suggests that health education, particularly when packaged in a way that is entertaining, may empower individuals to make positive changes to benefit their health and longevity.

Exercise interventions involving *hypoxia*, or oxygen deprivation, may also prove to be useful in extending longevity. Additionally, programs of this kind can be tailored to meet the needs of unique elderly populations. In a randomized, single-blinded, placebo-controlled conducted by Pramsohler et al. (2017), 40 participants over the age of 65 took part in a 3-week rehabilitation program. The impact of endurance exercises in low oxygen conditions on elderly physiological measures was tested. Experimental participants were placed in an oxygen chamber set to conditions of 3000 meters elevation for 30 min. There, they spent 10–30 of those minutes on a treadmill. Their heart rate target was set off of 80% peak oxygen consumption. Two key physiological benefits were noted. These were cardiac revascularization, or increases to blood flow, and lowered physical stress, or increases to endurance. In the experimental group, physical exertion required in order to meet target heartrates was significantly reduced at studies end by 28%.

Practical Recommendations for Healthy Aging Practices

Personalized methods in practically implementing strategies for optimal health and QoL enhancement in older populations have also been studied and described. Physicians with expert knowledge in these areas may be able to continue to enhance the lives of their older patients in the future. One way of doing this may be in modifying poor health practices.

Sedentary behaviors have been found to influence poor health outcomes. There may be approachable ways to combat the ease of a sedentary lifestyle that are already available to the elderly who do not currently require nursing or other medical assistance. It was suggested in the text *Complementary & Alternative Therapies in Nursing* by chapter authors Treat-Jacobson, Bronäs, and Salisbury (2014) that seniors should make it a point to be active by engaging in active housework, hobbies, and recreational activities.

Gardening, swimming, yoga, mild to moderate intensity sports play, and light walks may be easy to implement into many healthy elderly individual's routines. Moderate- to high-intensity physical activity, however, is an arduous undertaking for some, and many activities might not be recommended for those who are in a frail condition. Still, it is likely that many older adults can be motivated to participate in low-stress exercise programs if given appropriate knowledge and resources.

It has also been suggested that individuals may alter their dietary habits in specific ways which may help them in their pursuit of offsetting mortality. Specific dietary habits are believed to influence the processes of aging. This may actually be due to the interaction of diet and telomerase. Boccardi, Paolisso, and Mecocci (2016) investigated the role of diet, telomerase, and telomere length in their review of diet interventions and healthy aging. Telomerase is an enzyme that may restore cells, as it has been found to reverse cell degeneration in animal models, as previously discussed earlier within this chapter. Particular dietary supplements, namely, folate and vitamins B, D, E, and C, were found to enhance telomere durability. Antioxidant-rich foods were also related to enhanced telomere length and human longevity. The list of foods high in antioxidants were listed and are as follows: tuna, salmon, herring, mackerel, halibut, anchovies, catfish, grouper, flounder, flax seeds, sesame seeds, kiwi, black raspberries, green tea, broccoli, sprouted foods, red grapes, tomatoes, olives, and olive and grapeseed oils. Further, foods low in saturated fats were found to increase telomerase activity, suggesting that reducing or eliminating meat and dairy products may play a role in offsetting mortality to some degree. The broad recommendation was for individuals to eat many fruits, vegetables, whole grains, seeds, and plant-based fats, such as is a common practice in the *Mediterranean diet*.

Another method of altering health habits for individuals may be found in the workplace. Workplace-based incentives programs were examined by Pitt-Catsouphes, James, and Matz-Costa (2015) for their usefulness in enhancing the health of employees. Workplace-based health and wellness programs (HWPs) aim to instill positive health practices for older adults in the workplace. These programs were said to potentially reduce costs for employers as they relate to greater productivity and later retirement ages in employees. An example of an incentive described in this model involved engaging older employees in prosocial activities which included healthy exercise, like giving them a day off for participation in a charity marathon. Other potential program initiatives described involved implementing fun nutritional activities, such as cooking classes, providing the workers with paid leave for their successes and time spent in the program, and giving the older employees a sense of community and group support in these programs, such as with weekly meetings to share their triumphs or setbacks with one another.

Other recommendations for practically enhancing healthy longevity in older adults may involve policy changes on a local or national level. For example, The World Health Organization [(WHO, 2015a, 2015b)] recommends taking several steps to ensure that the elderly are given the best opportunity to enhance their longevity now and in the years to come. The first course of action to implement is suggested to be a community obligation to the assurance of wellness in the aging population. Such a goal is broad and requires an understanding of the meaning of healthy aging, motivation on behalf of community members to adopt wellness initiatives, and research-based engagement in healthy aging practices which are followed by the elderly community members.

The second call to action on behalf of the WHO (2015a, 2015b) stipulates that the healthcare systems in place at local, national, and multinational levels should be arranged in alignment with one another. With this cohesion in place, it will be much more feasible to address proper care of older populations. The healthcare system may be in need of restructuring so that the design of programs is streamlined in a way that allows for meeting the needs and improving the capabilities of older citizens. This might involve tackling the issue of universal healthcare. Such an implementation would benefit a growing number of older citizens who are going to require regular healthcare and who would benefit from an integrated healthcare system which addresses providing standardized professional and humanitarian services.

A tertiary goal of the WHO (2015a, 2015b) involves creating and implementing an organized healthcare model which addresses chronic needs of the elderly. With advanced aging, one can expect to experience progressive and long-term issues of declining health. Due to this, it may be important to provide citizens with a healthcare system that will address noncommunicable diseases in need of long-term management, particularly within regions that have no serviceable antecedents of this kind. Some of these implementations might involve palliative (i.e., compassionate care), integrated and global healthcare network, and person-oriented services.

The fourth recommendation encourages the creation of settings which are conducive to healthy advanced aging. One issue in need of addressing herein would involve combatting socially constructed attitudes, such as *ageism*, or bias against the elderly. Other environmental changes would facilitate autonomy in the elderly, possibly by enacting new designs to infrastructures within cities that are more elderly-friendly. Additionally, social services and recreation for elderly citizens could encourage connection to other community members and healthy creative and physical outlets.

Finally, the WHO (2015a, 2015b) recommends the continued advancement of research on the quantification and qualification of healthy aging. It is believed that there should be an agreed-upon medical and scientific pursuit of the observation, reporting, and comprehension of issues facing aging and elderly citizens of the world. Such work is currently being done on behalf of the WHO, with the Study on Global AGEing (SAGE), though developing more models like this would likely improve our grasp of the scope of issues of aging. An adaptive and comprehensive research approach could continue to enhance the scientific knowledge base on QoL and longevity that has been steadily accumulating over the years.

Future Research Directions

The traditional goals and actions of biologists and medical researchers who focused on longevity were often founded in the *biomedical approach*. A biomedically minded scientist may look to physical symptoms and mechanisms of disease in an older person. This approach might leave little regard for the interplay between other influential factors on aging and disease. The National Cancer Institute, for example, often conducts medical research exclusively on the organic nature and course of disease. Even the "elderly" focused National Institute on Ageing focuses about half of its funding on a single age-defining illness, Alzheimer's disease (Kaeberlein, Rabinovitch, & Martin, 2015).

New fields of research on aging, like geroscience, are focusing on life extension and enhancement of quality of life (QoL) using a biopsychosocial, rather than a biomedical, approach. Originally developed by George Engel (1977), the biopsychosocial approach conceives health and illness as being influenced by the interaction of biological, psychological, and experiential elements. The biopsychosocial approach may seek to explain how health and illness interact with physical complaints, stress, behaviors, relationships, culture, personality, mood, memories, and perceptions. Geroscience is a burgeoning new field of study that focuses on the complex biological, psychological, and sociological aspects of aging in a fashion similar to this model. Geroscience seeks to bridge the divide between more traditional scientific pursuits, such as with biomedicine, and the more comprehensive models. Biopsychosocial approaches, such as this, might guide future scientists to connect with other researchers who have diverse backgrounds and specializations. Such collaborations may more swiftly advance studies of longevity modification. Future researchers may be from diverse fields of science and may include physicians and basic researchers (Kaeberlein et al., 2015).

Others are looking to the manipulation of genes and telomeres as potential future avenues for altering age of mortality. Farahzadi, Fathi, Mesbah-Namin, and Zarghami (2017) reviewed newly developed technologies in stem cell therapies, telomere manipulation, and epigenetic clinical approaches for advancing age and health in older populations. For example, mesenchymal stem cells, composed of embryonic connective tissue, can become many different types of tissue and have regenerative abilities, unlike other cells. This may highlight their future utility in gene therapies. The gene *hTERT* constructs telomerase, the enzyme that gives additive value to the telomere caps of chromosomes. Gene targeting of *hTERT,* through promoting its expression, has led to mixed but promising results. Zinc sulfate (ZnSO4) research may be the most likely avenue for future telomerase research. Zinc sulfate (ZnSO4) is a highly active anti-inflammatory antioxidant that has been assigned for therapeutic use in many chronic diseases, such as cancer and dementia. Additionally, zinc sulfate (ZnSO4) has been found to encourage telomerase activity. This effect was found to be pronounced in mesenchymal stem cells and statistically significant in all cells tested. ZnSO4 was also found to promote the expression of the gene *hTERT,* which led to a reduction in *senescent* (age-degraded) cells and an increase in telomerase activity and telomere length. It is worth noting, however, that researchers studying zinc gene manipulation have also been able to inhibit telomerase (Ren et al., 2007), but this is thought to be due to the zinc variant used and the particular gene target being associated with stress activation. Further researcher on the properties and utility of zinc may be needed in order to clarify its potential value in offsetting mortality and promoting telomere health.

Dietary medicine has developed rapidly in the last half century. Still, relatively little research has been done on the specific dietary needs of the elderly population. According to a report written by the Department of Food Scientists Faculty at the University of Copenhagen, Giacalone et al. (2016), the dietary scientists, are in need of focusing on the areas of food consumption habits, nutritional requirements, taste experiences, and diet preferences of older populations. In addition to this, the effects of declining general sensory function, mobility, and cognitive awareness have not been thoroughly explored. For example, more research support may need to be based on olfactory and gustatory acuity in the elderly. As it is typical for these senses to decrease with age, more spices may need to be added to make the food more appealing to these consumers. Further, aside from protein and Vitamin D requirements of this population, little is known about specific requirements for other essential nutrients. One University of Denmark project exploring this, CALM, for Counteracting Age-Related Loss of Skeletal Muscle Mass, has shown promise. CALM researchers have uncovered benefits of multiple, small, protein-rich, and diverse meals per day in elderly consumers.

Huang et al. (2018) has completed a project designed to assess the utility of a new index which may be used in identifying gender-specific nutritional predictors of health and lifespan. The new survey, called the Healthy Ageing Nutrition Index (HANI), may be used by clinicians and patients for the purpose of modifying poor dietary predictors of early mortality. Beginning in 1999, the study utilized 1898 participants over the age of 65 to complete the questionnaires and to be randomly assigned to the development and validation segments of the study. In 2008, death records from the National Death Registry were used to determine which questions best predicted gender-specific mortality. In the development group, four nutritional parameters were determined to be useful predictors of life expectancy for men: appetite, eating with others, dietary diversity score, and BMI. For women, cooking frequency, dietary diversity score, and BMI were found to be the best predictors of lifespan. The validation group provided the researchers with scores on the HANI indicating that plant-based diets and nutrients, high QoL scores, and higher muscle mass predicted the greatest life expectancy. High scores on this new, noninvasive tool were found to predict 44% and 61% reductions in mortality in men and women, respectively. This new index could prove useful as a continuously updated method for helping researchers and physicians with ways of monitoring and modifying the health of specialized groups in the future.

Conclusion

Development of a comprehensive view of QoL and health interactions can provide researchers, physicians, patients, and loved ones alike with bold new pursuits to increase overall lifespan and prevent unnecessary early mortality. New frameworks may be utilized in order to combine features of environment, personality, and health in order to best address the interconnected relationship they share in influencing the measures of well-being and health for older adults. Moreover, certain strategies may be implemented to help individuals to increase lifespan and enhance their QoL and wellbeing.

We have observe the roles of region and culture in influencing health practices and longevity outcomes in populations. The implementation of new public health programs and government incentives could enhance overall longevity within a community, particularly if suitable regional understandings guide them. This may even benefit the economy of a nation, as a reduced fiscal burden on the healthcare system and increased industrial productivity will likely result from a healthy aging workforce.

We have also observed the impact of recent studies into epigenetics and telomeres. Studies of this nature have given insight into how certain environmental experiences influence gene expression and the aging process. There may soon be new methods of reversing age-related physiological decline by way of altering certain telomere and gene modifiers (Sen et al., 2016). Such possibilities are highly exciting to scientists studying health in advanced age. Continuing to explore the relationship between genes, telomeres, and environments may give a better understanding of the strength of the influence of particular experiences and the impact they have on biological foundations and observable health outcomes.

We have also delved into health behaviors, such as diet, exercise, and social habits. It was discussed that sedentary practices, poor diet choices, and isolation tended to relate to a number of unsavory health outcomes, including increased instances of various chronic illnesses, such as diabetes, stroke, and heart disease. Many poor health practices have also been related to physiological dysfunction, negative mood, and reduced lifespan. Therefore, finding new ways to eliminate problematic health behaviors would likely be beneficial to many. Weight management may be utilized in order to optimize health and wellness in those with poor nutrition intake. Similarly, the growing older adult population may benefit from a better understanding of the role that physical fitness, sedentary habits, and exercise play in health outcomes. This could be a relatively inexpensive and positive way to promote one's own longevity. Giving physicians and their patients an understanding of the diverse ways to engage in physical fitness to suit their particular lifestyle may be a worthy future pursuit for health researchers. Further, implementing new strategies of connecting isolated elderly populations might benefit the QoL of a large number of socially isolated adults.

New approaches to modifying longevity and enhancing the lives of older adults may be pursued in a number of areas. Projects investigating personal health practices, epigenetics, coping mechanisms for stress, enhanced social networking, improved diet and fitness, and greater community involvement could uncover new applications for enhancing wellness and health in older adults. As time goes on, field professionals might serve this population well by taking a preventative approach in promoting healthy aging practices. Taken together, an understanding of how to empower communities and individuals to make autonomous changes may lead to many lives being enhanced and extended.

Now and in the future, there may be a need for a more expansive and focused research network on these issues. One which prioritizes data collection and analyses on aging and health problems in need of addressing. Potentially, insights gained in areas of advanced age, wellness, and longevity might lead to rapid social, biological, and psychological practices and programs that have not yet been evidenced. Such advances may give realization to that ever-elusive fountain of youth, from which billions of global older citizens may soon benefit.

> Ageing is not lost youth but a new stage of opportunity and strength. (Betty Friedan (1921–2006))

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Biopsychosocial Rehabilitation Approaches for Older Adults

3

Chasley Jones, Nancy D. Kishino, and Robert J. Gatchel

Overview

As reviewed in other chapters in this handbook, elderly/older adults are usually defined as 60 years of age or older. Currently, there are about 35 million older Americans, which is about 12.4% of the American population. By the year 2030, it is projected that 20% of the population will be older adults (U.S. Census Bureau, 2000; U.S. Census Bureau, 2001). Throughout life, we have continual maintenance to keep our body and minds performing for us. Whether it is showering, working out, or sleeping, we all do several different tasks in order to better prepare ourselves for upcoming events or just to assist with overall quality of life. During the later years of life, this can become more difficult; with the difficulties that develop, more effort is required for the typical behaviors required. It has been suggested that these cognitive declines and difficulties are, in part, due to the fact that the elderly tend to reduce their interactions with the environment around them (Miklashevsky & Fischer, 2017). These reductions, in turn, can increase loneliness which has been shown to be related to reductions in mental and physical quality of life in old-age adults (Gerino, Rollè, Sechi, & Brustia, 2017).

Unfortunately, the older adult population also has a higher risk of falling, and they then withdraw from physical activity which further increases their fall risk (Arfken, Lach, Birge, & Miller, 1994). Indeed, falls and fall-related injuries are a primary concern for older adults because they are antecedents to pain, disability, and functional impairment which, overall, causes a lower quality of life (D'Arcy, 2010; Halvarsson, Franzén, & Ståhle, 2015). Moreover, risk of falling increases as gait is impaired. Frail adults are often bedbound and need walking aids. Fortunately, though, recent research has shown that even frail adults can still join exercise programs specifically tailored to their needs and abilities. The exercise programs have been shown to increase muscle strength, balance, and overall physical functioning (Pils, 2016; Polatin, Bevers, & Gatchel, 2017).

Along with risk of falling, the elderly also have several different psychosocial issues that need to be accounted for during rehabilitation. Indeed, approximately 30–50% of older adults have symptoms of depression; 1–4% have depressive disorders; and about 25% have suicidal ideation,

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along with other symptoms of psychopathology that are more likely to occur at an older age (e.g., anhedonia, apathy, loss of appetite, hypochondriasis, and psychomotor slowing; Polatin et al., 2017; Cohen & Krajewski, 2014; Wuthrich, Johnco, & Wetherell, 2015). The highest suicide rates occur in those aged 65 years and older and increase with advancing age. Depression is commonly seen in older adults, although they are rarely diagnosed/treated appropriately or even referred to mental health specialists by their primary care providers (Cohen & Krajewski, 2014). In addition, pain is very common in the elderly (Hadjistavropoulos et al., 2007; Kaye et al., 2014; Piotrowski, 2014; Polatin et al., 2017). Because of its high prevalence, the present chapter will focus primarily on the rehabilitation of pain in older adults.

The Biopsychosocial Model: The Need for an Interdisciplinary Rehabilitation Approach with Older Adults

The biopsychosocial model assumes that illnesses are a result of a complex interaction among biological, psychological, and social variables. Figure 3.1 provides a visual representation of the biopsychosocial model for pain rehabilitation (adapted from Kaiser, Treede, & Sabatowski, 2017). Unfortunately, earlier in time, pain patients had traditionally been homogeneously grouped as the same and all treated in a similar manner, regardless of individual biopsychosocial differences. However, it has been shown that, even when pain patients have the same diagnosis and treatment, they still can have different tailored treatment need and outcomes (e.g., Fairhall et al., 2013; Gatchel, McGeary, McGeary, & Lippe, 2014). The traditional outdated *biomedical approach* to pain simply included limited interventions (e.g., surgery, medication) and lacked long-term benefits for the pain patient (Chou, 2013). Therefore, it is essential that treatments be “tailored” to the specific biopsychosocial differences of the individual in an interdisciplinary pain intervention program (IPIP).

Pain is a psychophysiological construct which can initially be subjectively measured from the patient’s report of the experience of pain. Due to this reason, we use many different measures to gather data on pain. However, it is ultimately up to the clinician’s interpretation of each measure to gauge what level of pain is being experienced (Gatchel, 2005). Pain is very rarely the only symptom experienced by a pain patient, especially with regard to chronic pain. Typically, pain is also associated with comorbid psychosocial issues, such as depressive disorders (40% prevalence), generalized anxiety disorders (22%), panic disorder (12%), and alcohol abuse (5%) that furthers the complexity of the assessment and treatment of pain (Darchuk, Townsend, Rome, Bruce, & Hooten, 2010; Polatin et al., 2017). In the experience of pain, there is also the problem of “stress and worry” (e.g., Will I be able to go back to work? How will I financially survive if I cannot?). This “stress and worry” will further determine how one’s behaviors will affect pain, through the “pain-stress cycle” [i.e., if pain is lowered, then stress and worry decrease; likewise, if stress and worry are lowered, then pain usually decreases (Gatchel, 2005)]. These pain-related relationships may then further amplify the experience of pain by triggering additional emotional and behavioral reactions (e.g., fear avoidance, catastrophizing, depression) that perpetuate the vicious cycle of pain, stress, and disability (Gatchel et al., 2014). This process can culminate in chronic pain patients adopting a “sick role,” whereby they increasingly focus on their pain and related disability while reallocating social and occupational responsibilities to others. The biopsychosocial model has generated some very effective comprehensive IPIPs that address this maladaptive “sick role” phenomenon (Gatchel et al., 2014).

Cognitive behavioral therapy (CBT) is well accepted as one of the best psychosocial treatment components of an IPIP. For example, Morley, Eccleston, and Williams (1999) initially documented, from a meta-analysis of studies, that CBT for chronic pain resulted in improved coping and social functioning. Catastrophizing, acceptance of the pain condition, and avoidance of activity (kinesiophobia) are a few of the areas addressed by CBT with

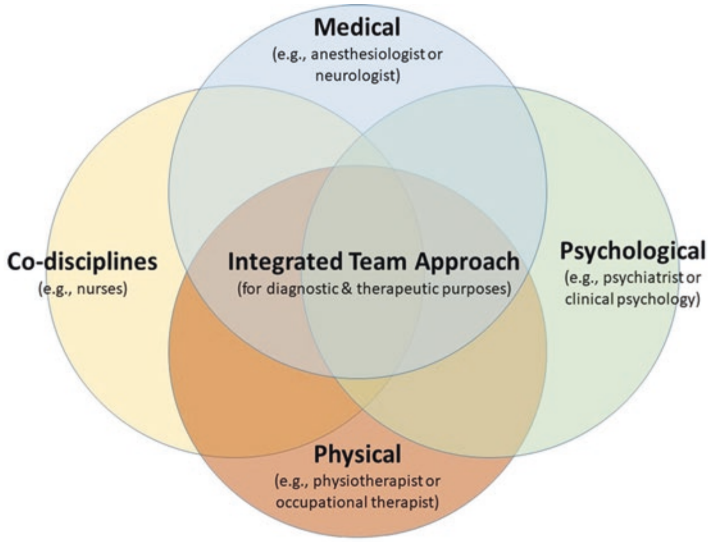

Fig. 3.1 Treatment structure of an interdisciplinary multimodal pain intervention approach. (Adapted from Kaiser et al., 2017)

chronic pain patients. Other methods used in CBT include relaxation training, attentional control, and motivational interviewing. CBT is advantageous because it is a short-term intervention that focuses on developing practical coping skills (Gatchel et al., 2014).

The biopsychosocial model is now viewed as the most heuristic approach to use in an IPIP and aptly depicts pain as a complex interaction among biological, psychological, and social factors that contribute to the pain experience (Gatchel, 2005; Gatchel et al., 2014). Moreover, in one study of an elderly population, those who were experiencing chronic low back pain (CLBP) scored higher on the psychosocial components of pain interference and fatigue (Hulla, Moomey, Garner, Ray, & Gatchel, 2016). Also, pain was found to impair several different other psychosocial outcomes (sleep impairment, increased anxiety, decreased functional capacity due to fear of movement, decreased physical activity, and increased risk of depression). This study further reinforces the use of the biopsychosocial model when evaluating and treating pain in older adults. Other examples will be presented later in this chapter.

Types of Interdisciplinary/Integrative Care

At the outset, it should be clearly noted that there is a difference between a multidisciplinary pain management program versus an IPMP. These terms are often used interchangeably; however, they are not the same. Multidisciplinary implies that several different healthcare providers are involved during the pain management treatment; however, the integration and communication among these providers may be limited because they may not be located at the same healthcare facility. In striking contrasts, an IPMP involves a fluid communication among several different healthcare providers because they are all working "under one roof" at a facility for the patient. This results in greater coordination of services, which helps alleviate stress and worry for the patient (Fricton, Gupta, Weisberg, & Clavel, 2015; Gatchel et al., 2014; Kaiser et al., 2017; Polatin et al., 2017). Interdisciplinary treatment for chronic pain patients is considered the most cost-effective and high-quality treatment that can be provided for chronic pain and has the highest long-term effectiveness across a range of domains (e.g., pain severity, interference of pain with function, etc.; Polatin et al., 2017; Fricton, Gupta, et al., 2015; Harris, Loveman, Clegg, Easton, & Berry, 2015; Gordon & Bloxham, 2016; Cramer, Lauche, Haller, & Dobos, 2013; Waterschoot et al., 2014; DeBar et al., 2012; Chou et al., 2009; Gatchel & Okifuji, 2006; Oslund et al., 2009). An IPMP must be fully integrated across various needed disciplines (i.e., behavioral specialists, nurse case managers, physicians, and physical therapists) in order to achieve the best outcomes (DeBar et al., 2012; Gallagher, 2011; Polatin et al., 2017; Turk, Wilson, & Cahana, 2011; Waterschoot et al., 2014).

Functional Restoration

Functional restoration (FR) was the first evidence-based IPMP for chronic pain disorders. Successful diagnoses, interventions, and management of chronic pain have been empirically documented using FR. From its formal initiation by Mayer and Gatchel (1989), FR required a team of clinicians who actively communicated well among themselves and consolidated their goals to improve physical and psychosocial functioning. One key component of this group-based FR program was the development of social support among the patients. As noted at the beginning of this chapter, such support can decrease loneliness, which has been shown to be related to reductions in mental and physical quality of life in older adults (Gerino et al., 2017). Gatchel et al. (2014) have provided an additional review of the successful FR approach. Subsequently, IPMPs (most of which are based on FR) were developed: Mayo Clinic Rehabilitation Center, Brooks Pain Rehabilitation Program, Rehabilitation Institute of Chicago Center for Pain Management, Cleveland Clinic Foundation, Chronic Pain Rehabilitation Program, and Functional Occupational Restoration Treatment (FORT) program (Gatchel et al., 2014).

Since this initial FR program, many other IPMPs have been shown to be effective. For example, in a study conducted by Darchuk et al. (2010), 411 patients with chronic pain, who also had psychosocial comorbidities, such as depression, sleep disturbances, anxiety, isolation, and impaired gait, were evaluated. They were also being “weaned off” of opioids and other medications. An intensive 3-week outpatient IPMP was used. Again, the program was based on a biopsychosocial model, which also incorporated opioid withdrawal. A total of 292 participants returned questionnaires assessing medication use, physical functioning, and emotional well-being 6 months after discharge. A significant decrease in depression, catastrophizing, pain severity, and pain interference was found among older patients who completed the IPMP, both immediately after discharge and at the 6-month follow-up. The intervention program also significantly bolstered perceived control, physical, and social functioning among older adults after discharge and at the 6-month follow-up. As participation in the program progressed, significant improvements were observed in mood, pain catastrophizing, pain severity, interference of pain, control of pain, health perception, physical functioning, social functioning, and role limitations from physical and emotional factors. Additionally, analgesic use decreased substantially as the rehabilitation program progressed.

Functional neurological symptom disorders (FNSDs) can be described as a motor or sensory disturbance in the absence of concrete neurological evidence. It is generally accepted that severe psychosocial stress can manifest itself physically, although an identifiable traumatic event is not necessary to diagnose FNSDs. A standard treatment for FNSDs has yet been developed. The most effective approach to addressing FNSD, as recommended by the DSM-5 (American Psychiatric Association, 2013), however, is an interdisciplinary approach in which coordinated efforts are made by physiatrists, neurologists, psychologists, speech pathologists, physical therapists, etc. (Yam et al., 2016). With interdisciplinary treatment, speech becomes mostly fluent and gait mostly normal. Once discharged, overall neurobehavioral functioning ratings improved (Yam et al., 2016). Relatedly, another concern which is best managed by interdisciplinary treatment is *dysphagia*, which is a common result of a stroke, and involves difficulty swallowing.

Approximately 37–78% of stroke victims develop *dysphagia* and often suffer further complications as a result. Efficient detection and management of *dysphagia* in stroke patients has been shown to reduce the length of inpatient care and institutionalization. In one study, it was found that a multidisciplinary protocol reduced the risk of many of the complications associated with *post-stroke dysphagia* (Gandolfi et al., 2014).

In another study, Boorsma et al. (2011) evaluated elderly pain patients in ten residual care facilities located in the Netherlands. Five of the facilities introduced interdisciplinary care, which included monitoring of disabilities, empowerment of the patient, and coordination of care from the interdisciplinary healthcare team at the facility. Participants in the integrative care group received a multidimensional assessment every 3 months which helped to guide the individualized care plan for the patient and which was discussed with patients and incorporated into their personal wishes/goals. Residents with complex care needs were scheduled twice a year for a multidisciplinary meeting, along with optional supplementary consultations with geriatrician or psychologists. As for the usual care control group, they received typical medical care from the family physician, which was neither coordinated nor structured. As a last integrative advantage, the elderly patients reevaluated outcomes every 3 months and were compared to benchmark values derived from data on all residents of residential facilities in the Netherlands, using the same instrument. The instrument showed good validity and reliability, developed by Morris, consisting of a 32-sum score, from the 32 risk-adjusted quality-of-care indicators (Morris, 2004). Using this instrument, it was revealed that the interdisciplinary treatment improved quality of care for the older adults in residential care facilities, relative to usual care (Boorsma et al., 2011).

Physical Medicine and Rehabilitation

The broad medical field of *physical and rehabilitation medicine* (PMR) was initially and specifically developed for reducing the impairment caused by illness when possible, thus preventing complications while improving functioning and activity. It can be viewed as an early form of IPMP. The most enlightened PMR programs fulfilled these aims by using a biopsychosocial approach to rehabilitation, which can be carried out in acute care or community care facilities. Pharmacological, physical, technical, educational, and vocational interventions are among some of the treatment components that PMR specialists may use. Prevention/management of illness and injury, promotion of health, and a focus on autonomy in daily activities are the focus for the intervention with geriatric patients. These specialists lead intervention teams that are interdisciplinary and are expected to assist patients in creating a program that will help them increase muscle strength, improve functional performance, and improve quality of life. PMR can be a well-coordinated process that starts at the onset of an injury or illness and continues until the patient has achieved a role in society consistent with his or her wishes. Specialists encourage elderly patients to take on an active approach to their aging, rather than a passive one. These interdisciplinary programs have been found to facilitate discharge and promote autonomous performance in daily activities (e.g., Pils, 2016; Polatin et al., 2017).

There have been a number of studies demonstrating the effectiveness of this approach. For example, Fairhall et al. (2013) administered a 12-month at-home intervention to 120 individuals over the age of 70, which only assisted participants who were defined as frail by the *Cardiovascular Health Study* (CHS) frailty phenotype, and helped them strengthen themselves. The participants had to meet three or more CHS criteria (i.e., slow gait, weak grip, exhaustion, low energy expenditure, and weight loss) to be considered frail. Also, the participants were older adults that were being discharged from the Division of Rehabilitation and Aged Care Services at Hornsby Ku-ring-gai Health Service (Sydney, Australia). Each intervention was tailored per participant's psychosocial profile and physical limitations. However, generally, there would be ten exercise therapy visits (which recentered balance) and lower limb training exercises (which were prescribed 20–30 min per day [and 3–5 times a week]) for the 12-month period, administered in addition to the usual care available to the older residents from community services and their general practitioner. For participants assigned to usual care (control group), the general practitioner was responsible for medical care and offered it on request. There was neither coordination nor structured planning of care. Using the scores from the *Physiological Profile Assessment* (PPA), which includes five measures of physiological functioning (postural sway, knee extension strength, reaction time, lower limb proprioception, and visual contrast sensitivity), it has been found to be reliable and predictive of falls (Lord, Menz, & Tiedemann, 2003). The intervention group performed significantly better than the control group by the end of the 12-month intervention through improved quadriceps strength, sway, and postural balance. There were also significant improvements in the short physical performance battery and 4-m walk, with an overall score of the intervention group being almost significantly higher than the control group. Fall risk factors were also successfully reduced by the 12-month intervention program, but fall rates themselves seemed to have remained unaffected by the intervention. This is most likely due to 25–50% adherence of participants averaging <1 h of intervention exercise per week. The fall risk outcome significantly improved for the participants who adhered >50% to the intervention program.

Another study, conducted by Cederbom et al. (2014), demonstrated that women who completed a 12-week multidisciplinary exercise therapy, which involved patients setting goals and cognitively critiquing their own physical therapies and goals. The comparison group received advice about physical activity and cognitive exercises for only the first visit; the remaining visits were only to collect diary entries. For exercise, the patients were asked to perform age-appropriate exercises (e.g., walking, chair-stand exercises, stair climbing, sit-ups, etc.) for 30 min a day, 5 days a week. The intervention (multidisciplinary) group also performed therapy involving setting goals for self-efficacy and balance, along with cognitively structuring and managing chronic pain. The intervention was found to improve the level of physical activity and self-efficacy more than the comparison group. This supports that a multidisciplinary intervention is more efficacious than a strict exercise regime. It would have been interesting to have evaluated whether a more comprehensive IPMP-type program would have produced better outcomes.

Other Integrative Models

Several treatments have been developed that closely resemble the earlier documented FR approach, although they are not purely interdisciplinary in nature. One such treatment, called *Improving Mood: Promoting Access to Collaborative Treatment* (IMPACT), was a multidisciplinary intervention model that consisted of psychologists and nurses who had expertise in geriatric depression. These geriatric depression specialists collaborated with primary care physicians and nurses at clinic sites to address depressive symptoms presented by older adult patients. The IMPACT program successfully alleviated depressive symptoms, boosted patient satisfaction, and improved clinical outcomes for 2 years following treatment. Unfortunately, most IMPACT programs ceased operations after their grant funding ran out (Cohen & Krajewski, 2014). Another short-lived study intervention was the *Prevention of Suicide in Primary Care Elderly* (PROSPECT) model, which aimed to treat depression and prevent suicide in older adult patients. Like IMPACT, PROSPECT used the expertise of psychologists and psychiatric nurses working in primary care. PROSPECT clinicians evaluated older patients using a comprehensive treatment algorithm and then provided physicians with treatment recommendations (drug doses, psychotherapy, etc.). The inclusion of depression care managers successfully decreased remission rates and also reduced suicidal ideation over a 2-year period in elderly patients with major/minor depression (Cohen & Krajewski, 2014).

Following the IMPACT and PROSPECT programs, transitions were tested between multidisciplinary and interdisciplinary approaches. A program called *Primary Care Research in Substance Abuse and Mental Health for the Elderly* (PRISM-E) was a study that compared *integrated models of care*, with *enhanced referral models*, focused on treating substance abuse and improving mental health. *Integrated models of care* and *enhanced referral models* differed in the fact that the former had substance abuse and mental healthcare specialists, as well as primary physicians, located in the same facility, whereas the latter referred patients out to separate clinics. Both models had comparable rates of depression remission, but the *enhanced referral model* was more effective at addressing older patients who were suffering from major depression (Cohen & Krajewski, 2014). Thus this PRISM-E program again showed that there is a significant advantage in interdisciplinary care over multidisciplinary care. It takes extra steps "off the patients' shoulders" and allows them to focus more on their own treatment.

Remote Integrative Care

This was an attempt to create a more remote interdisciplinary intervention through a program called *Bridging Resources of an Interdisciplinary Geriatric Health team* via *Electronic Networking* (BRIGHTEN), which used a team of interdisciplinary medical professionals located in different facilities who communicated electronically. Screening, assessment, team recommendations, and connection to appropriate services made up the BRIGHTEN approach. Screening was carried out using patient interviews and psychometric testing that included a modified version of the *Patient Health Questionnaire–2*, the *Geriatric Depression Scale*, the *Medical Outcome Study Short Form–12*, and the *Rush Interdisciplinary Needs Assessment*. Qualified patients then received individualized treatment plans and met with the program coordinator who informed them about the team's recommendations and then connected them with appropriate services. Evaluations of BRIGHTEN revealed that the program increased access to geriatric mental healthcare and reduced symptoms of depression to nonclinical levels, although physical health status usually remained unchanged (Cohen & Krajewski, 2014). The interpersonal interaction was discontinued here, and adherence to the physical treatment regime was decreased because there was low accountability for the patient. Behavioral health is imperative for the improvement of adaptive abilities and skills in geriatric patients. Each of the multidimensional models targets the assessment and treatment/management of depression to improve functional effectiveness, which then fortifies resilience (e.g., physical status, personal care, reduced falls, and pain relief; Leppin et al., 2014).

Mindfulness Skill Training Model

Another integrative care model, *Mindfulness Skills Training* (MST), teaches meditation and a mindfulness approach to a variety of medical conditions that include pain (Vranceanu et al., 2014). Mindfulness approaches have been demonstrated to decrease pain levels and contribute to improved quality of life, through a structured intervention which consists of eight weekly, 2-h group sessions that are then supplemented by home practice. All sessions include mindfulness exercises (e.g., yoga and other forms of mindfulness movement), along with CBT, structured to teach patients cognitive and behavioral skills for adapting to chronic pain and that maladaptive cognition and behavior can be changed to improve functioning (Cherkin et al., 2014). However, it is not clear whether the Cherkin et al. (2014) investigation systematically addressed improvement in function. A key outcome variable, such as physical function, is important to measure because there is significant evidence that self-report of physical function may often be unreliable (Prince et al., 2008). Overall, the training model can be a cost-effective method for reducing pain, but it is unclear whether the intervention restores function per se (Jackson, 2016).

Human-Animal Interaction Therapies

There are many other different treatment components available when applying the biopsychosocial model to pain management. There are even human-animal interaction therapies that are goal-oriented and planned interventions aimed to assist in daily living and quality of life. These programs provide a variety of positive outcomes of health and well-being for older adults. For example, Gee, Mueller, and Curl (2017) found that owning a pet also influences cardiovascular health, depression and anxiety, and social support for the owner. The owners of pets are required to be more active walking a dog or taking care of barn animals, which can significantly reduce health risks due to inactivity. Along with social interacting with pets, it provides a sense of support for the owner. Quality-of-life and life satisfaction scores decrease during retirement; however, for pet owners, life satisfaction does not decrease as much due to the network support and activities which are still kept up by pet owners (Gee et al., 2017. Due to the supportive pet being around and with the owner being involved in more physical activity, there are, however, increased risks of falls that are already a primary concern for older adults. Due to this increased fall risk, pet therapies need to be carefully and individually evaluated for practical use. If the patient has a high fall risk, it may be more beneficial to use another form of intervention, even though there are several health benefits involved in human-animal interaction interventions.

Transformative Care for Chronic Pain and Addiction

This relatively new approach, developed by Fricton, Gatchel, Lawson, and Whitebird (2017), emphasizes how to successfully manage patients in the healthcare system. This transformative care model operates with similar principles from the biopsychosocial model. The transformative care model (TCM) continues progressing the principles of the biopsychosocial model by recentering the focus from the healthcare providers to the chronic pain patient. The main goal of TCM is to retrain patient behavior with interventions toward better self-maintenance strategies. This is accomplished through patient trainings of self-management through personalized care strategies, which include integrative teams that are both online and in-person (Fricton, Gupta, et al., 2015). TCM focuses patient-oriented healthcare principles that prompt a passive patient to become an empowered patient through responsibility (Simon, 2012). As this transition moves from the healthcare provider being solely responsible for treatments to a more patient-empowered self-managed treatment approach (combined with evidence-based biomedical treatments), the outcomes become dramatically improved, and patients become less dependent on the healthcare system (Fricton et al., 2017; Fricton, Gupta, et al., 2015). Figure 3.2 provides a schematic of one form of the TCM approach, to be discussed in the next paragraph.

The most recent version of TCM is called *Personalized Activated Care and Training* (PACT), which involves in-house integrative care of the TCM, with online risk assessment and training programs to help further empower the patient (Fricton et al., 2017). Through the availability of the Internet, pain management is more easily seen as a maintenance method for the patient which improves outcomes (Bender, Radhakrishnan, Diorio, Englesakis, & Jadad, 2011). PACT provides an online platform where healthcare professionals can provide integrative self-management training and health coaching for individualized treatment plans. Through these online platforms, there are six components that assist in empowering the patient (i.e., *self-management*, *healthy habits*, *daily pauses*, *calming practice*, *telehealth coaching*, and *online delivery*). *Self-management* is training which concentrates on reducing risk factors and strengthen protective factors. *Healthy habits* focus on improving positive daily habits, which involve exercise, posture, diet, sleep, injury prevention, etc. *Daily pauses* aim to maintain mindfulness by checking daily lifestyle, thoughts, and social harmony. *Calming practice* is a relaxation training method to relax the body and mind.

Fig. 3.2 The PACT Program is designed to support the patient in self-management through their health professional, health coach, support group (i.e., family and friends), and personal online training. (Adapted from Fricton et al., 2017)

Telehealth coaching provides periodical alerts and reminders that involve coaching and strategies to help maintain the other principles. Finally, the *online delivery* component allows for a versatile and easily assessable treatment for the patients (Fricton et al., 2017). *Self-management* and *healthy habits* have been shown to have excellent outcomes that lower the risk of addiction and are more cost-effective long term, as supported by previous research (Fricton, Anderson et al., 2015), as well as from systematic reviews of randomized clinical trials (Cramer et al., 2013; Fricton, Velly, Ouyang, & Look, 2009; Gordon & Bloxham, 2016; Harris et al., 2015; Hayden, Van Tulder, & Tomlinson, 2005; Marley et al., 2014; Morley et al., 1999; Tang et al., 2015). *Daily pauses* also have evidence for improved outcomes, as documented by systematic reviews of mindfulness-based stress reduction (Chiesa & Serretti, 2011; Garmon, Philbrick, Padrick, & Goodman, 2014; Hilton et al., 2017; Rosenzweig et al., 2010). In addition *calming practice* has been supported through systematic reviews of meditation, relaxation, and resilience training (Galante, Galante, Bekkers, & Gallacher, 2014; Kwekkeboom & Gretarsdottir, 2006; Leppin et al., 2014). The availability of the *online delivery* component, and support from *telehealth coaching*, also has been documented to be efficacious from previous research (Bailey, Carleton, Vlaeyen, & Asmundson, 2010; Fricton, Anderson, et al., 2015; Simon, 2012) and systematic reviews of health coaching, social support, as well as computer- and Internet-based interventions (Veehof, Oskam, Schreurs, & Bohlmeijer, 2011; Campbelll, Wynne-Jones, & Dunn, 2011; Kamper et al., 2015; Holden, Davidson, & O'halloran, 2014; Garg, Garg, Turin, & Chowdhury, 2016; Buhrman, Gordh, & Andersson, 2016).

Key Research to Practice Message

Practice Recommendations

Pain management techniques have advanced from a simplistic biomedical model to a more heuristic and comprehensive biopsychosocial model in order to more thoroughly and cost-effectively treat patients with pain. The slow "morphing changes," which have been described above, reveal that patients' health outcomes improve when participating in an IPMP-type approach. Often, rehabilitation programs for pain involve relapse if contributing factors outside of pain are left untreated. Treatments have not only changed from biomedical toward biopsychosocial, but the biopsychosocial model has also shifted to a more holistic interdisciplinary care approach, which has allowed for a faster, a more thorough, and a goal-oriented approach, incorporating the wishes and self-management motivations of the patient toward positive health outcomes. The interdisciplinary approach requires a team of clinicians which communicates well among themselves, under the same organization, or "roof," and consolidates their goals to improve physical and psychosocial functioning. From the interdisciplinary methods, innovations have been incorporated by adapting the method to our technologically advancing society, which features interconnectedness through the Internet. The Internet involves higher treatment adherence with treatment reminders and allows for more rapid and accessible training/assessment, as well as connecting to healthcare professionals. Therefore, TCM is quite promising and is the most recent and updated model, putting more responsibility in the hands of patients and allowing them to recover as quickly as possible.

Future Directions in Practice and Research

Clinical research has clearly documented the advantages of the most recent developments in the biopsychosocial model. The most recent TCM provides patients with the potentially best chances in order to help in the rehabilitation process, instead of just remaining passive recipients of treatment. Still, there have sometimes been "disconnects" from using interdisciplinary pain management in practice. With the needs of pain management being a long-term problem when rehabilitating patients, one of the difficulties with the use of some of the approaches to pain management (e.g., cognitive behavioral therapy) is that they can be short term (Gatchel et al., 2014). That is why the biopsychosocial model of pain and disability is needed, because it produces the best long-term outcomes. The best long-term treatment outcomes are shown when specialty centers work closely with the patient's home provider (Gatchel et al., 2014). Therefore, adapting the TCM into clinical practice will greatly improve the treatment outcomes for chronic pain patients.

While using the biopsychosocial model to treat pain, the program has to be tailored to each participant; this is especially true for older adults. As reviewed earlier, there are certain risks that are more prevalent for older adults (e.g., falls, depression, problems, medication, etc.). Any intervention needs to take these risks into account and adapt the intervention in order to accommodate such risks (Hulla et al., 2016; Polatin et al., 2017). The majority of healthcare spending is on chronic pain, with a significant portion of that being for older adults; the TCM has the potential to be the most cost-effective method, even though it may take more time (Fricton et al., 2017).

Summary and Conclusions

It should be noted that the biopsychosocial model of illness was originally introduced by George Engel (1977). It was not specifically developed for better understanding pain but, rather, for more fully holistic focusing on a broader consideration of how illness, disease, and suffering one affected by the multiple biopsychosocial interactions that need to be attended to for successful treatment. The basic principles, practice, and scientific inquiries involved in his original biopsychosocial model were subsequently reviewed by Borrell-Carrió, Suchman, and Epstein (2004). This broad-based model is now used in the area of pain, as well as other illnesses and different models of intervention/rehabilitation. In the present chapter, we reviewed how it has been applied to pain, which is a prevalent and frequently untreated problem in older adults.

From the existing clinical research literature, we know that a large portion of Americans utilize the healthcare system for chronic pain, especially older adults. Older adults have specific risks that are more prevalent than in the general population and, with that in mind, treatment needs to be structured with accommodations to these risks in mind. The biopsychosocial, interdisciplinary approach for chronic pain has made significant advances in the field when it started incorporating several components instead of simply biomedical factors. This incorporation, called the biopsychosocial model, changed the understanding of pain by viewing it as being influenced by a variety of factors (e.g., social support, depression, anxiety, etc.) that all influence pain and pain sensitivity. The biopsychosocial model is continuing to evolve by taking an even more holistic approach and making it interdisciplinary by having several healthcare professionals involved and emphasizing the "tightening" of communication among these healthcare professionals (e.g., having the team work *under one roof*). The biopsychosocial model has continued shifting toward greater empowerment of patients, who play a more active role in their own rehabilitation. This allows for better treatment outcomes as patients embrace their own restoration. This continuing shift has resulted in the TCM, which connects the healthcare system to the patient in a way that patients are able to continue their treatment and adhere to the treatment program through use of the Internet. If we are able to adapt TCM treatment to clinical practice, it will greatly assist with treatment outcomes and its cost-effectiveness for chronic pain management, particularly in older adults. Indeed, the field of pain management has come a long way, from a simplistic biomedical approach to a more comprehensive biopsychosocial approach with requires the close interdisciplinary collaboration of healthcare professionals and patients. The progress in this field is reminiscent of the following quote:

> Coming together is a beginning; keeping together is progress; working together is success. (Henry Ford)

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4 Advancing Age-Friendly Workplaces Through the NIOSH National Center for Productive Aging and Work

Juliann C. Scholl, Bermang Ortiz, James W. Grosch, and Harpriya Kaur

Introduction

The workforce in the USA and other industrialized countries is aging, mainly because of increased life expectancy, the presence of the "baby boom" generation, and declining fertility rates (National Research Council and the Institute of Medicine, 2004, p. 1). More specifically, emerging trends, such as the shift toward nonstandard or contingent work arrangements and the erosion of defined-benefit plans, will require workers to prolong their stay in the workforce. Potential changes in state pension and retirement plans worldwide are expected to have an impact on retirement benefits as well as increase the age of retirement eligibility (Harris, 2017; Johnson & Steuerle, 2003). Early retirement is decreasing, and more people are continuing to work longer (Silverstein, 2008). Hence, understanding the safety and health needs of aging workers is a necessity, not only to better protect and advance the safety, health, and well-being of those who work into later life but also to take advantage of the important contributions that older individuals can make to their employers and society as whole.

The National Institute for Occupational Safety (NIOSH) has long recognized the growing need to examine the impact of age-related changes on the occupational safety and health (OSH) outcomes and well-being of aging workers. In 2015, NIOSH launched the National Center for Productive Aging and Work (NCPAW). Drawing from the concept *of productive aging* first articulated in the 1980s and adapting it to OSH, NCPAW seeks to advance the safety, health, and lifelong well-being of workers of all ages. This mission can be accomplished through the support of safe and healthy work environments for everyone through comprehensive strategies that allow workers to be safe, healthy, and productive at all ages. Older workers in particular are often the most skilled and the most susceptible to health and safety risk factors:

> Employers who do not anticipate the physical and cognitive capacities of older workers and who fail to provide the programs and policies needed to support their productive capacities and minimize their vulnerabilities will experience adverse impacts on quality, productivity, workplace safety, and workers' compensation. (Silverstein, 2008, p. 270)

As the populations of the USA and other developed countries have changed, so too has our

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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general outlook on the aging process and its interaction with work. While this chapter primarily discusses aging and work in a US context, the issues reflect similar international trends that pertain to the aging workforce. The purpose of this chapter is to explore the productive aging concept as it applies to workers of all ages. This chapter also applies this concept to workers' personal and professional development and their contributions to their organizations as they transition throughout the life cycle. Next is a review of the current landscape of the aging workforce in the USA and then a discussion of *productive aging* as a guiding framework for "age-friendly" workplaces, where the physical and psychosocial safety of all workers regardless of age is adequately sustained (de Guzman, Amrad, Araullo, & Cheung, 2014. This chapter also provides an overview of NCPAW's approach to *productive aging* in the context of occupational safety and health (OSH) and its research and practical implications.

The Aging Workforce

In the USA in 2015, persons 65 years or older represented 14.9% of the US population. By 2050, this figure is expected to grow to 22.1% (He, Goodkind, & Kowal, 2016). As the population ages, so does the workforce. In 2015, there were seven people of working age for each older (65+ years) person throughout the world; by 2050 that ratio will decrease to 3.2 or lower (United Nations, 2015). In 1994, the number of US workers 55 years and older was 15.5 million. Since then, the number has significantly increased to 23 million in 2004 and 33.9 million in 2014 and is projected to grow to 40.6 million in 2024. This group's share of the labor force has increased from 11.9% in 1994 to 21.7% in 2014, and it is projected to reach approximately 25% in 2024 (Toossi, 2015). These trends are mirrored in other parts of the world.

Also, most organizations in the USA have four or five generations of employees working side by side, something that workplaces have not seen until this point in history (Hammill, 2013; Knight, 2014). Similar trends can be seen in the advanced economies of Europe and East Asia (Coleman, 2015). Driving the aging of the workforce are longer life expectancies, falling fertility rates, and baby boomers staying in the workforce longer. Older workers are crucial for the prosperity of the US economy. Although millennials have overtaken the baby boomers in becoming the largest generation (Fry, 2016), employers will need to rely on older workers to remain competitive (Leoppke et al., 2013). Companies will need the contributions of workers of all ages while considering their health and safety needs.

Who Is an "Older" Worker?

To understand the occupational safety and health implications of an aging workforce, it is useful to examine certain assumptions associated with aging, health, and work. First, defining who is "older" often depends on the regulation being considered or the organization making the determination. The Age Discrimination in Employment Act (ADEA) protects workers 40 years of age and older from employment discrimination in the USA. The United Nations recommends 60+ years as the age at which an individual can be considered older (United Nations Population Fund & HelpAge International, 2012). The US Bureau of Labor Statistics has used both ages of 55 and 65 years old as cutoff points separating older employed adults from younger age groups in their statistical reports (Toossi, 2015; US Bureau of Labor Statistics, 2008). In Europe, the focus is typically directed toward workers age 45 or older (National Research Council and the Institute of Medicine, 2004, p. xii).

Chronological age has traditionally been used as an indicator of the physical, cognitive, and social changes that occur with aging and as the leading sorting variable by which a person is considered older (Truxillo, Cadiz, Rineer, Zaniboni, & Fraccaroli, 2012). Chronological age is a measure of time, a proxy variable used to understand age-related changes (Schwall, 2012). However, chronological age does not fully represent the age-related processes that influence the nature and trajectory of aging, and it does not explain the variation in functioning among older individuals. Older individuals tend to have greater variability in functioning than younger individuals, which suggests that chronological age by itself can be an incomplete way to gauge whether or not an older person can do a task or activity (Grosch & Pransky, 2010). A better predictor might be subjective age, which is how old or young one feels relative to their chronological age (Beier, 2015; Kunze & Boehm, 2015; Montepare, 2009). Exposure to work-related safety and health hazards in early life can have an impact on subjective age and consequently influence later life safety and health outcomes. Hence, it is vital to respond to safety and health hazards that pose threats throughout the life-span.

Impacts of an Aging Workforce

The process of aging influences the safety and well-being of workers in both positive and negative ways (Leoppke et al., 2013). Age can be positively related to safety performance and organizational citizenship behavior (Ng & Feldman, 2010). In addition, older workers tend to experience lower rates of nonfatal work-related illness and injury compared to younger workers; however, fatality rates are higher for older workers (Silverstein, 2008; Topf, 2000). Unavoidable age-related changes in function do not necessarily lead to reduced job performance or incapacity. While some older workers leave work because of illness or limitations, many do remain, according to Silverstein.

There are certain occupational risks associated with aging on the job. For instance, the changes in different organ systems of the body (e.g., musculoskeletal, cardiovascular, respiratory, sensory, and immune) typically result in declines in functional capacities that influence worker safety, health, and well-being (Maertens, Putter, Chen, Diehl, & Huang, 2012). Moreover, research suggests that some cognitive functions such as working or fluid memory, decision-making, and problem solving tend to decline as people age; however, job performance does not always suffer (Jex, Wang, & Zarubin, 2007; Park, 2000; Rizzuto, Cherry, & LeDoux, 2012). The rate of cognitive decline often depends on the nature of the job or the health of the individual. Some mental functions that involve spatial abilities, processing complex stimuli, and problem solving are particularly age-sensitive (Silverstein, 2008). Controlling for a number of demographic and health variables, cognitive decline after retirement has been shown to be slower among individuals who held with higher mental demands (Fisher et al., 2014). Therefore, as discussed earlier, there is great variability in the changing physical and cognitive capabilities of older workers.

The positive and negative aspects of aging are not unique to older workers. A life-span approach to protecting an aging workforce acknowledges age diversity and differences among age groups. One dimension of variability is the perception and influence of time. Socioemotional selectivity (SES) theory points to perception of time as the influence on people's selection and pursuit of goals (Carstensen, 1995; Carstensen, Isaacowitz, & Charles, 1999). When time is viewed as more unrestricted, workers prioritize knowledge acquisition, as is the case with many younger workers. It makes sense, then, that older workers place more emphasis on emotion regulation, which is more oriented to the present rather than the future. Ng and Feldman (2010) use SES to explain the relationship between age and job attitudes. Their meta-analysis found that age was related to many job attitudes, such as satisfaction and involvement, and with older adults focusing more on emotionally fulfilling activities than on acquiring knowledge.

Older and younger workers exhibit attitudinal differences in the context of work, particularly in their attitudes toward supervision. Older workers tend to value authority and rules but highly regard freedom from supervision (Joyner, 2000). Younger workers dislike being micromanaged, but they tend to want strong leadership and clear instruction (Joyner, 2000). While younger workers appear to require regular feedback, older workers might be insulted by it (Jurkiewicz & Brown, 1998). Training needs also differ among younger and older workers. Whereas younger workers prefer to learn both hard (e.g., computer programing, machine operation) and soft skills (e.g., communication skills, teamwork) on the job, older workers welcome hard skills training through instruction (Deal, 2007). Although there are differences, the generations display similarities (Giancola, 2006), such as their work ethic (Smola & Sutton, 2002) and what motivates them to be engaged (Towers Perrin, 2006).

An aging worker population has some economic implications. Silverstein (2008) predicts that employment policies will likely be adapted to accommodate workers who want and need to stay on the job longer. There also will be a greater need for private health insurance until the age of 65 because of rising healthcare costs and the shift from defined benefit pensions plans to contribution-based retirement programs. Add to this the likelihood that continued employment of older workers will be crucial to the USA and global economy because employers will not have the steady stream of younger workers to depend on to remain globally competitive (Harris, 2017; Leoppke et al., 2013).

Age diversity in the workplace is not the only reason that productive aging is relevant across the working life. Workers young and old go through the aging process. Aging involves physical, cognitive, and socio-emotional changes that affect how people do their work and how they have to make adaptations to how they do their jobs and the environments in which those jobs are performed. Maximizing worker health and safety is beneficial at all life stages, is an investment that saves money, and reduces chronic health conditions later on in life (Leoppke et al., 2013).

Productive Aging and Work

Background

The concept of productive aging has been used to address the opportunities and challenges that come with an aging workforce (Cole & Macdonald, 2015; O'Reilly & Caro, 1994). It provides a context for how interventions, training, and educational material about worker safety and well-being can capitalize on the assets older workers bring to organizations (Wheeler & Giunta, 2009). Within the workplace, productive aging does not merely relate to older workers' ability to continue performing their jobs, but it also refers to how workers can thrive and make important contributions throughout their working lives (Butler, 1985; Butler & Schechter, 1995).

Not until the 1980s did the OSH field begin to direct interest toward the interface of work and aging. Cross-sectional studies among municipal employees emerged in 1981 and were conducted by the Finnish Institute of Occupational Health (FIOH) (Ilmarinen & Tuomi, 2004). Early efforts to study productive aging stem from concerns over negative perceptions of older people and the loss of their abilities (Bass, 2002). To combat perceptions that older adults were an economic burden on society, Butler (1985, 2002) introduced the term *productive aging* to provide a more well-adjusted view of the value and competencies of older adults. In response to the dominant discourse of dependency and burden that framed the discussion of older individuals in society, Butler and others sought to introduce a counterbalancing perspective that recognized the actual and potential contributions of older people to their work, community, and family (Leland, Elliott, & Johnson, 2012). Accordingly, productive aging emphasizes that older individuals have the skills, expertise, and experience needed to meaningfully engage in productive behavior in later life in different domains, such as paid labor, volunteer work, continuing education, housework, and caregiving at home.

There is some disagreement as to what should be considered and included under the umbrella of productive aging. Should only activities within the labor market be considered productive? Should it also include activities outside the traditional labor market such as volunteering, housework, childcare, homecare, and continuing education? The absence of a universal definition reflects these different preoccupations. For instance, productive aging may refer to any activity that produces goods or services, whether paid or not, or develops the capacity to produce goods or services (Bass & Caro, 2001). Morgan (1986) defines productive activities as “activities that produce goods or services that otherwise would have to be paid for” (p. 74). Herzog, Kahn, Morgan, Jackson, and Antonucci (1989) define productive aging as “any activity that produces goods and services, whether paid or not, including activities such as housework, child care, volunteer work, and help to family and friends” (p. 130). Butler and Schechter (1995) describe productive aging as “the capacity of an individual or a population to serve in the paid workforce; to serve in volunteer activities; to assist in the family; and to maintain to varying degrees, autonomy and independence for as long as possible” (p. 824). Albeit these definitions differed in the range of activities considered to be productive aging, they all seek to recognize the value of older people.

Productive aging might be conflated with *successful aging*, which Rowe and Kahn (1998) define as “growing old with good health, strength, and vitality” (p. 33). People who age successfully remain actively engaged with their social networks, exhibit a low risk for disease and disability, and have high mental and physical functioning. Successful aging can also mean being able to make plans and have control over one’s life, practicing healthy habits, and continuing some activities they have enjoyed in the past (Carlson, Clark, & Young, 1998). Compared with successful aging, *productive aging* is placed within the context of work, whether it be paid, volunteer, or in the form of caretaking (Butler & Schechter, 1995; Schulte, Grosch, Scholl, & Tamers, 2017). Cole and Macdonald (2015) also argue that productivity refers to both paid and unpaid occupations (e.g., student, caregiver, volunteer) that enhance individual and society-level development. While aging can be associated with cognitive and physical losses (e.g., hearing loss, diminished visual acuity), it is also linked with gains and growth (e.g., higher job satisfaction, lower rates of injury overall) (Silverstein, 2008). Focusing on the gains can help workers increase their sense of self-management (i.e., taking charge of one’s own aging process), use social connections, and participate in self-fulfilling activities to continue to contribute in meaningful and productive ways (Cole & Macdonald, 2015) both in and outside the work environment (Caro & Bass, 1995; Hinterlong, 2008). The implication is that a multifaceted view of aging and occupational safety and health (OSH) can facilitate work environments that are supportive of health, well-being, and productivity to sustain workers throughout their working lives (Schulte, Grosch, et al., 2017).

As a construct, productive aging has important limitations and criticisms that need consideration. Remaining productive in later life often is not a choice, but a necessity for many (Wheeler & Giunta, 2009), especially for historically marginalized groups like women and ethnic monitories who are obliged to remain productive due to economic vulnerability and/or social commitments (Estes, 1999). Thus, social dimensions such as gender, race, ethnicity, and socioeconomic status play a major role in shaping one’s experience in old age. Each of these characteristics, along with age, can add obstacles to workers’ safety and health (NIOSH, ASSE, 2015). Consequently, critics suggest that such a concept needs to explicitly recognize the social structures and power relations that determine older people’s opportunities, choices, and experiences related to the many forms of “productive” or “nonproductive” activity they undertake (Estes & Mahakian, 2001).

Additionally, productivity is not just about participation in the labor market; people also can be productive when they engage in leisure activities, volunteering, caretaking, and other endeavors outside of work (Butler, Oberlink, & Schechter, 1990). As previously discussed, earlier conceptualizations overlook continued personal growth and enrichment through the life-span, and the benefits of maintaining a physically active lifestyle (Bass, 2002). While leisure activities and other endeavors outside of work might not seem tied directly to traditional labor, they are a part of what contributes to an individual’s self-actualization (Wheeler & Giunta, 2009), which can have a significant impact on the kinds of contributions employees make in the workplace, such as modeling safer work practices, calling attention to hazards in the physical environment, or transferring knowledge to co-workers who have less experience on the job.

The National Center for Productive Aging and Work (NCPAW)

Early in the twenty-first century, NIOSH and its partners asked the National Research Council and Institute of Medicine to examine the interaction between work and the aging process. This investigation resulted in the identification of some pressing needs for advancing the health and safety needs of older workers: (1) improved databases and data systems for conducting informative research, (2) research that leads to a better understanding of the factors that relate to the health and safety needs of older workers, and (3) identification and clarification of the aspects of policies, programs, and interventions that benefit older workers (National Research Council and Institute of Medicine, 2004).

In 2012, NIOSH and the American College of Occupational and Environmental Medicine (ACOEM) convened a summit to discuss barriers to integrating programs that protect aging workers' health (Leoppke et al., 2013). Attendees produced recommendations for establishing best practices, such as prioritizing work flexibility, managing environmental hazards, providing interventions that promote healthy lifestyles, and requiring aging workforce skills training for managers. Leoppke et al. also argue that a widespread discourse is needed to build awareness for protecting and promoting the health of aging workers.

Current projects at NIOSH that address aging include training for the design of age-friendly workplaces for nurses, examination of the long-term health and economic consequences of work, age-awareness training for workers and employers, chronic illnesses and conditions that affect older workers, and the development of resources to help organizations meet the needs of their aging workers ("Productive aging and work: Current research." NIOSH, 2015a). Notwithstanding current and published research on the aging workforce, there exists a substantial gap between what we know about the aging process and how it interacts with the experiences of workers. In addition, to increase collaboration and interaction among investigators, NIOSH strives to build more structured and continuous activities in research and practice in order to better meet the health, safety, and wellness needs of aging workers.

To better meet these needs, NIOSH officially launched the National Center for Productive Aging and Work (NCPAW) in 2015. The purpose of NCPAW is to pool the knowledge and expertise on aging within NIOSH and to work with external partners to develop resources for advancing "age-friendly" workplaces. The fourfold mission of NCPAW is to:

- Develop institute-wide research goals and leadership with regard to workers of all ages, *as they age*.
- Facilitate both intramural and extramural collaboration when it comes to advancing research on the aging workforce.
- Further develop knowledge on interventions and best practices for creating an "age-friendly" workplace from the physical, emotional, economic, and labor relations perspectives.
- Develop and promote a broad range of translational products and resources that target workers, organizations, and sectors where aging issues are particularly salient.

The center's approach to productive aging emphasizes the importance of the work environment and changes to the environment that ideally benefit both workers and organizations. Programs and strategies designed to meet the changing needs of aging workers are not just intended to benefit older employees (e.g., those aged 50 and over), but those of all ages.

Work Ability

NCPAW's approach to productive aging is informed by the concept of work ability, which was first introduced and developed by researchers at the Finnish Institute for Occupational Health (FIOH) (Ilmarinen, Gould, Järvikoski, & Järvisalo, 2008; Ilmarinen et al., 1991a. 1991b). Work ability refers to a worker's capacity to continue working in his or her current job, given adequate working conditions and available resources (Ilmarinen et al., 2008). Working conditions include aspects of the work environment such as physical characteristics (e.g., ergonomic issues), work organization (schedule flexibility), and supervision. Resources include health, functional abilities, job skills, and family/community support (Ilmarinen, 1999). Work ability—perceived or actual—is an important factor in preventing early departure from work due to debilitating injuries or illnesses (McGonagle, Fisher, Barnes-Farrell, & Grosch, 2015). McGonagle et al. have found that personal factors, such as emotional stability and sense of control, have found to be more reliable predictors of perceived work ability than more physical indicators of health status, such as environmental conditions or body positioning.

Strategies to maintain or improve work ability can be grouped into four basic areas: (1) working conditions (ergonomics, industrial hygiene, and safety), (2) employee health (healthy lifestyles, functional capacity), (3) professional skills (job-related knowledge and competence), and (4) psychosocial factors (work arrangements and flexibility, social support, and culture) (Ilmarinen, 1999; Silverstein, 2008). Research in this area resulted in the development of the Work Ability Index (WAI) (Ilmarinen & Tuomi, 2004), which has been shown to be a reliable measure applied to the research and practice of occupational healthcare (de Zwart, Frings-Dresen, & van Duivenbooden, 2002).

Total Worker Health®

NCPAW's approach to productive aging is also informed by Total Worker Health® (TWH), which is characterized by "policies, programs, and practices that integrate protection from work-related safety and health hazards with promotion of injury and illness prevention efforts to advance worker well-being" ("What is Total Worker Health(R)?" NIOSH, 2016c). TWH integrates workplace interventions that protect workers' safety and health with activities that advance their overall well-being, on and off the job. The emphasis on integration reflects the fact that occupational safety and health programs have traditionally been compartmentalized and often function as disjointed components, and a growing body of research suggest that an integrated approach is more effective than traditional safety and health programs that operate in isolation (Schill & Chosewood, 2013).

TWH not only prioritizes a hazard-free work environment for all workers. But it also comprehensively addresses other workplace systems, including those relevant to the control of psychosocial hazards and exposures, the organization of work, compensation and benefits, and work-life management efforts. Encouraging optimum well-being includes employee engagement, support for healthier behaviors, and more balance between work and life (Schill & Chosewood, 2013). TWH calls for a holistic understanding of the factors that contribute to worker well-being, one of which is aging. Workplace risk factors previously considered unrelated to work (e.g., obesity, sleep disorders, cardiovascular disease, depression) can be especially problematic for older workers. Also relevant to older workers is productive aging and preparing for a healthier retirement.

Both TWH and work ability provide useful frameworks for productive aging within the context of work. The emphasis rests on developing sustainable, well-coordinated strategies that span several different dimensions of safety and health, including factors outside of the workplace. These strategies are not limited to a specific age group and are intended to have benefits for workers of all ages.

Model of Productive Aging and Work

Drawing on both work ability and TWH, NCPAW strives to support productive aging across the life-span by encouraging age-friendly workplaces. Such workplaces are those that use best practices and interventional strategies to keep employees of all ages healthy and safe, thus helping them to reduce or manage their risks throughout their working lives (Johns & Weissman, 2015). Age-friendliness has both physical (e.g., office design, provision of healthcare services) and psychological aspects (e.g., employee involvement, bullying prevention) (de Guzman et al., 2014). NCPAW's approach to productive aging has four attributes suggesting that age-friendly workplaces embody (1) a life-span perspective, (2) a comprehensive and integrated framework, (3) outcomes that recognize the priorities of both workers and organizations, and (4) a supportive multigenerational work culture.

A Life-Span[1] Perspective A goal of productive aging is to better understand the pattern of change that occurs during different periods of a person's life (i.e., life-span) and to identify the forces that underlie such patterns (Baltes, Lindenberger, & Staudinger, 2006; Sigelman & Rider, 2015). These transitional patterns ensue from the first day on the job to post-work retirement. Age-related transition is experienced by all workers, not just those over a certain age. In other words, everyone ages, and this aging process is dynamic, influenced by the environment and culture, and is marked by both gains and losses.

In addition to chronological age previously discussed, there is subjective age (perceptions of age), identity age (the age group with which one feels connected to), felt age (the age one feels), and cognitive age (how one looks, feels, acts, and interests are affiliated with) (Truxillo et al., 2012). These different measures of age can give more information on how workers perceive and approach the characteristics of their jobs and how well they are able to perform them (Cleveland & Hanscom, 2017). These measures of age also shed light on how people adapt to context and environment as they get older. According to the life-span work motivation framework (Kanfer & Ackerman, 2004), four developmental patterns can predict work motivation: *loss* is the decrease of intelligence (e.g., attention, working memory) due to age. *Growth* represents the increase in experience-based knowledge and learning capacity that develops with age. *Reorganization* refers to how people's abilities and nonabilities change and are restructured throughout adulthood (e.g., goal structures, priorities). *Exchange* characterizes the strengthening of certain tendencies (e.g., emotional stability, self-esteem) with progressing adulthood. Work motivation is one of many patterns that reflect adaptive processes over time. More specifically, older workers' motivation to work tend to revolve around interacting with others and to transmit knowledge to others (Kanfer, Beier, & Ackerman, 2013). Also according to Kanfer et al., older workers' motivation to retire are less known because research has not done much to distinguish motivation to leave a specific job and motivation to retire from work altogether. Motivation at work (in the context of performing one's job) can change with age, depending on job demands (e.g., physical demands, job complexity) and personal characteristics (e.g., perceptions of time left at work, opportunities). Truxillo et al. (2012) explain, "A lifespan perspective is useful for examining the interplay between age and work characteristics because adults spend a significant part of their lifespan at work, where they have ample opportunity to display these adaptive processes" (p. 7).

The life-span perspective also acknowledges the development of universal and interindividual differences (Baltes et al., 2006; Bengston, Elder, & Putney, 2005). There is a cumulative effect of different factors. For example, a work-related

[1]The authors acknowledge that life-span and life course are sometimes used interchangeably, but that the two terms originate from different disciplines. Life-span, a term from psychology, emphasizes heterogeneity across older individuals and the importance of plasticity and within-individual change. Life course, a sociological term, focuses on events at the macro level, studying the effect of groups, organizations, and institutions on the lives of individuals; principal considerations include social factors such as economic conditions and social networks. In this chapter, productive aging is discussed in relation to the adaptability, plasticity, and change that are inherent to the aging process, which is why this term is used instead of life course.

accident or injury even in early life could result in increasing detriments to physical ability, health, finances, and social relationships. This illustrates the contextual nature of the aging process. The cognitive, social, and biological changes taking place during the life-span do not occur in a vacuum but in important contextual settings: families, friendships, community, workplace, and society. All these dimensions can vary in how they affect the functional decline of individuals that establish different limits for different people in their ability to be productive. The structure and design of one's work, the type of workplace relationships individuals develop, and certain work-related happenings (e.g., disability, career progression, retirement) can all have an impact on a worker's capacity to age productively.

Comprehensive and Integrated Framework Aging is multileveled, contextual, and dynamic. Consequently, policies, programs, and interventions targeted to protect the safety and advance the health and well-being of workers across their life-span should be multidimensional, well-coordinated, and holistic. This implies that any program or intervention that enhances workplace age-friendliness must incorporate several different aspects of safety and health in order to be sustainable. In their review of research addressing older workers' health and safety needs, Crawford, Graveling, Cowie, and Dixon (2010) suggest that interventions needs to account for physical activity, intellectual pursuits, and lifestyle factors when moderating age-related changes.

Frameworks should also be comprehensive in the topics areas they draw upon. For instance, frameworks that address working conditions need to incorporate ergonomics and industrial hygiene. Psychosocial health campaigns should combine information on social support, safety culture, and work design (Ilmarinen, 1999). An integrated approach also means protecting and advancing workers' health as they age and at the same time maximizing the intellectual, physical, and social assets they bring to the job (Leoppke et al., 2013). Finally, integrated strategies should not be limited to certain age groups, but provide benefits to all workers as they age.

Outcomes That Recognize the Priorities of Both Workers and Organizations A productive aging approach underscores the importance of worker- and organization-centered outcomes and how they can mutually influence each other. These outcomes can include improving safety and well-being (worker-centered) to reducing absenteeism, maintaining job performance, and lowering healthcare costs (organization-centered). For example, an organization that can improve its productivity might be able to use additional earned income to invest in worker well-being programs and injury prevention interventions. Similarly, improvements on "worker-centered" outcomes such as trust and well-being can lead to reduced organization-centered outcomes such as, absenteeism, higher productivity, and fewer reported workplace injuries (Harter, Schmidt, & Keyes, 2003). Preferably, any changes directed to make the workplace more age-friendly can and should focus on outcomes that are beneficial to both workers and organizations, such as worker satisfaction, work engagement, and job performance (Truxillo et al., 2012).

The duality of worker and organizational outcomes is represented in Fig. 4.1, which shows their interdependent relationship. The bidirectional arrow between the two types of outcomes illustrates that changes in either workers' or organizations' outcomes can influence the other. For example, installing new flooring to reduce knee strain might be a benefit to employees but might seem too costly for the company. Despite the potential negative outcomes to both parties, the reciprocal nature of the worker-organization relationship suggests that implementing integrated safety and health measures is not only beneficial to workers of all ages, but that it also translates to organizational benefits. If a worker with a chronic disease chooses to remain working, it might be because the health condition is not severe enough, and the desire to leave work could be outweighed by the continued income and health insurance. With strong support and reasonable job

Worker-Centered Outcomes	Organization-Centered Outcomes
Maintenance of individual physical and mental health	Lower health care costs
Safe work environment	Reduced workplace injuries, disability, and worker's compensation costs
High level of job satisfaction	Low turnover and absenteeism
Ability to make contribution to the organization	Maintenance or improvement in overall productivity of workforce
Ability to meet needs outside of work	Recruitment and retention of experienced workers
Fair treatment and respect	Transfer of expertise between generations

Fig. 4.1 Worker- and organization-centered outcomes. (Source: NIOSH, 2015d)

accommodations, the worker can continue to gain the benefit of employment, and the organization can retain the skill and experience of that employee (Silverstein, 2008). Thus, both categories of outcomes need to be recognized and incorporated into any attempt to encourage safe and healthy workplaces where workers of all ages can thrive.

Productive aging is a useful framework wherein the interrelationship of worker-centered and organization-centered outcomes of aging and work can be better understood. It also suggests a course of action for employers to develop and implement programs and policies that support the changing work capacities of aging workers, minimize work-related safety and health hazards, and ultimately benefit from the gains in competiveness, productivity, and sustainable business practices. For instance, changes to Social Security in the USA imply that retirement benefits will be affected and the age of eligibility will continue to rise (Moody & Sasser, 2015). Therefore, it is important to understand what factors predict early departure of employees from the workforce. McGonagle et al. (2015) argue that research into these factors can help employers improve the work ability of their workers and reduce the reduction of highly skilled and experienced employees due to early departure.

Supportive Multigenerational Work Culture A generation is a cohort of individuals born during the same period of time that share a set of formative life experiences (e.g., economic and political movements, historical events) that shape their attitudes, beliefs, and values (Borman & Hedge, 2012). Given shifting population demographics, multigenerational workplaces are increasingly common and bring unique challenges and opportunities to the workplace (Schill & Chosewood, 2013). The generations in today's workforce can be categorized as World War II (or Silent) Generation, 1925–1945; Baby Boom Generation, 1946–1964; Generation X, 1965–1980; and the Millennial Generation, 1981–2001 (Horovitz, 2012; Howe & Strauss, 1991). Although often subtle, differences between generations can include attitudes toward work and supervision, preferred communication style, training needs, and work habits (Deal, 2007; Joyner, 2000; Jurkiewicz & Brown, 1998; Smola & Sutton, 2002). Learning to manage these differences and build upon the unique strengths of each generation creates an inclusive workplace culture that also contributes to productive aging.

This level of generational diversity raises important considerations related to the well-being of workers immersed in a multigenerational workplace. For instance, there is a risk in simplifying a single generation down to one characteristic when there can be a great deal of variability. For example, the relationship between retirement and age-related cognitive decline does not occur at the same rate for all workers. Fabrizio and Franco (2017) found the decline was more pronounced for people who had more physically demanding jobs. Another consideration is that it can be difficult to separate the effects of age from other work-related changes that occur over time (e.g., career progression, disability). Because behaviors and training needs can vary across age cohorts, organizations are well-advised to take inter- and intragenerational differences into account when designing or implementing training, motivating workers, or using communication strategies to foster teamwork and knowledge transfer among employees. Such strategies might have to take into consideration age-related stereotypes about co-workers when teamwork and mentoring are utilized.

A supportive age-diverse work culture involves knowledge of the age group makeup of a workforce. Such knowledge can aid in developing programs and policies that are broad enough to address all workers' needs (e.g., family leave policies that appeal to both younger and older workers). A supportive culture also facilitates conversations about generational issues and encourages constructive interactions among employees (e.g., mentoring that leads to knowledge transfer). A key goal of this culture should be to use the diverse skills, knowledge, and perspectives of all workers to create a more unified and productive organization. Broadening the discussion about aging within the workplace will likely encourage stronger collaboration and cross-generational knowledge transfer (Leoppke et al., 2013).

Implications for Advancing Productive Aging

The study of aging and work offers a fertile ground for the advancement and application of varied research and practice related to occupational health and safety. In addition to basic and applied research on the aging workforce, advancement of productive aging has to consider the advancement of best practices, appropriate use of interventions, and the translation of key findings into useful tools and resources. Using the four-pronged mission of NCPAW that was previous discussed, this section outlines recommendations in four areas: (1) research, (2) internal and external collaborations, (3) best practices for age-friendly workplaces, and (4) translating research into products and resources.

Research

One of NCPAW's missions is to develop institute-wide research goals and leadership with regard to workers of all ages, *as they age*. NCPAW has identified three areas of research goals to advance the understanding of workplace factors that contribute to the productive and healthy aging of workers ("Productive aging and work: Research goals." NIOSH, 2015b). These three areas are (1) surveillance, (2) research on the health effects and mechanisms of aging, and (3) research on evidence-based practices and intervention targeted to aging workers.

In terms of surveillance, NCPAW conducts and facilitates the collection, analysis, and interpretation of workplace health and safety data to better understand the life-span health outcomes and harmful workplace risk factors such as physiological, cognitive, and psychosocial that aging workers are exposed to. Surveillance is used to recognize and comprehend salient OSH issues and trends and allows for identifying priorities for research and intervention. For example, changes to Social Security in the USA imply that retirement benefits will be affected and the age of eligibility will continue to rise (Johnson & Steuerle, 2003). Monitoring such trends is important for organizations to understand what factors predict early departure of employees. McGonagle et al. (2015) argue that research into these factors can help employers improve the work ability of their workers and reduce the reduction of highly skilled and experienced employees due to early departure.

Second, research is being conducted to identify and characterize mechanisms and health effects of workplace risk factors for productive aging in workers across the working life. Observational and laboratory research examining risk and protective factors associated with aging leads to greater knowledge and ways to improve interventions. Despite the positive consequences of prolonged work such as economic and cognitive ability, there are also risks of continued work, including burnout and age discrimination (Fisher, Ryan, & Sonnega, 2015). Other important areas of health effects research include job lock (restricted job mobility), changes in cognitive functioning before and after retirement, job-related physical performance, and effects of chronic conditions like coronary disease among older workers (see "Productive aging and work: Current research." NIOSH, 2015a).

Third, the purpose of evaluation research is to determine the effectiveness of interventions, communication tools, policies, and practices designed to support workers and improve effectiveness at different points across the working life. This goal focuses on developing and then assessing policies and programs intended to improve safety or health outcomes in workers as they age. Some interventions aim to improve workers' functional capacity or job-related skills as they age. Programs that involve training, environmental and organizational changes, and human resources practices that are relevant to various age groups also need to be evaluated. In sum, NCPAW's research goals are to advance and conduct etiologic, surveillance, and intervention research on the most critical issues in workplace safety and health affecting aging workers.

Internal and External Collaboration

Another element of the NCPAW mission is to facilitate both intramural and extramural collaboration when it comes to advancing research pertaining to the aging workforce. NCPAW seeks to build and foster intramural and extramural partnerships with occupational health and safety researchers, policymakers, labor, employers, intermediaries, and other stakeholders interested in the aging workforce. These collaborations enhance the impact and reach of research, translation, and dissemination activities aimed at preventing and reducing work-related injuries and illnesses in the aging workforce. NCPAW's collaboration efforts are consistent with the mission of Total Worker Health, which is to "Motivate transdisciplinary collaboration among investigators focused on preserving and improving the health of people who work" (Schill & Chosewood, 2013, S10).

Intramurally, the center has worked with other NIOSH sector and cross-sector programs to integrate aging and work issues into the NIOSH research agenda. To advance productive aging and work, NCPAW is actively engaged in partnership development and collaborations with international partners who share an interest in healthy aging and work (e.g., EU-OSHA, Finnish Institute of Occupational Health, Canadian Institute for the Relief of Pain and Disability, Institut de recherche Robert-Sauvé en santé et en sécurité du travail). As NCPAW has developed and increased its internal and external visibility, it has raised awareness about the concept of productive aging in occupational safety and health through conference presentations, publications, webinars, and other online communications tools.

One important reason for external collaboration is for stakeholders to have the opportunity to identify the areas of greatest need facing the aging workforce. Collaborative research also is likely to lead to discovering unanticipated or unpredicted factors. For instance, preliminary findings from a needs assessment being conducted by the authors at the time of this writing suggest that both organizational-level issues (e.g., stress management) and macro-level concerns (e.g., changes in departure from the workforce due to Social Security modifications) are important for small businesses, but most owners of small enterprises often lack the resources to address these issues.

Without external collaboration, these issues might be overlooked or less understood.

Best Practices

NCPAW also seeks to further develop knowledge on interventions and best practices for creating "age-friendly" workplaces from the physical, emotional, economic, and labor relations perspectives. Application of productive aging can encourage *age-friendly* workplaces because they help individuals "adapt, learn, and grow together, across demographic divides. The focus [is] on keeping employees healthy by beginning interventional efforts early in their careers aimed at helping them manage their health risks to stay productive over time" (Leoppke et al., 2013, p. 503). To that end, programs and policies can encourage the crafting of jobs that enable workers to adapt their work to their own needs and skills as they age (Truxillo et al., 2012).

As previously discussed, work ability is one of the concepts informing the NCPAW approach to productive aging. Maintaining work ability requires attention to worker health and safety (Ilmarinen, 1999). For workers experiencing reduced work ability, work-related accommodations and interventions that boost psychological resources should be considered (McGonagle et al., 2015). Of concern to all workers, regardless of age, is how organizations can design jobs and tasks to meet workers' needs as they age so they can continue to be productive (Kooij, Van Woerkom, Wilkenloh, & Denissen, 2017; Morgeson, Medsker, & Campion, 2008; Schulte et al., 2017). Unfortunately, according to Truxillo et al. (2012), we are only beginning to learn how to enhance satisfaction, engagement, and productivity for workers across the life-span.

A one-size-fits-all approach to productive aging is not the most efficient strategy, partly because organizations vary in their size and scope. For example, smaller businesses bear a greater burden of occupational illnesses, fatalities, and injuries than larger companies (Okun, Lentz, Schulte, & Stayner, 2001). They also have access to fewer resources, such as money and staff, with which to implement well-being or safety training and programs (Page, 2009). At the time of this chapter's writing, the authors are conducting focus group and in-depth interviews as part of a larger needs assessment to determine the most pressing needs for research and practice in workplace aging. The data collected thus far reveal the ways in which small and large businesses differ in their ability to engage in workplace aging management. Interviews with high-level executives of larger corporations suggest that large companies have specific occupational roles to which certain aspects of health and safety can be delegated. For example, occupational safety issues (e.g., fall prevention, hearing loss) might be taken on by middle-level management whereas employee wellness (e.g., smoking cessation) might have oversight from human resources. Employee health, safety, and well-being are often managed through fragmented departments that operate as silos (Schill & Chosewood, 2013).

In comparison, the authors' needs assessment interviews confirm that owners of small businesses often have to deal with OSH-related issues and problems by themselves unless they get external assistance, and age-related health and safety issues often get low priority. According to Cunningham and Sinclair (2015), small business owners often lack the opportunities to meet in person with intermediaries to obtain important OSH information and build business relationships. For smaller enterprises, facilitating age-friendly workplaces might require interventions that improve the systems used to deliver OSH information and resources. Moreover, this requires that initiating organizations (i.e., initiators), such as public health agencies, identify the needs of small businesses and working intermediaries to diffuse the needed information and resources to the small businesses they serve. Sinclair, Cunningham, and Schulte (2013) provide an extended model for small business OSH intervention diffusion, which takes into account characteristics of the intervention itself, the target audience(s), how information is communicated, and the time it takes to adopt the intervention. The model offers guidance for both initiators and intermediaries in the diffusion. To put this in the aging context, it is arguable that the success of the system requires the cooperation of intermediaries who have expertise and a commitment to meeting the needs of aging workers and the organizations who employ them.

Translating Research into Products and Resources

Another part of NCPAW's mission is to develop and disseminate a broad range of products and resources that target workers, organizations, and sectors where aging issues are particularly salient. To this end, NCPAW seeks to advance and conduct research translation that engages stakeholders and intermediaries to reduce and prevent work-related injuries and illnesses in the aging workforce. Translation is the process of taking findings from scientific investigation and transforming them into practice (Straus, Graham, & Mazmanian, 2006), taking into account the drivers of and barriers to putting recommendations into practice. Translation involves (1) generating solutions to workplace risks and testing them, (2) using experimental and observational approaches to test new interventions, (3) moving tested recommendations and interventions into the field to identify barriers and to test delivery for broader audiences, and (4) testing the outcomes of the interventions or recommendations when they are adopted in the "real world" (Scholl, Van Bogaert, Forrester, & Cunningham, in press).

The ultimate goal of educational materials, training curricula, and other products is to make an impact on the OSH problems they were created to address. Regarding the aging workforce, such impacts of translational products and resources can yield many benefits in the short and long term:

- For workers and their families: keeping healthy and productive, being treated with fairness and respect, contributing meaningfully to the organization, staying safe regardless of age-related changes
- For employers: a maximally productive and engaged workforce, lower healthcare costs, lower turnover and absenteeism, retention of experienced and skilled workers, knowledge transfer to younger workers
- For the community and society: enhanced national prosperity, a globally competitive economy (Harter et al., 2003; Leoppke et al., 2013; Wilson, Dejoy, Vanderbeg, et al., 2004)

For these impacts to be realized, the best practices and recommendations that are shared through translational products have to reach the intended audiences and resonate with them. Making an impact on the safety and health outcomes of aging workers means taking into account the diversity within the aging workforce. Some of the most significant demographic shifts that intersect with the rise of aging workers are increases in temporary and contingent workers (Cummings & Kreiss, 2008; Hipple & Hammond, 2016), workers employed by small businesses (Choi & Spletzer, 2012; Cunningham, Sinclair, & Schulte, 2014), female workers (Toossi, 2012), and vulnerable worker populations such as young immigrants (NIOSH, ASSE, 2015) and Latinos (Diuguid, 2014).

Older workers make up a significant portion of the contingent workforce in the USA (Bolden-Barrett, 2017). According to the (*Toossi & Torpey*, 2017), at least 40 percent of workers over 55 are looking for work in the *gig economy*, a market that is characterized by the rise of short-term employment and decline of permanent jobs (Friedman, 2014). Workers 65 years and older have the highest percentage (24.1) of self-employment, and those aged 55–64 make up 14.7% of freelancers (Hipple & Hammond, 2016). In addition to the lack of legal protections and workers' compensation and retirement benefits, temporary workers lack the safety training needed to protect them from harm (Zohar & Luria, 2005), which further exposes workers to injuries that present an increased threat to older workers. The translation-related challenge is to make an impact on a segment of aging workers who may work for companies that "incorrectly behave as if they do not share safety and health responsibilities" (Howard, 2017, p. 4). There is confusion over who bears the responsibility for safeguarding these workers: Is it the temporary agency who supplies the workers? Or is it the company who pays the temporary agency to find people to fill the jobs? This confusion is a significant barrier to knowing the intended audience, which is crucial to effective translation of OSH research findings.

Recommendations

More employers are seeing the value of older workers for the greater knowledge, experience, and emotional intelligence they bring (Anderson & Morgan, 2017). The shift toward an older workforce in the USA and in other countries means adapting workplaces to accommodate not just older workers, but workers of all ages. Organizations that make age-friendly accommodations might do the following:

- Support flexibility in work schedules, work conditions, and work location.
- Use adaptive technology and design work tasks to meet older workers' physical needs (e.g., physical movement, vision).
- Manage hazards (e.g., noise, slips/trips/falls) and conditions that are more challenging to older workers.
- Provide ergo-friendly work environments, such as workstations, tools, floor surfaces, and adjustable seating that reduce musculoskeletal strain.
- Maintain better illumination where needed, such as computer screens and surfaces that have less glare.
- Arrange for health promotion and lifestyle interventions, particularly those that are voluntary and do not appear to penalize workers who do not participate.
- Enable workers to engage in medical self-care in the workplace and provide time away for health visits.
- Invest in training and skills-building at all age levels.
- Administer reasonable accommodations and return-to-work processes after illness or injury absences ("Productive aging and work: Safety and health outcomes." NIOSH, 2015c).

When making organizational changes to encourage productive aging, what might work best is simple guidance that is easy to put it into practice, such as a few simple steps to get started ("Total Worker Health: Simple steps to get started." NIOSH, 2016a). For example, the NIOSH document *Older Drivers in the Workplace: How Employers and Workers Can Prevent Crashes* (NIOSH, 2016b) presents checklists of simple steps that can encourage all workers to implement safe driving practices. From an employer's perspective, some steps might appear more feasible than others, and they can be encouraged to start with the steps that are simpler and can yield results right away.

Supervisors who want to facilitate an age-friendly workplace would benefit from management skills training that focuses on the specific needs of older workers in addition to the needs of all age groups (Leoppke et al., 2013). Because a one-size-fits-all approach is not likely to work with most workplace settings, managers could be trained to use a needs assessment framework to identify the most pressing needs they face, set a goal to address each, and create an action plan to make the necessary changes. Based on the areas of work ability previously discussed including working conditions, employee health, professional skills, and psychosocial factors (Ilmarinen, 1999; Silverstein, 2008), organizations can generate and choose one or more areas needing improvement and generate one or more goals that address those areas (University of Washington, 2009). This integrated approach requires organizations to describe the action steps to be done, who will ensure it gets done, when it will be finished, and what challenges or barriers need to be overcome. Training curricula and other educational materials can incorporate a needs assessment or goal structure to help organizations take the first steps. Furthermore, a breakdown and prioritization of specific steps can make it easier to recognize the outcomes that are worker- and/or organization-centered. Setting goals and addressing the challenges to meeting those goals can shed light on the mutual influence that worker- and organization-centered outcomes can have on each other (Harter et al., 2003).

Future Directions in Practice and Research

There is a need to continue research about the functional, physiological, and cognitive effects of worksite hazards on aging workers (National Research Council and Institute of Medicine, 2004). In addition to the attention devoted to economic implications of an aging worker population, retirement, and pension-related issues, more needs to be directed toward the interaction between the aging process and work.

Gains can be achieved in developing and improving data collection and data systems in order to better understand the workplace safety and health vulnerability of aging workers (Leoppke et al., 2013). The data that are collected might also include those from workers that comprise the entire life-span, which can better track the cumulative effects of aging on work-related outcomes as well as variations within age cohorts (Bengston et al., 2005). The data might contain employment histories and specific demands of workers' jobs. The National Research Council and Institute of Medicine (2004) also recommends that organizations continue to collaborate to identify and use databases that contain data relevant to aging research.

Also, research is needed to identify and evaluate promising practices in job design, training programs, polices, and interventions targeted to aging workers. Questions that could guide the development of intervention and policies should include the following: "How does work need to be remodeled to suit aging workers? What social support is needed for aging workers to maintain working capacity" (National Research Council and the Institute of Medicine, 2004, p. *xii*). Leoppke et al. (2013) recommend more return-on-investment studies of integrated programs to determine the impact of programs and policies that go beyond the reduction of medical and pharmaceutical costs. Interventions also should be evaluated based on the impact of supervisor-based training (Hammer et al., 2015). Other indicators should include increased participation by employees, perceived value of the integrated programs, the reduction of health risks, and potential increases to productivity.

Current economic and market trends require continued surveillance of the impacts of contingency work arrangements and changes to pension provisions, such as Social Security in the USA. McGonagle et al. (2015) argue that research into Society Security changes can encourage employers to improve the work ability of their workers and reduce the reduction of highly skilled and experienced employees due to early departure. As discussed earlier, translation of research on productive aging needs to take into account the needs of workers that occupy nonstandard work arrangements, such as contract work, gig work, and work through temporary agencies (Howard, 2017). Such jobs have been shown to put workers' health at risk in general (National Research Council and the Institute of Medicine, 2004), and more focused attention on older workers in these arrangements is warranted.

In addition, there is the need to explore the intersectionality of age with other factors, such as immigrant or minority status, that might put workers across the life-span at increased risk for occupational injury and illness (NIOSH, ASSE, 2015). The aging populations around the world also include rising numbers of women and ethnic minorities. For example, gender is a significant determinant of health outcomes and experiences of older workers: social roles, types of jobs held, work-related exposures, and other patterns

(National Research Council and the Institute of Medicine, 2004, p. 4). Targeting socioeconomic and demographic variables that are related to age-related safety and health risks at work can go a long way to predicting retirement decisions and employment of older workers among more vulnerable populations (National Research Council and Institute of Medicine, 2004).

Conclusion

A productive aging approach can be used to address the opportunities and challenges that come with an aging workforce. Productive aging involves providing a healthy and safe work environment for all workers as they age through comprehensive strategies that allow workers to function at their best. This approach is not only beneficial for older workers, but for workers of all ages. The four attributes of productive aging outlined by NCPAW, research, collaboration, intervention, and translation, can facilitate the design of age-friendly workplaces. Productive aging implies that young workers can reach later life with little to no injury or illness, and older workers can maximize their changing work ability and continue to work without injury or illness. Such efforts can ensure that younger workers are set up for longer and more productive working lives as they age, which improves the quality of life of workers of all ages on and off the job.

The four attributes also illustrate how productive aging can eventually lead to social, economic, and political policies that benefit workers of all ages (Johnson & Mutchler, 2014). Implementing programs to increase the health of aging workers also helps address the current demographic transition into an older, more age-diverse workforce. To avoid doing so has implications for long-term decreased health and productivity (Fisher et al., 2015). Future exploration of productive aging also needs to move away from viewing the aging workforce as a homogenous entity, but rather, as individuals who occupy various sectors and occupations, as well as represent various demographic characteristics, which present challenges to providing meaningful guidance to make an impact on such a diverse audience.

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5 Measurement of Gait and Postural Control in Aging

B. Rhett Rigby and Christopher T. Ray

Overview

The *gait cycle* is a term that describes locomotion and movement patterns between successive heel strikes of the same foot. Proper gait requires dynamic balance and postural control by maintaining the body's center of gravity (COG) within its base of support while walking (Dicharry, 2010; Farley & Ferris, 1998; Kuo & Donelan, 2010). In older adults, *gait analysis* is an objective measure of physical function (Studenski et al., 2003), health status (Cesari et al., 2005), and quality of life (Ferrucci et al., 2000). With aging, there are associated physiological changes that may lead to gait dysfunction. For example, changes in the sensorimotor system with a decline in tactile sensations (e.g., touch, pressure, vibration) and proprioceptive sensations (e.g., sense of joint position, resistance) and alterations in pain and temperature sensations may be observed in the elderly (Riemann & Lephart, 2002). These changes may, in turn, alter neuromuscular control and therefore gait (Riemann & Lephart, 2002).

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Although walking appears to be a simple task that is critical for maintaining other activities of daily living (ADLs), it is a very complex movement to model biomechanically and physiologically (Beauchet et al., 2017; Nutt, Marsden, & Thompson, 1993; Zajac, Neptune, & Kautz, 2002). Neural input, through the use of cortical networks and cognitive functions, is continuously needed during all phases of the gait cycle (Alexander & Crutcher, 1990; Seidler et al., 2010; Zwergal et al., 2012). Even at a self-selected pace in environmentally controlled conditions, the cortex plays a critical role with proper gait (Gwin, Gramann, Makeig, & Ferris, 2011; Perrey, 2014; Petersen, Willerslev-Olsen, Conway, & Nielsen, 2012). Cortical activity may be measured using position-emission tomography (la Fougère et al., 2010), electroencephalography (Gwin et al., 2011), or function near-infrared spectroscopy (Miyai et al., 2001; Perrey, 2014). In those with hypoxic-ischemic brain injury, a consequence of cardiac arrest or respiratory failure, gait may be altered by the loss of function to the basal ganglia-thalamus-frontal cortex complex (Fève, Fénelon, Wallays, Rémy, & Guillard, 1993; Hawker & Lang, 1990; Yoon, Lee, & Kim, 2016). Loss of bilateral gait coordination, which may be measured using spatiotemporal parameters of gait, is often noticeable with this population (Yoon et al., 2016). Definitions for various gait variables are listed in Box 5.1.

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Box 5.1 Definition of Gait Variables

Term	Definition
Spatial parameters	
Stride length	Distance between heel centers of two consecutive footfalls of the same foot
Step length	Distance between heel center of one foot and heel center of previous foot on opposite leg
Toe angle	Angle between line of progression and midline of foot
Leg length	Distance between greater trochanter and walking surface
Step width	Distance between midpoint of one foot and midpoint of previous foot on opposite leg
Stride width	Distance between midpoint of one foot and line created between two midpoints of successive steps taken by opposite foot
Base of support	Area beneath and between feet
Temporal parameters	
Step time	Time between first contact of one foot and first contact of opposite foot
Stride rate Gait cycle time	Time between first contact of one foot and first contact of the same foot
Gait velocity Gait speed	Distance traveled divided by trial time
Stride velocity	Stride length divided by stride time
Single support	Time between last contact of one foot and first contact of the same foot. Time measurement refers to opposite foot. Can be expressed in time units or as percentage of gait cycle. Total time is expressed as additive from both feet
Double support	Time period when both feet are on the surface. Can be expressed in time units or as percentage of gait cycle. Total time is expressed as additive from both double support periods
Stance time	Time between the first contact of one foot and the last contact of the same foot. Can be expressed in time units or as percentage of gait cycle. Often used to describe either right or left foot only
Swing time	Time between last contact of one foot and first contact of the same foot. Can be expressed in time units or as percentage of gait cycle. Often used to describe either right or left foot only

Measurement Issues: A Brief Review

Spatiotemporal parameters of gait, arguably the most widely reported clinical gait measures, may therefore be very useful in not only to determine the risk factors for various chronic conditions that affect the brain with age but to also differentiate gait characteristics between the sexes and to assess changes in the gait cycle due to the manipulation of the environment or with the gait cycle itself. A list of spatiotemporal parameters of gait and how these variables change with age can be found in Table 5.1.

Observed dysfunction with several parameters of gait may be an early marker for dementia in older adults (Verghese, Wang, Lipton, Holtzer, & Xue, 2007). If these abnormalities can be identified early, proper interventions may be undertaken to prevent the progression of dementia. In older adults without dementia, there are three quantitative gait factors that can predict the risk of cognitive decline: the pace factor, rhythm factor, and variability factor. Dysfunction with pace variables, such as gait speed and stride length, can predict a decline in executive function and

Table 5.1 Quantitative references values (i.e., mean ± standard deviation) for spatiotemporal gait parameters by age group (65–74 years, 75–84 years, and ≥85 years) and sex (n = 954)

	Total population (n = 954)			*P*-value*	Age											
	Total	Female (n = 437)	Male (n = 517)		65–74 years (n = 711)			*P*-value*	75–84 years (n = 207)			*P*-value*	>85 years (n = 36)			*P*-value*
					Total	Female (n = 312)	Male (n = 399)		Total	Female (n = 101)	Male (n = 106)		Total	Female (n = 24)	Male (n = 12)	
Age (years), mean ± *SD*	72.8 ± 4.8	73.2 ± 5.1	72.4 ± 4.5	0.006	70.6 ± 2.4	70.7 ± 2.4	70.5 ± 2.3	0.649	77.6 ± 2.6	77.8 ± 2.5	77.4 ± 2.6	0.274	87.7 ± 2.8	87.2 ± 2.0	88.6 ± 4.0	0.585
BMI (kg/m²), mean ± *SD*	26.2 ± 4.1	26.0 ± 4.8	26.4 ± 3.3	0.105	26.0 ± 3.8	25.6 ± 4.4	26.2 ± 3.2	0.094	26.6 ± 4.1	26.2 ± 4.7	27.0 ± 3.4	0.171	28.0 ± 7.2	28.2 ± 8.4	27.6 ± 3.8	0.379
Stride time																
Mean value (ms)	1123.7 ± 122.4	1095.5 ± 109.8	1147.6 ± 127.4	**<0.001**	1118.5 ± 122.3	1081.5 ± 104.3	1147.3 ± 127.5	**<0.001**	1132.7 ± 117.0	1124.3 ± 109.4	1140.7 ± 123.7	0.314	1176.1 ± 140.9	1155.7 ± 139.2	1216.9 ± 141.1	0.177
CoV (%)	2.2 ± 1.1	2.2 ± 1.1	2.1 ± 1.0	0.244	2.1 ± 1.1	2.1 ± 1.0	2.1 ± 1.0	0.520	2.3 ± 1.1	2.4 ± 1.1	2.2 ± 1.0	0.053	2.8 ± 1.3	3.1 ± 1.3	2.3 ± 1.3	0.067
Swing time																
Mean value (ms)	414.1 ± 40.2	402.1 ± 36.5	424.2 ± 40.5	**<0.001**	416.3 ± 40.0	403.4 ± 36.2	426.3 ± 40.0	**<0.001**	409.6 ± 39.6	401.2 ± 36.7	417.5 ± 40.8	0.003	396.7 ± 43.1	388.6 ± 37.5	413.1 ± 50.2	0.188
CoV (%)	4.2 ± 1.8	4.2 ± 2.0	4.2 ± 1.6	0.863	4.0 ± 1.7	3.9 ± 1.9	4.1 ± 1.6	0.063	4.5 ± 1.7	4.7 ± 1.8	4.4 ± 1.6	0.199	6.0 ± 2.7	6.5 ± 2.7	4.9 ± 2.3	0.020
Stance time																
Mean value (ms)	706.6 ± 91.2	689.3 ± 87.3	721.2 ± 92.0	**<0.001**	700.9 ± 88.1	677.6 ± 79.0	719.0 ± 90.6	**<0.001**	713.5 ± 91.6	706.6 ± 90.3	720.1 ± 92.7	0.291	779.4 ± 114.9	767.0 ± 122.6	804.0 ± 97.9	0.212
CoV (%)	3.1 ± 1.4	3.1 ± 1.3	3.1 ± 1.4	0.309	3.1 ± 1.3	3.1 ± 1.3	3.1 ± 1.4	0.743	3.2 ± 1.5	3.3 ± 1.4	3.0 ± 1.5	0.124	3.5 ± 1.7	3.8 ± 1.8	2.9 ± 1.4	0.029
Single support time																
Mean value (ms)	414.3 ± 39.8	401.5 ± 35.5	425.2 ± 40.0	**<0.001**	417.2 ± 39.5	403.4 ± 36.2	427.4 ± 39.6	**<0.001**	407.8 ± 38.7	396.8 ± 34.3	418.3 ± 39.8	**<0.001**	396.7 ± 43.1	388.6 ± 37.5	413.1 ± 50.2	0.188
CoV (%)	4.0 ± 1.8	4.1 ± 2.0	4.0 ± 1.6	0.453	3.9 ± 1.7	3.9 ± 1.9	3.9 ± 1.5	0.154	4.3 ± 1.7	4.5 ± 1.8	4.2 ± 1.6	0.102	6.0 ± 2.7	6.5 ± 2.8	4.9 ± 2.3	0.062
Double support time																
Mean value (ms)	292.6 ± 71.0	288.1 ± 74.1	296.4 ± 68.2	0.072	284.2 ± 64.5	274.5 ± 62.1	291.8 ± 65.4	**<0.001**	305.7 ± 74.2	308.8 ± 77.3	302.9 ± 71.4	0.569	381.4 ± 100.2	376.4 ± 115.3	391.3 ± 63.1	0.398
CoV (%)	6.6 ± 2.8	6.8 ± 2.7	6.5 ± 2.8	0.079	6.8 ± 2.9	7.0 ± 2.8	6.6 ± 2.9	0.117	6.3 ± 2.5	6.5 ± 2.8	6.1 ± 2.2	0.273	6.0 ± 2.1	6.2 ± 2.8	5.5 ± 2.6	0.177
Stride length																
Mean value (cm)	134.1 ± 18.9	126.5 ± 17.1	140.7 ± 18.0	**<0.001**	138.0 ± 16.6	131.1 ± 14.8	143.3 ± 15.9	**<0.001**	126.5 ± 19.7	118.2 ± 15.1	134.4 ± 20.4	**<0.001**	102.9 ± 15.3	100.7 ± 16.2	107.3 ± 13.0	0.166
CoV (%)	2.3 ± 1.2	2.7 ± 1.3	2.2 ± 1.1	0.005	2.2 ± 1.1	2.2 ± 1.2	2.1 ± 1.0	0.087	2.6 ± 1.3	2.7 ± 1.3	2.6 ± 1.3	0.743	3.6 ± 2.1	4.1 ± 2.4	2.7 ± 1.0	0.026
Stride width																
Mean value (cm)	9.9 ± 3.1	9.4 ± 3.1	10.2 ± 3.0	**<0.001**	9.9 ± 3.1	9.5 ± 3.1	10.3 ± 3.0	0.001	9.6 ± 3.2	9.0 ± 3.4	10.1 ± 2.9	0.010	10.0 ± 3.2	9.9 ± 2.5	10.2 ± 4.3	0.804
CoV (%)	26.6 ± 49.0	30.9 ± 69.8	23.0 ± 17.2	0.013	24.6 ± 34.7	27.4 ± 48.5	22.5 ± 17.2	0.057	33.0 ± 82.6	43.4 ± 116.9	23.0 ± 12.8	0.075	28.2 ± 23.4	22.5 ± 9.1	39.5 ± 36.8	0.934
Walking speed (CM/S)																
Mean ± *SD*	121.5 ± 23.4	120.2 ± 23.8	122.7 ± 23.0	0.103	125.4 ± 21.7	126.1 ± 21.7	124.9 ± 21.6	0.488	113.9 ± 23.5	109.7 ± 21.3	118.0 ± 24.9	0.011	88.5 ± 17.8	88.3 ± 19.4	88.9 ± 14.9	0.934
Stride velocity																
Mean value (cm/s)	119.9 ± 22.5	118.8 ± 23.2	120.8 ± 21.8	0.175	122.9 ± 21.1	123.6 ± 21.2	122.3 ± 21.0	0.426	114.8 ± 22.8	111.1 ± 22.7	118.5 ± 22.5	0.020	89.0 ± 17.8	88.9 ± 19.4	89.3 ± 15.0	0.251
CoV (%)	3.5 ± 1.7	3.5 ± 1.7	3.4 ± 1.6	0.244	3.4 ± 1.6	3.4 ± 1.7	3.4 ± 1.6	0.983	3.7 ± 1.7	3.8 ± 1.8	3.6 ± 1.6	0.280	4.2 ± 2.0	4.6 ± 2.0	3.5 ± 1.9	0.084

Note: Table adapted with permission from Beauchet et al. (2017). *SD* standard deviation, *m* meter, *s* second, *ms* millisecond, *CoV* coefficient of variation, *comparison based on unpaired t-test; P significant (i.e., P < 0.0006) indicated in bold therefore vascular dementia. Dysfunction with rhythm variables, such as cadence, swing, and stance time, can predict a decline with memory. Dysfunction with gait variability (i.e., a measure of the motor control of gait and calculated using the changes observed from step to step; Gabell & Nayak, 1984), such as stride length and swing time variability, can predict incident dementia (Verghese et al., 2007).

Among the elderly, gait speed is slower among women when compared to men (Ishizaki et al., 2011; Seino et al., 2014). Indeed, muscle strength (Bohannon, 1997), standing balance (Seino et al., 2014), and the ability to rise from a chair (Merrill, Seeman, Kasl, & Berkman, 1997; Ostchega et al., 2000) are typically increased in older men versus women. The measurement of walking speed is important because decreased walking gait speed is associated with an increased risk of falls (Mortaza, Abu Osman, & Mehdikhani, 2014; Verghese, Holtzer, Lipton, & Wang, 2009). In men, body mass index (BMI) and quadriceps strength are independent determinants of gait speed (Inoue et al., 2017). In women, BMI, hip flexion, hip abduction, and quadriceps strength are determinants of gait speed (Inoue et al., 2017). Other spatiotemporal parameters of gait are correlated with gait dysfunction and physiological function during daily activities. In women, the spatiotemporal parameters of gait velocity, stride time, and time spent in double support are correlated to the onset of gait dysfunction. More specifically, changes in these variables (i.e., increased double support time and decreased velocity and stride time) are manifested after the age of 60 years, with the first symptoms appearing after the age of 50 years (Kaczmarczyk, Wiszomirska, Błażkiewicz, Wychowański, & Wit, 2017). In another study, changes in stride length, velocity, stride time, and cadence were all associated with impairments in physical ADLs in men, while a comprehensive-gait assessment of all spatiotemporal parameters was recommended to assess any associated impairments in both physical and cognitive ADLs in women (Verlinden, van der Geest, Heeringa, Hofman, & Ikram, 2015).

The external and internal environment can also play a role with gait variables in the elderly. Some widely reported external variables include walking modality and dual-task conditions. When deciding between walking modalities on a treadmill or overground, there are some significant differences. At a self-selected walking pace, older adults walk faster, have increased stride length, and have a more rapid stride rate during overground gait versus gait on a treadmill (Marsh et al., 2006). This is significant because decreased gait velocity, stride length, and stride rate are correlated with less confident gait in the elderly (Maki, 1997). The level of enjoyment is also generally more positive during overground walking when compared to walking on a treadmill in seniors (Marsh et al., 2006). Different sloped terrains can also be a factor. When walking downhill, older adults exhibit decreased gait velocity and step length and increased cadence versus young adults (Scaglioni-Solano & Aragón-Vargas, 2015a). Similarly, these variables describe conservative gait and are also correlated to less confident gait and an increased risk of future falls (Senden, Savelberg, Grimm, Heyligers, & Meijer, 2012). Dual-task walking and its effect on gait speed in older adults have also been recently summarized (Smith, Cusack, & Blake, 2016). The addition of a cognitive dual task is associated with decreased gait speed (Smith et al., 2016). Some of these tasks include responding to questions (e.g., Guedes et al., 2014), reciting letters of the alphabet in different ways (e.g., Donoghue, Cronin, Savva, O'Regan, & Kenny, 2013), spelling exercises (e.g., Hollman et al., 2010), naming objects that begin with a specific letter (e.g., Ijmker & Lamoth, 2012), counting (e.g., Gillain et al., 2009), or other basic mathematical operations (e.g., Mirelman et al., 2012). The relationship between gait speed and fall risk has been clearly defined by others (Callisaya et al., 2011). Aside from the neuromuscular and skeletal changes that accompany the aging process, other internal factors may be associated with an age-related decline in physical function through changes in gait parameters. These include basal temperature (Simonsick, Meier, Shaffer, Studenski, & Ferrucci, 2016) and plasma compounds, including sphingolipids (Wennberg et al., 2017), inflammatory markers such as interleukin-6 (IL-6; Verghese et al., 2011), and proteolytic enzymes such as calpain (Samantaray et al., 2015).

The manipulation of the gait cycle itself might be a worthwhile assessment for predicting the decline in cognitive function and physical function, leading to an increased risk of falls. For example, purposefully slow-gait speed challenges motor control of gait, more than a self-selected walking pace or walking at a faster than normal pace, in the elderly (Almarwani, Van Swearingen, Perera, Sparto, & Brach, 2016). Therefore, this alteration in gait speed might be a more sensitive test for assessing gait variability and predicting cognitive decline in an aging population (Almarwani et al., 2016). The gait cycle may also be manipulated with the use of walking aids. When using a walker, older adults are typically more fearful of falling and exhibit several altered gait characteristics, such as slower gait speed, decreased cadence, and shorter step length and step time (Roman de Mettelinge & Cambier, 2015). The use of walking aids is therefore a risk factor for future falls (Roman de Mettelinge & Cambier, 2015).

One in four individuals 65 years or older experiences a fall every year in the United States (National Council on Aging, 2017). Falls are the leading cause of death from injury and are the leading cause of trauma-related hospitalizations in the aging population (National Council on Aging, 2017). Risk factors for falls can be categorized as behavioral, extrinsic, and intrinsic. *Behavioral risk factors* include any activity-related factors (Tinetti, Speechley, & Ginter, 1988). *Extrinsic risk factors* are due to the environment, such as improper footwear or unstable living conditions (Tideiksaar, 1997). *Intrinsic risk factors* include any patient-related factors, such as medication use (Blake et al., 1988; Spirduso, 1995), syncope (Tinetti et al., 1988), decreases in joint flexibility (Hughes, Dunlop, Edelman, Chang, & Singer, 1994), reduced nerve conduction velocity (Collins, De Luca, Burrows, & Lipsitz, 1995), decreases in visual perception, a decline in vestibular and somatosensory function (Manchester, Woollacott, Zederbauer-Hylton, & Marin, 1989; Okuzumi, Tanaka, & Nakamura, 1996; Stelmach & Worringham, 1985), or muscle weakness (Jette, Branch, & Berlin, 1990; Shumway-Cook, Gruber, Baldwin, & Liao, 1997; Whipple, Wolfson, & Amerman, 1987).

Postural instability, or abnormal postural control, is another intrinsic risk factor of falling (Tinetti et al., 1988). Postural control is the neuromuscular maintenance of equilibrium and a key element in the execution of daily activities (Alfieri et al., 2012; Vandervoort, 1992). The relationship between postural instability and other intrinsic risk factors of falling is evident. For example, aging affects the visual, vestibular, or somatosensory by causing an attenuated or inappropriate feedback response to the postural control centers, thereby increasing the risk of falls (Nagy et al., 2007). The elderly are also more deconditioned when compared to young adults, typically leading to a decline in skeletal muscle strength and the deposition of adipose tissue and connective tissue in the muscle (Berger, Chuzel, Buisson, & Rougier, 2005; Nagy et al., 2007; Yarasheski, 2003). Deconditioned skeletal muscles are often atrophied, either through decreased myoglobin mass or decreased cross-sectional area of the muscle or both (Berger et al., 2005). An observed decrease in skeletal muscle strength is correlated to reduced postural control and, therefore, an increased risk of future falls (Lord, Ward, Williams, & Anstey, 1994; Onambele, Narici, & Maganaris, 2006; Wolfson, Judge, Whipple, & King, 1995). Indeed, elderly patients with a history of falls exhibit decreased dynamic strength in the muscles around the knees and ankles, when compared to patients without a history of falls (Whipple et al., 1987). Reduced strength in these skeletal muscles has been associated with reduced gait speed and difficulties in climbing stairs and moving from a seated to a standing position (Brown, Sinacore, & Host, 1995). Muscle effectors may also be unable to communicate and respond properly to perturbations in posture and balance (Chodzko-Zajko et al., 2009). These muscle factors are a consequence of aging and may negatively affect postural stability. Given these factors, the relationship between gait and posture is evident, as postural stability is crucial for healthy gait and may be a marker for an early diagnosis of a neurodegenerative disease such as Parkinson's disease or multiple sclerosis (Lord et al., 2013).

Because proper gait requires appropriate postural control, these measurements are often performed synchronously. Quantitative assessments of the center of pressure (COP) and center of mass (COM) in the elderly have been widely reported in the literature as dependent variables (e.g., Seidler & Martin, 1997; Yu et al., 2008). To properly shift body weight or transfer weight during ADLs, a smooth shift in the COP and COM is required (Kasahara, Saito, Anjiki, & Osanai, 2015). During voluntary shifts, older adults exhibit reduced maximum displacement of the COP (Blaszczyk, Lowe, & Hansen, 1994) and increased reaction times (Tucker, Kavanagh, Morrison, & Barrett, 2009) versus young adults. Measurements of the COP and COM in the medial-lateral direction are predictive of fall risk, while measurements in the anterior-posterior direction can be used to differentiate individuals with a history of falls from those without a history of falls (Maki, Holliday, & Topper, 1994; Piirtola & Era, 2006). However, it is also possible to assess postural control during quiet standing. While maintaining this posture, older adults often experience a co-contraction of the dorsiflexors (e.g., tibialis anterior) and the plantarflexors (e.g., soleus) to maintain the necessary torques needed to remain stabilized (Benjuya, Melzer, & Kaplanski, 2004; Laughton et al., 2003). The nature of this co-contraction during quiet standing may increase lower-body joint stiffness, particularly at the ankle (Vette et al., 2017). The prevalence of joint stiffness, in addition to deconditioned skeletal muscle, may further impair postural control and contribute to postural instability during quiet standing.

In this chapter, measurements of gait and postural control will be discussed. In addition, instruments and techniques used to collect and analyze spatiotemporal parameters of gait and kinematic and kinetic data are presented. Accelerometers, force plates, and other integrated devices are also presented as tools to quantify gait and postural variables. Clinical assessments are also analyzed, including questionnaires, ordinal scales, and other static and dynamic functional tests. Finally, a summary of methodological techniques used by researchers to disseminate gait and posture characteristics is provided.

Measurement Techniques

Gait and posture in an aging population may be described using spatiotemporal variables, kinematics, and kinetics. Techniques to measure these variables must include proper instrumentation and analysis.

Spatiotemporal Parameters of Gait

The measurement of spatiotemporal variables may allow clinicians and researchers to properly assess gait and identify physical dysfunction. In elderly men, gait velocity, cadence, stride length, and time spent in stance phase are often altered (Watelain, Barbier, Allard, Thevenon, & Angué, 2000). After the age of 60 years in women, gait velocity, stride time, and time spent in double support declines (Kaczmarczyk et al., 2017). Although some researchers have quantified spatiotemporal parameters of gait with no equipment by having older participants walk a known distance while counting steps (Camargo et al., 2015; Nagasaki et al., 1996), these parameters are typically measured using various devices, including timing mats and walkways, inertial sensors, motion capture, force plates, or optical sensors.

Timing Mats and Walkways

There are various commercial timing mats available that can be used to assess spatiotemporal parameters of gait. The *GAITRite* (CIR Systems, Inc., Franklin, NJ) is the most widely reported timing mat used by researchers to quantify gait parameters in older adults. The *GAITRite* has been shown to be reliable and has been validated for use in healthy older adults (Bilney, Morris, & Webster, 2003; Menz, Latt, Tiedemann, Mun San Kwan, & Lord, 2004) and in older adults with knee replacement surgery (Webster, Wittwer, & Feller, 2005). This system is a portable, carpeted walkway with embedded pressure sensors within its length (Bilney et al., 2003). The sensors are activated upon footfall and deactivated with toe-off, allowing for a recording of consecutive footfalls as a function of time (Ferraro, Pinto-Zipp, Simpkins, & Clark, 2013; Hollman, McDade, & Petersen, 2011). The raw data from the sensors are collected by onboard processors, transferred to a computer, and transformed into spatiotemporal gait parameters (Beauchet et al., 2009).

In research studies, the *GAITRite* is traditionally used to assess gait variables with older adults who walk at a self-selected speed. However, there are some varying protocols with the mat, including gait with a walker (Protas, Raines, & Tissier, 2007), inclined gait (Ferraro et al., 2013), walking using music and metronome cues (Wittwer, Webster, & Hill, 2013), and dual-task walking (Autenrieth et al., 2013; Donath et al., 2014). When using the *GAITRite*, the participants are typically instructed not to incur rapid periods of acceleration or deceleration while walking on the mat. On each end of the walkway, extensions may be attached that are electronically inactive and are visually identical to the rest of the mat. The purpose of the extensions is to allow for the initial acceleration and the deceleration at the end of a walking trial. Therefore, steady-state measurements of gait may be made (Donath et al., 2014).

The length of the *GAITRite* varies in the reported literature, from 3.6 m (Protas et al., 2007) up to 10 m (Beauchet et al., 2009; Donath et al., 2014). The sampling rate reported also varies, from 60 Hz (Donath et al., 2014) up to 240 Hz (Lord et al., 2013). In the research studies in which the *GAITRite* was validated and shown to be reliable among older adults, the reported frequency was typically 80 Hz (Bilney et al., 2003; Hollman et al., 2011; Menz et al., 2004; Webster et al., 2005; Wittwer et al., 2013). Some researchers have also synched the output of the *GAITRite* with electromyography (EMG) sensors, with a sampling rate of 1000 Hz (Hanada, Johnson, & Hubley-Kozey, 2011). Advantages of the mat include portability, placement over any flat surface, minimal setup and testing time, and no requirement of any devices placed on the participant (Ferraro et al., 2013). A list of selected variables reported in the literature that includes the elderly as the participant population is found in Box 5.2.

The *Zeno Walkway* (Protokinetics LLC, Havertown, PA) is a pressure-sensitive walkway that can record data during balance and gait assessments (Protokinetics, 2017). The device is customizable, and users may choose from 8 to 40 ft in length and from 2 to 4 ft in width. The wide mat allows participants to turn or use aids, such as canes or walkers, during gait (Protokinetics, 2017). Spatiotemporal parameters (e.g., gait velocity, stride length, stride width, cadence, double support time, contact time, contact area) were captured, with a sampling rate of 120 Hz, as older adults walked across the mat at a self-selected pace in a recent study (McKay et al., 2017).

Wearable Inertial Sensors

Kinematic data captured using wearable inertial sensors may be useful for evaluating levels of physical activity. These sensors, also referred to as inertial measurement units (IMUs), can contain one-, two-, or three-axis accelerometers, gyroscopes or magnetometers, GPS sensors, or barometers, all housed within a small casing (Grimm & Bolink, 2016). Some manufacturers have integrated IMUs with EMG within the same sensors (Trigno IM, Delsys Inc., Natick, MA). Sensor attachment can be made to the body using tape, elastic straps and bands, or rubber bands. Full-body suites are available that contain embedded IMUs, alleviating the need for sensor placement on the participant. Advantages of inertial sensors include measurement accuracy, size, energy usage, and processing time (Grimm & Bolink, 2016).

A number of inertial sensors have been utilized to measure spatiotemporal parameters of gait with older adults, including the *Physilog* (Gait Up, Switzerland; Malatesta, Canepa, & Menendez Fernandez, 2017; Rouhani, Favre, Crevoisier, & Aminian, 2011), *AX3* (Axivity, UK; Del Din, Godfrey, & Rochester, 2016; Del Din, Hickey et al., 2016), *Tech IMU V4* and *CV4* (Technaid SL, Spain; Scaglioni-Solano &

Box 5.2 Selected Spatiotemporal Parameters of Gait Measured Using the GAITRite in Older Adults

Variable	References
Velocity (cm/s)	Autenrieth et al. (2013), Dehzangi et al. (2013), Donath et al. (2014), Hanada et al. (2011), Hollman et al. (2011), Kirkwood, Gomes, Sampaio, Furtado, and Moreira (2016), Lord et al. (2013), Marsh et al. (2006), Protas et al. (2007), Roman de Mettelinge and Cambier (2015) Wittwer et al. (2013)
Cadence (steps/min)	Autenrieth et al. (2013), Dehzangi et al. (2013), Donath et al. (2014), Ferraro et al. (2013), Hollman et al. (2011), Kirkwood et al. (2016), Protas et al. (2007), Roman de Mettelinge and Cambier (2015), Wittwer et al. (2013)
Step length (cm)	Autenrieth et al. (2013), Ferraro et al. (2013), Hanada et al. (2011), Hollman et al. (2011), Kirkwood et al. (2016), Lord et al. (2013), Roman de Mettelinge and Cambier (2015)
Step time (s)	Hollman et al. (2011), Kirkwood et al. (2016), Lord et al. (2013), Roman de Mettelinge and Cambier (2015)
Step width (cm)	Hollman et al. (2011), Lord et al. (2013)
Stride length (cm)	Beauchet et al. (2009), Donath et al. (2014), Hollman et al. (2011), Marsh et al. (2006), Protas et al. (2007), Wittwer et al. (2013)
Stride time (s)	Beauchet et al. (2009), Donath et al. (2014), Hollman et al. (2011), Wittwer et al. (2013)
Stride rate (stride/s)	Marsh et al. (2006)
Stride width (cm)	Beauchet et al. (2009), Donath et al. (2014), Wittwer et al. (2013)
Base of support (cm)	Hanada et al. (2011), Kirkwood et al. (2016)
Time in stance phase (s)	Beauchet et al. (2009), Hollman et al. (2011), Kirkwood et al. (2016), Lord et al. (2013)
Time in swing phase (s)	Beauchet et al. (2009), Hollman et al. (2011), Kirkwood et al. (2016), Lord et al. (2013), Wittwer et al. (2013)
Stance phase (%GC)	Hollman et al. (2011), Roman de Mettelinge and Cambier (2015)
Swing phase (%GC)	Hollman et al. (2011), Roman de Mettelinge and Cambier (2015)
Time in single support (s)	Hollman et al. (2011)
Time in double support (s)	Donath et al. (2014), Hanada et al. (2011), Hollman et al. (2011), Kirkwood et al. (2016)
Single support (%GC)	Hollman et al. (2011)
Double support (%GC)	Hollman et al. (2011), Wittwer et al. (2013)

Note: *GC* gait cycle

Aragón-Vargas, 2015a, 2015b), *Opal* (APDM Inc., Portland, OR; Trojaniello et al., 2014), *MVP-RF8* (MicroStone, Japan; Misu et al., 2014), *G-Walk* (BTS Bioengineering Corp., Brooklyn, NY; Pau, Leban, Collu, & Migliaccio, 2014), and the *DynaPort* (McRoberts B.V., the Netherlands; de Groot et al., 2014). A list of selected sensors and their physical features can be found in Table 5.2. The *Physilog* has been validated (Dadashi et al., 2013; Mariani et al., 2010) and shown to have excellent test-retest reliability (Mariani et al., 2010) in older adults. The *Physilog* has also been used to digitize signals from individual, miniature, piezoelectric gyroscopes in older adults (Aminian, Najafi, Büla, Leyvraz, & Robert, 2002).

A list of selected temporal parameters of gait measured using inertial sensors with older adults is found in Box 5.3. Other gait variables that have been measured in this population include gait

Table 5.2 Common inertial sensors used with older adults

Device	Dimensions (mm)	Weight (g)	Features
Physilog	50.0 × 37.0 × 9.2	11	3D accelerometer (range ± 3 g), 3D gyroscope (range ± 800 degree/s), barometer
AX3	23.0 × 32.5 × 7.6	11	3D accelerometer (range up to ±16 g)
V4	36 × 26 × 11	10	3D accelerometer (range up to ±16 g), 3D gyroscope (range ± 2000 degrees/s), 3D magnetometer (range ± 8.1 gauss)
CV4	36 × 26 × 8	14	3D accelerometer (range up to ±16 g), 3D gyroscope (range ± 2000 degrees/s), 3D magnetometer (range ± 8.1 gauss)
Opal	43.7 × 39.7 × 13.7	22	3D accelerometer (range up to ±200 g), 3D gyroscope (range ± 2000 degrees/s), 3D magnetometer (range ± 8.0 gauss)
G-Walk	70 × 40 × 18	37	3D accelerometer (range up to ±16 g), 3D gyroscope (range ± 2000 degrees/s), 3D magnetometer (range ± 12.0 gauss)
MVP-RF8	45 × 45 × 12 or 45 × 45 × 18	25 or 60	3D accelerometer (range up to ±60 g), 3D gyroscope (range ± 2000 degrees/s)
Dynaport	85.0 × 58.0 × 11.5	55	3D accelerometer (range up to ±6 g)

Note: *3D* three-dimensional

velocity (Aminian et al., 2002; de Groot et al., 2014; Malatesta et al., 2017; Misu et al., 2014; Pau et al., 2014; Scaglioni-Solano & Aragón-Vargas, 2015a, 2015b; Trojaniello et al., 2014), cadence (Misu et al., 2014; Scaglioni-Solano & Aragón-Vargas, 2015a, 2015b), and several spatial parameters, including stride length (Aminian et al., 2002; Malatesta et al., 2017; Misu et al., 2014; Pau et al., 2014; Trojaniello et al., 2014), step length (Del Din, Hickey et al., 2016; Scaglioni-Solano & Aragón-Vargas, 2015a, 2015b), and swing width (Malatesta et al., 2017).

Box 5.3 Selected Temporal Parameters of Gait Measured Using Inertial Sensors with Older Adults

Variable	References
Stride time (s)	de Groot et al. (2014), Malatesta et al. (2017), Trojaniello et al. (2014)
Stride frequency (Hz)	de Groot et al. (2014), Malatesta et al. (2017)
Step time (s)	Del Din, Hickey, et al. (2016), Trojaniello et al. (2014)
Stance time (s)	Trojaniello et al. (2014)
Swing time (s)	Trojaniello et al. (2014)
Stance time (%GC)	Aminian et al. (2002), Malatesta et al. (2017), Pau et al. (2014)
Swing time (%GC)	Malatesta et al. (2017), Misu et al. (2014), Pau et al. (2014)
Double support time (%GC)	Aminian et al. (2002), Malatesta et al. (2017)
Double support time (s)	Pau et al. (2014)
Loading response (%GC)	Malatesta et al. (2017)
Foot flat (%GC)	Malatesta et al. (2017)
Push-off (%GC)	Malatesta et al. (2017)
Gait cycle duration (s)	Aminian et al. (2002), Pau et al. (2014)

Note: *GC* gait cycle

Motion Capture

More often used to capture kinematic and kinetic data during movement, motion capture systems may also output spatiotemporal parameters of gait with proper analysis and mathematical calculations (e.g., Lee & Park, 2013; Mills & Barrett, 2001; Yang, Espy, Bhatt, & Pai, 2012). Motion capture involves the recording of 2D or 3D movement, typically with the use of a camera (capturing movement with inertial sensors can also be considered a form of motion capture, but, for the purposes of this chapter, the sections are separated). Most systems require the participants to have markers affixed to the body in strategically placed locations. Older systems tracked these markers using a standard video camera, and data were digitized using available software (e.g., *Peak Motus Motion Measurement System,* now *Vicon Motus*). Spatiotemporal gait variables, including gait velocity, stride length and duration, time spent in single and double support, and swing duration and period, were quantified in older adults using this system (Mills & Barrett, 2001). In modern systems, markers may be reflective and tracked using cameras that operate on the infrared spectrum. Markers may also contain LEDs, often connected by wires. Other systems do not require markers and instead use software to track movement.

When deciding between the various motion capture systems, camera sensor resolution and sampling rate are very important factors. The higher the resolution, the more detail can be collected from the marker. The higher the sampling rate, the capture of movements (particularly very dynamic, ballistic movements) can be made more accurately (Vicon Motion Capture Systems, 2017). Gait speed, time spent in stance phase, and stride length, width, and time have been reported using motion capture (Vicon Motion Systems Ltd., UK) in older adults (Lee & Park, 2013).

Force Plates

Spatiotemporal parameters of gait may also be found using force plates. These devices typically contain piezoelectric sensors that allow for components of movement to be accurately recorded (Kistler, 2017). Plates may be embedded into the floor so as not to disturb participants' normal gait patterns. When contacted, the device can output real-time ground reaction force data and other data related to the gait pattern. Many force plates that are currently manufactured are very sensitive and can detect very small perturbations in gait. Two brands of force plates, *Kistler* (Kistler Instrument Corp., Amherst, NY) and *AMTI* (Advanced Mechanical Technology, Inc., Watertown, MA), are used most often with older adults in research studies (e.g., Mills & Barrett, 2001; Yang et al., 2012).

Force-plate data can be combined with motion capture data to obtain spatiotemporal parameters of gait. In one study, periods of left and right foot touchdown, left foot liftoff, and stride length were measured using motion capture (Motion Analysis Corp., Santa Rosa, CA) and *AMTI* force plates to assess fall characteristics upon slipping in community-dwelling older adults (Yang et al., 2012). A *Vicon* motion capture system and *AMTI* force plates have been used to report gait velocity, cadence, stride length, and time spent in stance phase in elderly men (Watelain et al., 2000) and have been used to report gait velocity, step length, width and frequency, and time spent in stance and swing time in older adults (Kobayashi, Hobara, Heldoorn, Kouchi, & Mochimaru, 2016).

Optical Sensors

The *OptoGait* (Microgate Corp., Italy) system consists of infrared LED sensors placed strategically along a desired path. These sensors are housed within a bar, and the bars are placed on each side of the path. The system detects any changes between the communication of the LEDs across the path from each other, and the duration of gait phases and position of the individual can therefore be calculated (OptoGait, 2017). The system can output spatiotemporal parameters of gait, such as gait cycle time, gait velocity, stance and swing time, step length, and cadence. These variables have been reported with older adults (Lienhard, Schneider, & Maffiuletti, 2013). The *OptoGait* can be used with (Lienhard et al., 2013) or without (Item-Glatthorn & Maffiuletti, 2014) synchronized timing mats.

Kinematics and Kinetics of Gait

Motion capture technology and force plates are most often used to collect kinematic (e.g., linear and angular displacements, velocities, accelerations) and kinetic (e.g., ground reaction forces, joint forces and moments, power) data in one, two, or three directions during gait. Although motion capture technology may be used alone to capture kinematic data, researchers and clinicians working with an aging population will often synchronize motion capture systems with force-plate data to capture the additional kinetic data (e.g., Kobayashi et al., 2016; Mills & Barrett, 2001; Watelain et al., 2000). Common variables measured with older adults have included linear displacements (Kejonen, Kauranen, Ahasan, & Vanharanta, 2002; Mills & Barrett, 2001), linear velocities (Mills & Barrett, 2001), angular displacements represented by either absolute or relative angles (Kobayashi et al., 2016; Lee & Park, 2013; Mills & Barrett, 2001), joint forces (Rouhani et al., 2011), joint moments (Cattagni, Scaglioni, Laroche, Gremeaux, & Martin, 2016; Mills & Barrett, 2001; Rouhani et al., 2011), and muscle power (Rouhani et al., 2011; Watelain et al., 2000) in the upper and lower body. Inertial sensors have also been used to capture foot kinematic data (e.g., toe and heel clearance, angle at toe-off and heel strike) in older adults (Malatesta et al., 2017). Some researchers have also verified the use of inertial sensors to collect kinematic and kinetic data by synching the sensors with motion capture and force-plate data (Rouhani et al., 2011).

The Use of Accelerometers to Measure Gait and Posture

As mentioned previously, inertial sensors may be used to quantify spatiotemporal parameters of gait. Due to the inherent complexity of gait and its relationship to posture, many researchers have developed protocols to investigate both concepts using the same instrumentation in an attempt to identify any correlations. Accelerometers and other components of inertial sensors have been used to describe components of gait and posture in an aging population. Lamoth and van Heuvelen (2012) attached a three-axis accelerometer to the lumbar spine to quantify trunk accelerations in the anterior-posterior and medial-lateral directions in the elderly. The authors found that older adults, who had practiced sport in the past and continued to practice sport (i.e., ice skating), exhibited postural control similar to that of young adults. The postural efficiency of the elderly who practiced sport was also enhanced versus inactive older adults. More specifically, trunk accelerations in the anterior-posterior and medial-lateral directions during sway were less regular, more smooth, and exhibited more local stability in the active elderly group when compared to the inactive group (Lamoth & van Heuvelen, 2012).

Similar instrumentation and outcome measures were reported by de Groot et al. (2014). The authors found that older adults who exhibited a flexed posture while walking exhibited decreased, more irregular, less smooth, and more unstable trunk acceleration patterns compared to older individuals without a flexed posture. Those who displayed a flexed posture overall had a more variable, less consistent gait pattern and less correlated stride times versus those without a flexed posture.

Force-Plate Posturography

Force plates may also be used to assess balance and posture. Typically, participants stand on the plate barefoot, in a quiet, comfortable stance with arms at the side. Participants are instructed to look straight ahead, typically at a target, and are told to refrain from any voluntary limb or head movements. Trials may last seconds or minutes. Sensory input may be reduced by maintaining various postures with the eyes closed (e.g., da Costa Barbosa & Vieira, 2017; Petrella et al., 2012; Tanaka et al., 2015). Information communicated through the vestibular system may be further disturbed with some customized moving platforms (e.g., Gomes et al., 2015).

Although *Kistler* and *AMTI* force plates are used most often in the literature (e.g., da Costa

Barbosa & Vieira, 2017; Masani, Vette, Abe, & Nakazawa, 2014; Vette et al., 2017), other force plates have also been used to assess posturography in older adults, including the *Stabilotest* (TechnoConcept, France; Cattagni et al., 2016) and the *Force (Strength) Platform* (EMG System do Brasil LTDA, Brazil; Petrella et al., 2012; Tanaka et al., 2015). Among the variables reported in research studies, information regarding the center of pressure (COP) of the feet is typically given. Because force plates are flat, two-dimensional devices, kinematics of the COP are typically reported as magnitudes in the anterior-posterior and medial-lateral directions. Selected variables measured in older adults and the associated protocols can be found in Table 5.3.

In an aging population, COM kinematics have been quantified using calculations that include the ground reaction force data and mass of the participant. Further mathematical techniques (e.g., integration) may also be needed (Vette et al., 2017). Other researchers have combined force-plate posturography with motion capture (Kasahara et al., 2015), a laser displacement sensor (LK-500, Keyence Corp., Japan; Masani et al., 2014), or body-worn sensors (Optotrak, Northern Digital Inc., Canada; Corriveau, Hébert, Prince, & Raîche, 2001; Corriveau, Hébert, Prince, & Raîche, 2000) to characterize the movement of the COM. Force-plate posturography has also been combined with EMG (Cattagni et al., 2016; Vette et al., 2017) and various skeletal muscle strength assessments (Alfieri et al., 2012; Gomes et al., 2015) to give researchers a better understanding of the muscle contributions to balance and posture in older adults. Other researchers have employed skin stimulation methods (Lopes, Ueda, Kunzler, Britto, & Carpes, 2014), simultaneous cognitive tasks (Moghadam et al., 2011), or additional environmental stimuli (Freitas, Wieczorek, Marchetti, & Duarte, 2005; Prado, Dinato, & Duarte, 2011) while assessing posture on a force plate in older individuals.

Other Devices Used to Assess Posture and Gait

The *Neurocom SMART Balance Master System* and the *Neurocom Balance Master System* (Natus Medical Inc., Pleasanton, CA) incorporate a force plate with continuous visual feedback regarding the participant's position of the COG and postural control. These two systems can be combined in a clinical or research setting. The *SMART Balance Master* includes a three-sided wall surrounding the participant in front and to each side. Visual feedback may be provided with a monitor in front of the participant, who may also be secured on the device with a harness. The force plate is dynamic, and protocols can therefore include postural assessments on a stable or unstable platform. The *Balance Master* also provides visual feedback during postural assessments with a dynamic force plate but without the enclosed environment. The force plate included with this system is longer, thereby allowing for enhanced assessment and training protocols. Various protocols may be used with the systems, including a sensory interaction balance test, sensory organization test (SOT), adaptation test, limits of stability (LOS), rhythmic weight shift, weight-bearing squat, unilateral stance, sit to stand, tandem walk, step/quick turn, step up/over, and forward lunge (Natus, 2017). A common test performed on these devices is the LOS test, in which the participant leans as far as possible while maintaining static foot placement on the force plate and keeping arms at the sides throughout. This test allows for a quantification of postural sway and stability in various directions (e.g., forward, backward, left, right) or any combination of directions (e.g., right forward). This test has been validated for use in older adults (Clark, Rose, & Fujimoto, 1997) and has been used to quantify postural control following a period of knee extension strengthening in the elderly (Ryushi et al., 2000). The SOT was used to assess postural control in older adults who received corrective, vibrotactile feedback to reduce excessive sway during the test (Dehzangi et al., 2013).

Table 5.3 Selected protocols and associated variables measured using force-plate posturography in older adults

References	Variables measured	Protocol
Vette et al. (2017)	COP displacement (cm) COP velocity (cm/s) COM displacement (cm) COM velocity (cm/s) COM acceleration (cm/s^2)	Quiet stance (90 s)
da Costa Barbosa and Vieira (2017)	COP area (cm^2) COP velocity (cm/s)	Quiet stance on horizontal, inclined, declined surface, all for 70 s each with EO and EC
Cattagni et al. (2016)	COP displacement (mm) COP/height	Quiet stance (30 s)
Kasahara et al. (2015)	COP displacement (% foot length) COM displacement (% foot length, % height)	Quiet stance, max forward leaning stance, max backward leaning stance, all for a few sec
Tanaka et al. (2015)	COP area (cm^2) COP displacement (cm) COP velocity (cm/s)	Quiet stance (60 s), single-leg stance (30 s), tandem stance (60 s), stance on an unstable platform (5-cm-thick foam; 60 s), all with EO and EC
Masani et al. (2014)	COP displacement (cm) COP velocity (cm/s) COM displacement (cm) COM velocity (cm/s) COM acceleration (cm/s^2)	Quiet stance (90 s)
Lopes et al. (2014)	COP area (cm^2) COP displacement (cm) COP velocity (cm/s)	EC during quiet stance (30 s)
Petrella et al. (2012)	COP displacement (cm)	Quiet stance, stance on an unstable platform (5-cm-thick foam), all for 60 s each and with EO and EC
Alfieri et al. (2012)	COP area (cm^2)	Single-leg stance (10 s)
Moghadam et al. (2011)	COP area (mm^2) COP velocity (mm/s)	EO and EC during quiet stance, EC on unstable platform (10-cm-thick foam), all for 30 s
Jbabdi et al. (2008)	COP displacement (mm) COP area (cm^2) COP velocity (cm/s)	Max forward leaning stance, max rightward leaning stance, max leftward leaning stance, all for a few sec

(continued)

Table 5.3 (continued)

References	Variables measured	Protocol
Yu et al. (2008)	COP displacement (mm) COM displacement (mm) COM acceleration (mm/s^2)	Quiet stance (100 s)
Fujiwara, Kiyota, Maeda, and Horak (2007)	COP displacement (mm) COP velocity (mm/s)	Quiet stance (10 s), stance on a table oscillating at 0.5 Hz (60 s), both with EC
Nagy et al. (2007)	COP displacement (mm)	Quiet stance (20 s) with EO and EC
Freitas et al. (2005)	COP displacement (cm) COP velocity (cm/s)	Quiet stance (60 s), free posture without removing feet from force plate (30 min)
Moore, Korff, and Kinzey (2005)	COP displacement (in)	Quiet stance (30 s)
Hsiao-Wecksler et al. (2003)	COP displacement (mm)	Quiet stance and maintaining stance with a perturbation (a backward tug), both for 30 s

Note: Unless otherwise noted, eyes were open and the participant stood on both legs. The time in the parentheses represents the time completed for each trial. *COM* center of mass, *COP* center of pressure, *EO* eyes open, *EC* eyes closed

Information communicated through the vestibular system may be disturbed with some other customized moving platforms. One example is the *Synapsys Posturography System* (Synapys SA, France). This system can incorporate both static and dynamic tests on a force plate and includes handles for safety. During dynamic tests, the plate can move in the anterior-posterior or medial-lateral directions, in a sinusoidal pattern, or in a customizable direction. This system incorporates several evaluation tests including the SOT, a vestibular stimulation assessment, the Romberg Test, and a fall-risk assessment (Synapsys, 2017). Using this system, postural control and balance were assessed using the reaction time (i.e., the time elapsed between the onset of plate movement and the recovery) upon returning to a COP position ±2 mm from the baseline position in an aging population (Gomes et al., 2015).

The *Good Balance System* (Metitur Oy, Finland) is another force-plate-based device that includes a triangular-shaped plate with handles and real-time visual feedback. Postural control variables, such as the displacement and velocity of sway in the anterior-posterior and medial-lateral directions and the first moment of sway velocity, may be measured. Included in its system are references to over 7000 participants for comparison to normative data (Metitur, 2017). This system has been used to assess postural control in older female twins (Pajala et al., 2003; Viljanen et al., 2009), to investigate COP shifts in older women following 24 weeks of Tai Chi exercise (Zhou et al., 2015), and to predict fall risk in elderly women with or without a previous history of falls (Pajala et al., 2008).

The capacitance-based *FDM pressure platform* (Zebris Medical GmbH, Germany) can output postural sway parameters during static and dynamic measurements. The device is also long enough to capture multiple steps and therefore is a useful tool for gait analysis. The walkway is available up to 10 ft in length and 2 ft in width (Zebris Medical GmbH, 2017). Two platforms may be combined to increase the area of capture if needed. The software also allows for EMG data to be synchronized with data collection. Gait parameters, including normalized gait velocity, cadence, stride and step time, and time spent in stance and swing phase, single and double support, and pre-swing phase, have been recently assessed using this device in elderly women (Kaczmarczyk et al., 2017). Postural variables, including COP area, path length, displacement, and velocity, have also been reported using the platform in the elderly with and without sensory (i.e., vision) feedback (Pau et al., 2014).

The *Matscan* (Tekscan, Inc., Boston, MA) is a pressure sensing mat available for commercial use. This mat can record static and dynamic plantar pressure and can output data related to balance, sway, and posture (Tekscan, 2017). The mat can be synchronized with other biomechanical hardware, including EMG sensors and motion capture systems with a sampling rate up to 440 Hz (Tekscan, 2017). The device has been used to quantify the COP excursion index (CPEI), a measure of dynamic foot function. The CPEI is mathematically expressed as the ratio of COP excursion to foot width, expressed as a percentage (Hagedorn et al., 2013). In a protocol that included older adults from the *Framingham Foot Study*, data were collected at 40 Hz using the two-step method, in which the participant's foot struck the mat on the second step (Hagedorn et al., 2013).

There are body-worn devices that can also output postural sway parameters. One example is the *SwayStar* (Balance International Innovations GmbH, Switzerland). This device adheres to a strap at the lumbar region of the spine. Trunk angular kinematics, including angular displacements and velocities, are recorded by internal gyroscopes. The device can also provide vibrotactile and acoustic feedback with an attachment if needed. Displacements and velocities in the anterior-posterior and medial-lateral directions have been recorded using the *SwayStar* during various static and dynamic functional tasks in older adults (Lim, Horslen, Davis, Allum, & Carpenter, 2016).

Clinical Assessments

The postural control system is inherently complex due to the interaction of multiple systems that contribute to proper balance, posture, and gait (Nnodim & Yung, 2015). There are clinical assessments that may be performed to allow researchers and clinicians to better interpret signs of healthy or abnormal gait and posture. By performing these evaluations, parameters of dysfunctional gait and posture may be documented; a disorder that affects these objective health measures may be identified; and fall risk may be assessed. Clinical assessments may include questionnaires, ordinal scales, or other functional testing.

Questionnaires

Questionnaires may be given to the participant to complete before arriving for further clinical testing. A list of questionnaires and their properties can be found in Table 5.4. The *Activities-specific Balance Confidence* (*ABC*) *scale* is designed to evaluate balance confidence while performing selected ADLs. Created by Powell and Myers, this 16-item questionnaire is rated from 0% (i.e., no confidence) to 100% (i.e., complete confidence) for each activity (Powell & Myers, 1995). Activities may, however, correlate more to those that are avoided rather than future falls (Myers, Fletcher, Myers, & Sherk, 1998). A loss-of-balance confidence could affect postural control and gait, thereby increasing fall risk within the elderly population (Berg, Maki, Williams, Holliday, & Wood-Dauphinee, 1992). Older adults with a previous history of falling have lower *ABC scale* scores, when compared to older adults without a history of falling (Cleary & Skornyakov, 2017; Lajoie & Gallagher, 2004). Indeed, a score of up to 67% on the *ABC scale* is a reliable score for predicting future falls (Lajoie & Gallagher, 2004). Scores on the *ABC scale* can also be used to predict fall status and the incidence of falls after 6 months (Cleary & Skornyakov, 2017). When compared to other clinical tests, such as the *Timed Up and Go* and the *8-Foot Up and Go*, the *ABC scale* exhibits similar validity with older adults when assessing fall risk (Rolenz & Reneker, 2016). Some lifestyle habits, such as Pilates (Josephs, Pratt, Calk Meadows, Thurmond, & Wagner, 2016) and resistance exercise using elastic bands (Kwak, Kim, & Lee, 2016), can increase balance confidence and scores on the *ABC scale*, while other habits, such as lack of sleep, can decrease *ABC scale* scores (Tyagi, Perera, & Brach, 2017).

The *Dizziness Handicap Inventory* (*DHI*) is a 25-item questionnaire that identifies difficulties associated with dizziness. Participants answer “always,” “sometimes,” or “no” to each question, and a score that is associated with each question is summed (Jacobson & Newman, 1990). Scores on the functional and emotional subscales, but not on the physical subscale, are proportional to episodes of dizziness (Jacobson & Newman, 1990). There is a strong correlation between the *DHI* and other balance and postural control assessments, including the *Functional Reach Test* and dynamic posturography using a force plate or other device (Mutlu & Serbetcioglu, 2013). With regard to gait, participants with high scores on the *DHI* exhibit decreased cadence and step length, with an increased variability in cadence and time spent in double support and swing phase (Zanotto et al., 2017).

Ordinal Scales

Proper balance is required to maintain postural control and to safely perform ADLs (Mancini & Horak, 2010). Balance impairment may be assessed quantitatively with ordinal scales. A list of selected ordinal scales can be found in Table 5.5. The *Berg Balance Scale* (*BBS*) is a well-known balance assessment developed to be utilized with older adults. This 14-item scale involves reaching tasks, transfers, and maintaining postural control while decreasing the base of support or through a reduction in sensory input (Berg, Wood-Dauphinee, Williams, & Gayton, 1989). Scoring is performed using a five-point scale ranging from 0 (i.e., lowest function) to 4 (i.e., highest functioning). The maximum aggre-

Table 5.4 Selected questionnaires used for assessment of balance and postural control

Questionnaire	Components	Time to complete	Scoring	Other statistical metrics
Activities-specific balance confidence scale	16 items that relate to ADLs	15 min	0% : no confidence 100% : complete confidence > 80% : high level of PF 50 – 80% : moderate level of PF < 50% : low level of PF	ICCs = 0.7–0.92
Dizziness Handicap Inventory	Physical subscale : 7 items Functional subscale : 9 items Emotional subscale : 9 items Total : 25 items	20 min	0 : no 2 : sometimes 4 : always 16 – 34 : mild handicap 36 – 52 : moderate handicap ≥ 54 : severe handicap	Internal consistency: Cronbach $\alpha = 0.89$ Test-retest reliability: Pearson $r > 0.80$

Note: *ADLs* activities of daily living, *ICCs* intraclass correlation coefficients, *PF* physical functioning

Table 5.5 Selected ordinal scales used for assessment of balance and postural control

Scale	Components	Time to complete	Scoring	Other statistical metrics
Berg balance scale	14 items that relate to sitting, standing, and postural control during various tasks	15–20 min	Range : 0 – 4 max score : 56 41 – 56 : low fall risk 21 – 40 : medium fall risk 0 – 20 : high fall risk	Interrater reliability: Kappa coefficient = 0.98 Internal consistency: Cronbach α = 0.96 Specificity = 96% Sensitivity = 53%
Tinetti performance-oriented mobility assessment	Balance subscale : 9 items Gait subscale : 8 items Total : 17 items	10–15 min	Range : 0 – 2 max balance score : 16 max gait score : 12 Total test score : 28 25–28: low fall risk 19–24: medium fall risk 0–18: high fall risk	Interrater reliability: Pearson r = 0.85 Specificity = 93% Sensitivity = 11%
Balance evaluation systems test	Biomechanical constraints (I): 5 items Stability limits/vertically (II): 7 items Transitions/anticipatory (III): 6 items Reactive (IV): 6 items Sensory orientation (V): 5 items Stability in gait (VI) : 7 items Total : 36 items	30 min	Range : 0 – 108 max score in I : 15 max score in II : 21 max score in III : 18 max score in IV : 18 max score in V : 15 max score in VI : 21	ICC (total score) = 0.91 ICC (subscales) = 0.79–0.96 Sensitivity: 74% Specificity: 67%
Brunel balance assessment	Sitting : 3 levels Standing : 3 levels Stepping : 6 levels Total : 12 levels Levels are arranged in a hierarchy, with task difficulty increasing with assessment progression	10 min	Pass/fail score Each participant has 3 opportunities to pass each level Progression continues until the test ends or a level is failed	Coefficient of reproducibility = 0.99 Coefficient of scalability (subjects) = 0.88 Coefficient of scalability (items) = 0.69 Item-Total correlation = 0.34–0.84 Internal consistency: Cronbach α = 0.92

Physiological profile approach	Vision – 3 items Vestibular function – 1 item Muscle force – 3 items Reaction time – 2 items Postural Sway – 4 items Peripheral sensation – 3 items Total : 16 items	30–45 min	Scored using software that outputs raw score, z score, falls risk score Composite score: < 0 = low fall risk 0–1 = mild fall risk 1–2 = moderate fall risk > 2 = high fall risk	ICCs = 0.51–0.97 Interrater reliability (proprioception) = 0.70 Interrater reliability (tactile sensitivity) = 0.81
Fullerton advanced balance scale	10 items that relate to postural control while standing, changing stances, during dynamic movements, and reactivity	10–12 min	Range : 0 – 4 max Score : 40 Cut off : ≤ 25	Test-retest reliability: Spearman ρ = 0.96 Interrater reliability = 0.94–0.97 Intrarater reliability = 0.97–1.00 Sensitivity: 75% Specificity: 53%

Note: *ICCs* intraclass correlation coefficients gate score that can be achieved is therefore 56. Although a score of 41 to 56 is categorized as "low fall risk," a value of 45 has been proposed as a generalized cutoff score for likelihood of future falls. Older individuals who score less than a 45 are more likely to experience a fall, while those who score more than a 45 are less likely to fall (Bogle Thorbahn & Newton, 1996). Four items, including tandem stance, standing on one leg, look behind, and using alternating feet, are most important for participants to achieve a score of 45 (Kornetti, Fritz, Chiu, Light, & Velozo, 2004). Researchers and clinicians should be cautious in that a decreased score on the BBS is not necessarily correlated to an increased frequency of falling (Bogle Thorbahn & Newton, 1996). However, a change in eight points or more on the *BBS* is indicative of a change in physical function in older adults (Conradsson et al., 2007). The *BBS* has been utilized in many research studies, including the reporting of scores to characterize balance and postural control (e.g., Jbabdi, Boissy, & Hamel, 2008), and before and after an intervention (e.g., resistance exercise using elastic bands; Kwak et al., 2016). The scale correlates moderately with measurements of laboratory sway. However, scores on the *BBS*, along with vision deficits and a recent incidence of falls, can predict the number of falls that may occur within the following year (Berg, Maki et al., 1992). The scale has good specificity (i.e., 96% of individuals without a history of falling are categorized correctly) but poor sensitivity (i.e., 53% of individuals with a history of falling are categorized correctly; Mancini & Horak, 2010). The *BBS* has been validated for ambulatory individuals who have had a stroke, as scores are strongly correlated with functional and motor performance in this population (Berg, Wood-Dauphinee, Williams, & Maki, 1992). The *BBS* has good concurrent validity ($r = 0.91$) with the *Tinetti Performance-Oriented Mobility Assessment* (*POMA*), another ordinal scale (Nnodim & Yung, 2015).

The *POMA* is arguably the most frequently used ordinal scale with the aging population (Yelnik & Bonan, 2008). This 17-item scale is divided into two subscales: balance and gait (Tinetti, 1986). Most items on the balance subscale are scored using a three-point scale from 0 (i.e., highest level of impairment) to 2 (i.e., lowest level of impairment, indicating independence). The exceptions are sitting balance, standing with eyes closed, and turning 360°, all of which are scored using a binary system of 0 (i.e., did not complete or improperly completed the task) or 1 (i.e., adequately completed the task). Most items on the gait subscale are scored using this binary system. The exceptions are deviations in walking path and trunk sway, both of which are scored using the three-point scale mentioned above (Nnodim & Yung, 2015; Tinetti, 1986). A maximum aggregate score of 16 can be achieved on the balance subscale, while a maximum aggregate score of 12 can be achieved on the gait subscale. A score of 25 or greater (out of 28) is correlated to a low fall risk, and a score of 18 or less is correlated to a high fall risk. The scale has good specificity (i.e., 93% of individuals without a history of falling are categorized correctly) but poor sensitivity (i.e., 11% of individuals with a history of falling are categorized correctly; Mancini & Horak, 2010). The *POMA* has been used as a clinical tool with older adults in recent research studies (e.g., Borowicz, Zasadzka, Gaczkowska, Gawłowska, & Pawlaczyk, 2016; Knobe et al., 2016; Mulasso, Roppolo, Liubicich, Settanni, & Rabaglietti, 2015).

The *balance evaluation systems test* (*BESTest*) is a 36-item scale that addresses 6 components of balance control so that any abnormal responses and potential causes may be treated. Components include biomechanical constraints, stability limits/vertically, transitions/anticipatory, reactive, sensory orientation, and stability in gait (Horak, Wrisley, & Frank, 2009). These components "represent relatively independent neural mechanisms underlying control of postural equilibrium" (Horak, 1987, 1997; Mancini & Horak, 2010). It is the only clinical balance assessment that accounts for tests with external perturbations and vertical postural position (Mancini & Horak, 2010). Scoring is completed using a scale from 0 (i.e., worst performance) to 3 (i.e., ideal performance), and percentages are calculated for each subscale and the total aggregate score. A lower score is indicative of a potential deficit with balance and postural control. Among 22 participants with and without balance deficits, the scores for those with balance dysfunction were significantly lower than those without balance dysfunction (Horak et al., 2009). A score of 82 has been identified as a cutoff point to identify fall status (Marques et al., 2016). When performing the test, participants can wear flat-heeled shoes or no shoes at all. Assistive devices are permitted while testing, but the evaluators are instructed to score the item (with which the device was used) one category lower. If physical assistance is needed, evaluators are instructed to score a 0 for that item. There are several items needed for the assessment, including a stop watch, measuring tape, 4-inch thick foam, 10-degree inclined ramp, 6-inch stair step, 2 shoe boxes, 2.5-kg free weight, chair, and masking tape (Horak et al., 2009). The *BESTest* correlates well with scores on the *ABC scale*. Total scores correlate well between the scales (r = 0.685). With regard to specific subscales, the stability limits/vertically section has the best correlation (r = 0.78) to scores on the *ABC scale*, while the transitions/anticipatory section has the worst correlation (r = 0.41) to the *ABC scale* (Horak et al., 2009).

Two shortened versions of the *BESTest* have been developed. The *Mini-BESTest* is a 14-item scale that includes items from the transitions/anticipatory, reactive, sensory orientation, and stability in gait sections (Franchignoni, Horak, Godi, Nardone, & Giordano, 2010). The maximum possible score is 28, with a cutoff value of 19.5 (Marques et al., 2016). The *Brief-BESTest* is a six-item scale that includes one item from each of the six components in the *BESTest* (Padgett, Jacobs, & Kasser, 2012). The maximum possible score for this test is 24, with a cutoff value of 12.5 (Marques et al., 2016). With both scales, the scores are proportional to postural control and balance. A significant correlation (ρ = 0.83–0.96) exists between the *BESTest*, *Mini-BESTest*, and *Brief-BESTest* (Marques et al., 2016). The *BESTest* and its derivatives have been utilized with frail older adults (e.g., Marques et al., 2017) and with older adults diagnosed with various neurodegenerative disorders, including Parkinson's disease (e.g., Santos et al., 2017), Alzheimer's disease (Tangen, Bergland, Engedal, & Mengshoel, 2017), and multiple sclerosis (Potter et al., 2017).

The *Brunel Balance Assessment* (*BBA*) is a 12-item scale designed and validated for individuals who have had a stroke (Tyson & DeSouza, 2004). Balance deficits, as determined by an evaluation using the *BBA*, are a predictor of function and recovery of function in those who have had a stroke (Tyson, Hanley, Chillala, Selley, & Tallis, 2007). There are three components of the *BBA*: sitting, standing, and stepping. The sitting and standing components contain three levels each, and the stepping component contains six levels. The level of difficulty increases as the assessment progresses (i.e., as the level number increases). As the tasks within each level become more dynamic, the base of support is reduced (Nnodim & Yung, 2015). A participant has three opportunities to "pass" a given level. Each level is therefore assigned a pass/fail score. Progression continues until the assessment ends with all levels passed, or a level is failed within a given component (Tyson & DeSouza, 2004). There is a significant correlation between the *BBA* and the *BBS* (Spearman's ρ = 0.97) indicating strong validity (Tyson & DeSouza, 2004). To address redundancy in the assessment, the coefficient of reproducibility (0.99), coefficients of scalability for subjects (0.88) and items (0.69), and internal consistency (Cronbach α = 0.92) were calculated, and all were found to be acceptable (Tyson & DeSouza, 2004).

The *Fullerton advanced balance scale* (*FABS*) is a valid and reliable assessment for independent older adults (Rose, Lucchese, & Wiersma, 2006). There are ten items on the *FABS*, each scored from 0 (i.e., unable to perform task or needs physical assistance) to 4 (i.e., able to perform task). Scores for each item are added into an aggregate, for a maximum possible score of 40 (Rose et al., 2006). A cutoff score of 25 for fall risk has been suggested, as more than seven out of ten adults who score less than a 25 on the *FABS* are at a high risk of future falls (Hernandez & Rose, 2008). In older adults diagnosed with

Parkinson's disease, the *FABS*, *Mini-BESTest*, and *BBS* provide a moderate ability to predict individuals with a history of one or more falls. All three assessments exhibit similar accuracy to predict future falls. Performance on specific items on the *FABS*, such as tandem stance, one-legged stance, and turning in a circle, contributes most to the detection of future falls (Schlenstedt et al., 2016). When compared to the *BBS* alone, a moderate correlation (0.75) has been found (Rose et al., 2006). Similar to the *BESTest*, there are several pieces of equipment needed to administer the *FABS*. These include a ruler, pencil, bench, masking tape, foam balance pads, and a metronome.

The *physiological profile approach* (*PPA*) is a 16-item assessment that is a valid and reliable measure of fall risk in the aging population (Lord, Menz, & Tiedemann, 2003). The *PPA* was designed to expose risk factors or impairments that lead to fall risk. The assessment includes items from the following components: vision, vestibular function, muscle force, postural sway, reaction time, and peripheral sensation (Lord et al., 2003). To confirm validity, reduced knee extension force, decreased tactile sensitivity, greater visual field dependence, and increased postural sway were observed in older adults with a history of falls, relative to older adults without a history of falls (Lord, Sambrook et al., 1994). Various pieces of equipment and software are needed to perform the assessment, putting the *PPA* at a disadvantage to other clinical balance assessments with regard to cost and time.

A shorter version of the *PPA* has been developed that includes one item from each component, with the exception of vestibular function. Specifically, these items are contrast sensitivity, proprioception, knee extension force, reaction time using a finger, and postural sway while standing on a foam rubber mat (Lord et al., 2003). These five items have been found to be most important for identifying those with a history of falls between those without a history of falls (Lord, Clark, & Webster, 1991; Lord et al., 1994; Lord, Sambrook et al., 1994). Scoring is completed using proprietary software. The output includes a fall-risk score, standardized (z) scores, and raw scores compared to references from a known database. A summary can be given to the participant that includes results and recommendations for decreasing the incidence of future falls (Lord et al., 2003). In one study, *PPA* measurements were used to identify individuals, ages 59 to 97 years, who had a history of two or more falls versus those who had a history of one or no falls with an accuracy of 79% (Lord et al., 1991). In another study, measurements were used to identify older women, ages 65 to 99 years, into similar groups with an accuracy of 75% (Lord et al., 1994).

Other Functional Assessments

The *Timed Up and Go* (*TUG*) test is a short, simple clinical test that is a reliable assessment of functional mobility and, more specifically, dynamic stability (Mathias, Nayak, & Isaacs, 1986; Nnodim & Yung, 2015). The *TUG* test involves a participant rising from a seated position on an armchair, walking three meters, turning, walking back to the chair, and sitting down (Podsiadlo & Richardson, 1991). Based on the time it takes to complete the test, future fall risk in older adults may be determined (Shumway-Cook, Brauer, & Woollacott, 2000; Whitney, Lord, & Close, 2005). Most healthy adults can complete the *TUG* test in less than 10 s. If it takes longer than 20 s to complete the test, independence may be negatively affected, and any ADLs that incorporate mobility and ambulation may be considered unsafe, particularly in community-dwelling older adults (Nnodim & Yung, 2015). A cut point of 13.5 s has been identified, as 13 of 15 fallers and 13 of 15 non-fallers are identified using this value (Nnodim & Yung, 2015).

There are also different variations of the *TUG* test. These different versions include an additional task while performing the test (Mancini & Horak, 2010). During the *TUG* cognitive test, participants count backward starting from a number between 80 and 100 while performing the standard *TUG* test. During the *TUG* manual test, participants carry a cup of water while completing the *TUG* test. The cut points for future risk of falls are 15 s and 14.5 s, on the *TUG* cognitive and the *TUG* manual test, respectively (Mancini & Horak, 2010). There are also versions of the *TUG* test that incorporate sensors to further characterize the body movements and gait pattern during the test. Typically referred to as the instrumented *TUG* (*iTUG*) test, participants have smartphones (with an embedded three-axis accelerometer) or inertial sensors attached while performing the *TUG* test. The *iTUG* test has been performed in older adults with Parkinson's disease (Zampieri et al., 2010) and without Parkinson's disease (Galán-Mercant & Cuesta-Vargas, 2014; Zakaria, Kuwae, Tamura, Minato, & Kanaya, 2015) to assess fall risk. Finally, related components of the *TUG* test have been developed as separate clinical tests with older adults, including the *Sit-to-Stand Test* (Millor, Lecumberri, Gómez, Martínez-Ramírez, & Izquierdo, 2013), *Timed Walk Test* (Connelly, Thomas, Cliffe, Perry, & Smith, 2009), *Distance Walk Test* (Camarri, Eastwood, Cecins, Thompson, & Jenkins, 2006), and the *Figure-of-8 Walk Test* (Hess, Brach, Piva, & VanSwearingen, 2010).

The *Single Limb Stance Test*, also known as the *One-Leg Stance Duration Test* or the *Unipedal Stance Test*, is a well-known clinical test that is fast and easy to perform (Mancini & Horak, 2010; Nnodim & Yung, 2015). During this test, the participant is instructed to stand on one foot while raising the opposite foot. Some protocols differ, but typically the test assessor will instruct the participant not to touch the ankle of the grounded foot with the raised foot. Participants are also usually barefoot while staring at an eye-level target on a wall in front of them with the arms crossed across the chest. The test is correlated with frailty and fall risk in the aging population (Drusini et al., 2002). Times during this test are typically greater than 30 s for those under the age of 40 years. However, as individuals age, the times decrease. For example, the time is 22.5 ± 8.6 s for those aged 60 to 69 years and 14.2 ± 9.3 s for those aged 70 to 79 years (Bohannon, Larkin, Cook, Gear, & Singer, 1984). When performing this test, stance width needs to be standardized before the assessment begins (Nnodim & Yung, 2015).

The *Romberg Test* is a measure of static balance with and without reduced sensory input (i.e., eyes closed). Participants are asked to stand with their feet together and touching, thereby reducing the base of support. The arms are either extended and held next to the body or are crossed over the chest. The degree of sway can then be measured and the test ends when balance cannot be maintained. A cutoff value of 20 s has been found to be associated with fall risk. Specifically, if a value of less than 20 s is recorded, that individual is at a three times greater risk of future falls. This cutoff value is typically met between the ages of 60 and 69 years (Agrawa, Carey, Hoffman, Sklare, & Schubert, 2011).

The *Functional Reach Test* is a measure of dynamic standing balance (Nnodim & Yung, 2015). During this test, participants typically perform a shoulder flexion movement in a standing position, reaching forward at shoulder height with one arm to the point of discomfort with a closed fist (Duncan, Weiner, Chandler, & Studenski, 1990). The participants are asked not to move their feet during the test. A cutoff value of 6 inches has been determined for fall-risk prediction (Nnodim & Yung, 2015). Other movements that can be incorporated into the *Functional Reach Test* include shoulder extension and shoulder abduction, performed in a similar manner as shoulder flexion. Although the forward-reaching test is correlated well with COP excursion, COM displacement within the base of support is not correlated well (Jonsson, Henriksson, & Hirschfeld, 2003; Mancini & Horak, 2010; Nnodim & Yung, 2015).

Data Analysis Strategies

In many research studies, authors will report other variables, using various strategies, in an attempt to give the readers a better understanding of the underlying mechanisms of gait and postural control. In this section, more common data analysis strategies are presented, including power spectral analysis, principal component analysis, stabilogram-diffusion analysis, and other models and theorems.

Power Spectral Analysis

Frequency is a characteristic of sinusoidal time-varying signals that represents how fast the signal oscillates. Units of frequency are typically cycles per second or hertz. Any time-varying signal can be represented by adding individual frequencies which is mathematically modeled by the Fourier series. Coefficients in the Fourier series can then be calculated using a discrete Fourier transformation (DFT) algorithm. Mathematical and statistical techniques are employed to determine the amount of a specific frequency present in a signal. The power at a certain frequency, or how much of the signal is composed of that frequency, can then be determined. The power at each frequency can be plotted and is called the power spectral density (PSD) or the power spectrum. A PSD plot displays the frequencies that include the greatest power. The data in PSD plots may also be normalized to allow for varying sampling rates to be compared (Derrick, 2014). Power spectral analysis has been used to determine fall-risk predictors using ambulatory accelerometery data (Rispens et al., 2015) and describe COP sway path (da Costa Barbosa & Vieira, 2017; Nagy et al., 2007), trunk movement patterns (de Groot et al., 2014; Lamoth & van Heuvelen, 2012), and the difference between COP and COG motions (Berger et al., 2005) in an aging population.

Principal Component Analysis and Gait Variability

When analyzing variables related to gait and posture, sinusoidal functions are not always a natural fit to the raw data. A better, unique set of data, called "basis functions," may be extracted from the waveforms and are related to the shape and modes of variation within the data (Deluzio, Harrison, Coffey, & Caldwell, 2014). These data, which may contain a large number of original variables, are reduced to a small number of transformed variables (Manly, 2005). This technique is called *principal component analysis* (PCA). In short, PCA is a mathematical algorithm that seeks to find a small set of orthogonal variables to capture the variation in the original variables (Chau, 2001). More specifically, the orthogonal transformation converts a number of correlated variables into a smaller number of uncorrelated, independent variables (Deluzio et al., 2014). These independent variables are called principal components. Principal component analysis is therefore ideal for data reduction and interpretation (Deluzio et al., 2014). The analysis works best if the original variables are highly correlated (either positively or negatively). The lack of correlation may lead to measuring different dimensions of data (Manly, 2005). Researchers have used PCA to characterize age-dependent sex differences in gait (Kobayashi et al., 2016), identify trends with recurrent female fallers (Moreira, Sampaio, & Kirkwood, 2015), and determine which factors contribute to independent ambulation and healthy gait in community-dwelling older adults (Kirkwood et al., 2016; Lord, Weatherall, & Rochester, 2010).

Reporting the variability in gait parameters is becoming more prevalent in research studies. Gait variability is correlated with the prediction of fall risk in older adults (Beauchet et al., 2009; Callisaya, Blizzard, Schmidt, McGinley, & Srikanth, 2010; Verghese et al., 2009). Increased variability in spatiotemporal variables while walking may reduce the inherent efficiency of the gait cycle, thus increasing the risk of falls (Hollman et al., 2011). For example, if an individual walks in one direction on a level surface, while maintaining gait velocity at a self-selected speed, and step width variability is increased, then that individual is at an increased risk of future falls (Brach, Berlin, VanSwearingen, Newman, & Studenski, 2005). Fall training, or executing falls in a safe environment with spotters, may decrease spatial gait variability parameters during dual-task walking (Donath et al., 2014).

The variability of some spatiotemporal gait parameters is more useful to report than the variability of others. Decreased gait velocity, arguably the most commonly reported gait variable, could be the catalyst for the increased variability observed in other gait parameters in older adults (Callisaya et al., 2010). There is a direct, proportional relationship between step time variability and age in women, particularly over the age of 60 years (Callisaya et al., 2010). According to some researchers, gait velocity and step length explained 13.9% of the total variance observed with gait in the elderly (Lord et al., 2013). Other researchers found that the primary source of variation in the gait cycle of older adults included changes in gait velocity, step time, stance time, and time spent in double support (Kirkwood et al., 2016). Hollman et al. (2011) identified that a rhythm factor, including cadence, step and stride time, stance and swing time, and time spent in single limb support, accounted for 25.8% of the variance observed during gait in older individuals. This is significant because changes in rhythm may be correlated to memory deficits and an increased risk of dementia (Verghese et al., 2007).

When reporting gait variability data, researchers must be cautious of the instrumentation that is used. Gait variability measures obtained from an accelerometer worn at lumbar-segment 5 (L5) were higher and showed poorer agreement versus measures obtained using the *GAITRite* (Del Din, Godfrey et al., 2016). Methods of reporting spatiotemporal gait variability have included the calculation of the coefficient of variation (Donath et al., 2014; Hollman et al., 2011; Kirkwood et al., 2016; Wittwer et al., 2013), standard deviation values (Del Din, Hickey et al., 2016; Lord et al., 2013; Scaglioni-Solano & Aragón-Vargas, 2015a), or the use of more complex calculations (de Groot et al., 2014).

To more objectively quantify gait variability, a gait variability index (GVI) has been created. The GVI is a measure derived from nine spatiotemporal parameters of gait (i.e., gait velocity, step and stride length, step and stride time, stance and swing time, time spent in single and double support) with each variable weighted (Gouelle et al., 2013). The GVI has been validated as an indicator of mobility deficits (Gouelle et al., 2013). More specifically, the GVI is lower in older adults versus younger adults, decreases with increasing age (particularly after the age of 50 years), discriminates older adults with some moderate mobility deficiencies from those who are higher functioning, and is correlated with some clinical measures of functional mobility and balance (e.g., walking velocity, *BBS*; Balasubramanian, Clark, & Gouelle, 2015).

Stabilogram-Diffusion Analysis

During quiet standing, the COP moves relative to a global coordinate system (Collins & De Luca, 1993). The time-varying behavior of the COP can therefore be calculated by squaring successive COP displacements in a given time interval and then averaging the squared values over the number of time intervals (Moore, Korff, & Kinzey, 2005). The mean squared COP displacement data are then plotted versus the change in time (Moore et al., 2005). This graph is called a *stabilogram-diffusion plot*. On a given plot, long-term time intervals and short-term time intervals (i.e., about 1 s; Collins & De Luca, 1993) may be identified. The long-term intervals represent closed-loop postural control mechanisms or the initiation of movement using sensory feedback (Moore et al., 2005). Closed-loop mechanisms have traditionally been thought to be the foundation of the postural control system. For many years, the regulation of muscular activity during quiet standing was thought only to be due to visual, vestibular, and somatosensory feedback (Collins & De Luca, 1993). However, it is now accepted that open-loop postural control mechanisms, represented by the short-term time intervals on the stabilogram-diffusion plot, account for postural control strategies without feedback (Moore et al., 2005). Open-loop mechanisms contain activation signals that can result in small mechanical fluctuations in muscles throughout the body. These fluctuations, and any drift caused by these movements, may go unnoticed by the postural control system until a threshold is reached. At this threshold, corrective feedback signals are employed (Collins & De Luca, 1993). Moore et al. (2005) used stabilogram-diffusion plots to assess postural stability after an acute bout of resistance exercise to fatigue in older adults. The authors found that resistance training had a negative effect on postural stability as evidenced by an increase in open-loop control. In another study, researchers found that similar control mechanisms are used to stabilize posture during a quiet stance versus a mild perturbation condition in older individuals (Hsiao-Wecksler et al., 2003).

The Pinned-Polymer Model and Fluctuation-Dissipation Theorem Applied to Postural Control

Although human posture and its control are extremely complex, researchers have attempted to mathematically model the response to perturbations. The output of the postural control system is very irregular, as evidenced by fluctuations in COP kinematics. The COP dynamics during quiet standing exhibit a stochastic system (i.e., often referred to as a "random signal," it is impossible to predict an exact future value even if its entire previous history is known). A pinned-polymer model has been proposed to describe the stochastic dynamics (Chow & Collins, 1995). This model has been adopted by other researchers and "is based on the assumption that the human body can be described by a continuum model analogous to a flexible string or polymer that is elastically pinned to an equilibrium position and under the influence of stochastic fluctuations" (Lauk, Chow, Pavlik, & Collins, 1998). The movement of the COP is represented by the movement of a single point along the polymer (Lauk et al., 1998). The pinned-polymer model can therefore characterize COP movement during quiet standing. The model contains several parameters, and deviations in these parameters could suggest a balance disorder (Chow & Collins, 1995). The model can also predict how alterations in physiological function would influence COP kinematics (Chow & Collins, 1995). The pinned-polymer model obeys the fluctuation-dissipation theorem (FDT), "which provides a relationship between the correlations of the fluctuations of a system and its relaxation to equilibrium" (Lauk et al., 1998). In an aging population, it is possible to use the FDT to predict postural responses due to mild perturbations during quiet standing (Hsiao-Wecksler et al., 2003).

Other Data Analysis Techniques

There are other variables that are less commonly reported than those listed in the *Measurement Techniques* section of this chapter. With regard to gait variables, spatiotemporal parameters may be normalized. For example, gait velocity may be reported as normalized velocity by dividing velocity by leg length (Protas et al., 2007) or by step length (Ferraro et al., 2013). The gait stability ratio has also been reported, defined as the cadence divided by the mean normalized gait velocity (Ferraro et al., 2013). Other variables that have been reported in the aging population include:

Step asymmetry: the absolute difference between right and left steps while walking and a marker for lower limb coordination (Del Din, Godfrey et al., 2016; Del Din, Hickey et al., 2016; Lord et al., 2013)

Coefficient of attenuation: the ability to dissipate accelerations from one body segment to another (Scaglioni-Solano & Aragón-Vargas, 2015a, 2015b)

Acceleration root mean square: the magnitude of acceleration in a given direction (Scaglioni-Solano & Aragón-Vargas, 2015a)

Harmonic ratio: a quantification of gait pattern smoothness (Scaglioni-Solano & Aragón-Vargas, 2015a, 2015b)

The root mean square (RMS) has also been used to further describe magnitudes associated with the COG, COM, and COP in older adults (e.g., Berger et al., 2005; Corriveau et al., 2000, 2001). The RMS and other postural variables not commonly reported with older adults are found in Table 5.6. A description of some variables is listed below:

Sway density curve: a time-dependent curve that accounts for the consecutive number of COP data points within a circle with a given radius in an instant of time (da Costa Barbosa & Vieira, 2017)

Sway vector: a vector characterized by its length (i.e., COP or COM velocity; correlates with uncertainty in postural control thereby affecting stability) and its polar angle (Błaszczyk, 2016)

Sway ratio: A ratio of COP/COM path lengths (Błaszczyk, 2016)

Detrended fluctuation analysis: RMS analysis that assesses long-range correlations (da Costa Barbosa & Vieira, 2017)

Sample entropy: the predictability of a time series (da Costa Barbosa & Vieira, 2017)

Phase plane portrait: a summary of the static and dynamic aspects of postural control while factoring the position and velocity of the COP, which has also been reported in older adults (Moghadam et al., 2011)

Key Research to Practice Message

Practice Recommendations

As both the utility and relationship between gait and postural measurement become better understood and more efficient, clinicians should seek to incorporate these measures into common practice. They should be used as both objective patient outcomes and to make placement, assistive device and return to activity recommendations. These tools can provide strong data to support practice-based decisions related to acute and chronic decline, response to treatment, and individual patient response to pharmacology treatments.

Table 5.6 Selected postural control protocols and associated variables measured in older adults

References	Variables measured	Protocol
da Costa Barbosa & Vieira, (2017)	COP displacement (Hz) COP mean power spectra (cm^2/Hz) Sway density curve Detrended fluctuation analysis Sample entropy	Same as in Table 5.4
Błaszczyk (2016)	Sway vector Sway ratio	Quiet stance (26.5 s) with EO and EC
Tanaka et al. (2015)	Mean amplitude of sway	Same as in Table 5.4
Moghadam et al. (2011)	SD of COP displacement (mm) SD of COP velocity (mm/s) COP phase plane portrait	Same as in Table 5.4
Prado et al. (2011)	Number of weight transfer events	Free posture without removing feet from force plate (30 min)
Yu et al. (2008)	COP-COM	Same as in Table 5.4
Nagy et al. (2007)	Spectral energy (power)	Same as in Table 5.4
Freitas et al. (2005)	COP frequency (Hz) COP RMS (cm)	Same as in Table 5.4
Berger et al. (2005)	COG_h area (mm^2) COG_h mean velocity (mm/s) COG_h RMS COG_h median frequency (Hz) COP – COG_v area (mm^2) COP – COG_v mean velocity (mm/s) COP – COG_v RMS COP – COG_v median frequency (Hz)	Quiet stance (32 s)

(continued)

Table 5.6 (continued)

References	Variables measured	Protocol
Corriveau et al. (2001)	COP-COM RMS	Quiet stance (120 s) with EO and EC
Corriveau et al. (2000)	COP-COM RMS	Quiet stance (120 s)

Unless otherwise noted, eyes were open and on both legs. The time in the parentheses represents the time completed for each trial. *COG_h* center-of-gravity horizontal motions, *COG_v* center-of-gravity vertical motions, *COM* center of mass, *COP* center of pressure, *EO* eyes open, *EC* eyes closed, *RMS* root mean square, *SD* standard deviation

Future Directions in Practice and Research

Continued development of both cross-sectional benchmarks and longitudinal modeling of gait and postural control is needed to streamline immersion across populations where these measures have been proven to be alerts of decline and functional capacity. As these data relationships and the development of longitudinal tracking become more robust, we will enable greater decision-making and improved monitoring of change in clinical- and home-based settings. Seeking to better support patient outcomes and modeling of specific pathologies should be prioritized, as well as monitoring response to treatment.

Conclusions

In conclusion, gait and postural measurements in older adults are important predictors of risk and impairment. They also serve as the salient data to inform therapeutic exercise and rehabilitation needs of the older individual. Gait and postural data have the capacity to drive the data-driven decision-making to improve patient outcomes by identifying problems earlier, engaging therapeutic interventions earlier, and preserving physiological health. These technologies, along with advances in home-based systems, provide new avenues to monitor individuals, whether it is intended to detect an early onset of a chronic disease or to assess the effectiveness of a treatment. Incorporation into clinical monitoring has the potential to be significant as it provides an ability to characterize individual change, identify valid associations between lifestyle factors and health outcomes, monitor and evaluate treatment paradigms, and alert clinicians of the need for further diagnostics and medical remediation. We urge both practitioners and policy makers to incorporate both gait and postural data cross-sectionally to describe, and longitudinally evaluate, the needs and effectiveness of programs focused on improving function and/or maintaining the independence of older adults.

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Part II

Major Illnesses and Disabilities in the Aging Population

6 Musculoskeletal Pain and Disability Disorders

Chasley Jones, Jessica Stephens, and Robert J. Gatchel

Overview

Musculoskeletal pain is the most common single type of chronic pain. That is why this chapter specifically focuses on musculoskeletal pain and disability and what it consists of. Obviously, musculoskeletal disorders involve the musculoskeletal system. Musculoskeletal disorders are a broad group of disorders that include any illness that impacts the skeletal muscles, connective fibers (i.e., the tendons, ligaments, and joints), supporting blood vessels of the skeletomuscular system, or any peripheral nerves (of the 43 pairs connecting the central nervous system to other sites of the body [Summers, Jinnett, & Bevan, 2015]). This group of disorders, which typically involves the experience of persistent pain and reduced functional capabilities, has been found to be the most common diagnosis of those living on disability worldwide, comprising 61% of this population (Perruccio et al., 2017). The musculoskeletal system involves 90% of the human body devoted to interacting with the external stimuli (Gatchel & Schultz, 2014). Even though the musculoskeletal system is associated with all the other systems, it is less involved with issues of homeostasis, sensory input, and problem-solving. Bones and joints of the body provide the frame, while ligament connectors and muscle/tendons provide the operation of the body. In this system, there is also inclusion of peripheral nerves and nerve roots that provide communication from the central nervous system. These nerve links are specifically important for disorders that involve the upper extremities. Relatedly, occupational musculoskeletal disorders account for the most significant component of occupational injury in frequency, disability, loss of productivity, and cost (Mayer, Gatchel, & Polatin, 2000; Punnett & Wegman, 2004). Indeed, occupational injuries represent an important cost to industry and therefore to the productive capacity of every nation.

Musculoskeletal disorders include a wide array of degenerative and inflammatory conditions that can occur (Punnett & Wegman, 2004). Moreover, it should be noted that there are various criteria used for musculoskeletal disorders that can create difficulty in having reliable universal statistics of the effect and cost among different jurisdictions in the United States. Nevertheless, according to the US Bureau of Labor Statistics (2007), musculoskeletal disorders comprise the greatest proportion of occupation injuries sustained in the

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United States, at 349,050 (31.1%) of the 1,122,960 injuries sustained in 2016. Furthermore, the proportion of musculoskeletal disorder-related injuries was linked to about one-quarter of all workers' compensation benefits paid to injured employees.

The National Institute for Occupational Safety and Health (2018) equates musculoskeletal disorder work-related injuries to costs of about $15.1 billion spent in the United States annually, without considering the productivity losses from the 10-day median absence they accrue. It also is only inclusive of those workers covered by workers' compensation, which is roughly 100 million (or less than two-thirds of the total labor force). In addition, some states implement lax regulations regarding the legal necessity to provide for workers' compensation. Moreover, musculoskeletal disorders are highly diverse in nature and expression. They accounted for 66% of the low-to-middle socioeconomic regional disability-adjusted life years, a measure of disease burden, experienced by approximately 43 million sufferers (Prince et al., 2015). In the United States alone, it is estimated that $100 billion are approximately spent annually on healthcare utilization and concomitant work productivity losses due to patients with the most commonly cited occupational musculoskeletal disorders (i.e., back and neck pain conditions; Research & Markets, 2009). This chapter will include a review of some causal theories/models of musculoskeletal disorders, a brief description/discussion of the most prevalent of these disorders, and an overview of the most common and effective treatment methods for these disorders.

Musculoskeletal Pain and Disability Disorders with Older Adults

In the first chapter of this handbook, the epidemiology of various illnesses in older adults was reviewed. As stated there, epidemiology is the study of the distribution and causes of diseases, illnesses, and injuries in human populations (Lary, 2011). Over the past three decades, there has been a profusion of research that has attempted to isolate specific risk factors associated with the development and treatment of various types of musculoskeletal pain and disability disorders. Musculoskeletal pain is often split into occupational and nonoccupational categories. This distinction is commonly overlooked during treatment but is considered when reviewing the outcome of treatment for legal purposes. An occupational injury is the one that results from a work-related event or from a single instantaneous exposure in the work environment. Injuries that are attained from work are reportable to the *Occupational Safety and Health Administration* by the employer, if they result in lost work time and require medical treatment and if the worker becomes unconscious or is transferred to another job (Injuries, 2001). Occupational illnesses are any other conditions or disorders that are developed from work, but not one particular injury (e.g., caused by exposure to some factor(s) associated with the work of the employee [e.g., inhalation, absorption, ingestion, or direct contact; Injuries, 2001]). Musculoskeletal injuries are often defined as traditional traumatic injuries (e.g., fractures, sprains, strains, dislocations, or lacerations), while musculoskeletal illnesses are commonly called repetitive motion injuries (RMI), musculoskeletal disorders, or cumulative trauma disorders (CTD). We will now review the prevalence of many of the musculoskeletal disorders in older adults.

Chronic Low Back Pain

Low back pain (LBP) is a very common problem which negatively impacts most individuals at some point in their lives; it has been shown that 70–85% of all individuals in the United States experience it (Andersson, 1999). According to the *Agency for Healthcare Research and Quality*, about 70% of individuals who experience an episode of LBP will seek medical treatment. Several studies have shown that approximately 25–27% of all US residents experience an episode of LBP

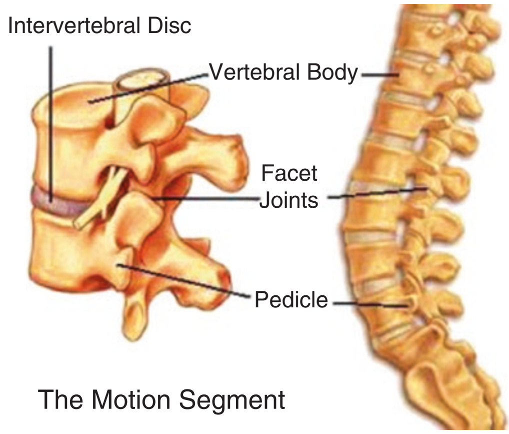

Fig. 6.1 Lateral view of spinal segment (left) and horizontal view of lower section of spine (right). (Pulled from http://www.southcoastspine.com.au/the-spine-basic-anatomy-and-mechanics, May, 2018)

annually (Deyo, Mirza, & Martin, 2006; Pleis & Lethbridge-Cejku, 2007). It is also reported that LBP causes 19 million office visits, which total over $3 billion in costs for office visits alone, annually (Katz, 2006). LBP office visits account for 2% of all visits to the doctor and are only exceeded in quantity by routine checkup visits (Martin et al., 2008). Needless to say, the overall costs of LBP are cumbersome and are only estimated to get worse by rising rapidly costs and lost wages due to interferences with work (Katz, 2006; Martin et al., 2008). Also, Dionne, Dunn, and Croft (2006) have estimated that the prevalence of LBP for those over the age of 60 is approximately 20%. These older adults also have the highest long-term consumption rates of medications for pain (MacFarlane et al., 2012).

It should be noted that the spinal column typically consists of 33 vertebrae, which include 7 cervical, 12 thoracic, and 5 lumbar vertebrae. This is the mobile portion of the spine, with five segments below the lumbar region fused to form the sacrum and four more bones joined on to form the coccyx. This is the anatomical structure that provides a rigid protective cover for the spinal cord while allowing enough flexibility to efficiently move the trunk. Each vertebra is effectively linked to connecting vertebrae above and below through intervertebral discs, paired facet joints, and numerous ligamentous attachments. The joints are freely mobile synovial joints that assist in the mobility of the back (Block & Shellock, 2014). With aging, there is a natural degeneration of these vertebrae (Fig. 6.1).

There are many potential anatomic sources of LBP (e.g., the paraspinal musculature, intervertebral disc, facet joins, and vertebral bodies). In many cases, multiple structures are interacting to produce the overall clinical presentation. However, they lead to clues to the dominant sources of pain and the appropriate treatment approach. The experience of LBP can be traumatic, protracted, and life-altering, or it can be just a difficult aversive problem that patients learn to manage. The individuals who have an identified cause which recommends surgery to treat will most likely experience pain for a greater duration and require more intense treatment than 54% of patients who cannot specify a cause for their pain (Martin et al., 2008). This is mostly due to the effects of emotional and psychosocial factors that can strongly influence the experience.

Arthritis

Researchers such as Helmick et al. (2008) estimated the prevalence rates of various forms of arthritis, based upon the data mined from the *National Health and Nutrition Examination Survey* (NHANES) and the *National Health Interview Survey* (NHIS). Roughly 46.4 million (21%) individuals in the United States were believed to suffer from any form of arthritis. Of this, about 17.2 million sufferers were aged 65 or older. More recent estimates by Jafarzadeh and Felson (2017) were based upon the 2015 *National Health Interview Survey*. Roughly 61.1 million adults were believed to be suffering from any form of arthritis. Estimates were that 55.8% of men and 68.7% of women over the age of 65 were sufferers of any form of arthropathy (i.e., the category of disorder involving disease and/or inflammation of the joints). This may suggest that previous estimates of arthritis prevalence in America have been inaccurately conservative.

Nair, Ting, Keen, and Conaghan (2016) outlined arthritis and various arthritic conditions in their chapter entitled *Arthritis in Older Adult*, highlighting various forms of arthritic illnesses. Arthritic conditions also go by the title of *Rheumatologic Diseases*. The prevalence of such diseases increases as a person ages, and by the time a person reaches 85, well over one-half (65%) can expect a diagnosis. Sufferers of arthritic musculoskeletal disorders, especially those at least 75 years of age, are often suffering from debilitating symptoms. Pain, muscular degeneration, tiredness and sleep disturbances, limits to functioning, and poorer life quality are just some of the common experiences of the diagnosed. Many variants of this broad form of illness were said to be more common in older adults, particularly osteoarthritis.

Osteoarthritis

In a review of the burden of disease in older populations worldwide, Prince et al. (2015) listed osteoarthritis (OA) as the second most prevalent of all musculoskeletal conditions. OA is said to afflict approximately 7.5 million worldwide, most of them older adults. Approximately 10–20% of individuals were said to expect to experience OA symptoms by the time they were 60 years of age. OA often has higher prevalence rates in the elderly due to its natural course. It is described as a bone disease that is both progressive and degenerative in its advancement.

Silverwood et al. (2015) discussed the findings of 34 meta-analyses and 12 systematic reviews on the risk factors associated with developing osteoarthritis as an older adult. OA is the sixth leading cause of disease worldwide and is estimated to impact about 9.6% of men and 18% of women. About one in four of adults over 55 years of age has complained of at least one episode of serious knee pain associated with OA within a given year. About 13% of this population can expect to receive a formal diagnosis. This form of arthritis was described as a primary cause of older adult declines in quality of life (QoL), a self-reported measure of overall physical and mental well-being. OA was found to be the primary cause of discomfort and disability in the elderly as well. Typical risk factors associated with OA knee pain experience were found to be associated with the following: being overweight, being obese, being female, and having a previous injury of the knee. In those with OA symptoms of the hand, a common risk factor could not be determined. As the most common joint problem experienced by the elderly, the causes of OA vary a great deal. The nature and course of OA symptom expression, though, tend to present in a highly systematic and predictable fashion. There is a degeneration of the bone tissue related to several key things: one being that there seems to be degeneration to the reparative mechanisms of the bone. Also, there appears to be a reduced ability for the body to create adequate amounts of hyaline cartilage (translucent cartilage of the joints) and subchondral bone (the layer of the bone just beneath joint cartilage) to compensate for their wear and tear (Nair et al., 2016).

The most common clinical features experienced by sufferers of OA are rigidity, structural deformity, tenderness, muscle deterioration, swelling, and crepitus. Rigidity involves stiffness present in the movement of an area surrounding the affected joint. Typically in OA, this occurs in the morning hours, just after rising. The structural deformity is commonly present in the hand at the site of the thumb, wherein indentations and bending of the bone and joint in the affected area may occur. Tenderness describes the painful sensation upon touch or movement of an area where a person is experiencing the arthropathy of a joint. Muscle deterioration is also common in OA, especially with signs presenting when a person tries to perform certain tasks. For one, it is difficult for them to abruptly stand from a seated position. Secondly, given the task to perform a *grip strength test* of the power of their hand as it squeezes a pressure gauge, this will lead to below-average results. Lastly, performing an exercise wherein one tries to slowly raise a completely straight leg while lying flat is negatively affected. Other physical symptoms include bone swelling, effusions of synovial fluid, and crepitus, which occurs when there is a painful friction and grating of the bones joining at the site of the cartilage loss (Nair et al., 2016).

Rheumatoid Arthritis

While OA is considered a degenerative rheumatic condition, *rheumatoid arthritis* (RA) is considered an inflammatory autoimmune variant. RA is a chronic pain condition, considered to be the second most common form of arthropathy, aside from OA. RA is the most common cause of autoimmune-related inflammation of the joints. It afflicts approximately 1.3 million individuals. The most likely to be diagnosed with RA are women and middle-aged or older adults (Firestein & McInnes, 2017). RA initially begins to unfold at the site or sites of synovial joints (Allen, 2016). Within the membrane of a joint is a fluid which nourishes it and provides it with cushion. This is the *synovial fluid* of the joint. The cartilage at the ends of the bones where a joint is placed allows the limbs to move freely and smoothly, due to the subtle nature of the joint connective tissue. The joints connecting the limbs in the body give appendages support, elasticity, and ease of motion. Sufferers of RA often have physical symptoms similar to osteoarthritis, such as stiffness and pain on both sides of the body in the joints of the wrists and hands. Other areas may also be afflicted, though less commonly, such as the knees, hips, shoulders, elbows, and neck.

RA is an autoimmune disease, which is enduring, orderly, and inflammatory in nature. The underlying reason for RA symptoms is an autoimmune response of unknown origin. This attack initiates cytokine and autoantibodies to release white blood cells that lead to the sites of the bones, joints, and synovial fluid and later initiate pannus there. Pannus is an abnormal layer of the fibrous tissue that destroys the cartilage and bone (Allen, 2016). RA may initiate fatigue in those afflicted. Fatigue may be particularly present at the sites of the body that cause the most issue in the patient. This commonly occurs after physical exertion of an afflicted limb, but the fatigue is also commonly general and broad in its expression. Other symptoms include swelling at the site or sites of the body where the joints are being attacked. Stiffness is a very commonly experienced symptom of RA, typically expressing the greatest severity early in the day after rising. It is not uncommon for the most heightened degree of stiffness to exhibit for a period of several hours before reducing in intensity. Swelling often arises in the areas near the afflicted joints due to fluid retention at these sites. A general loss of ability in the afflicted area or areas is also typical. The damage amassed at the sites of the joints that are afflicted leaves those diagnosed with a loss of function.

It may be imperative that an RA sufferer seeks out medical treatment immediately following the initial signs of the illness presenting. The responsiveness of RA to treatment has been found to be finite. After a certain early window of time after the onset of initial symptoms surpasses, alleviating the debilitating symptoms becomes difficult, and treatment outcome becomes less favorable (Van Nies, Tsonaka, Gaujoux-Viala, Fautrel, Van Der Helm-Van Mil, 2015). RA has also been associated with other latent illnesses, such as mood disorders, inertia, fibromyalgia, pain conditions, and other degenerative forms of arthritis, often found in older adults (Challa, Crowson, & Davis, 2017).

Diagnosing and Treating Arthritis

There remains no systematic and universally accepted way of formally diagnosing the common forms of arthritis. However, there are some common methods of identifying arthritis that are currently utilized by practitioners. These include symptom checklists for general practitioners and radiography. Radiography, or the practice of utilizing X-ray scanning of the body to create an image of the bone and joint structures, is also commonly used. X-rays may aid in identifying bone deformations associated with OA. Clinical presentations, such as swelling, tenderness, and joint deformations at the afflicted sites, can be helpful indicators for physicians in making a formal diagnosis as well (Nair et al., 2016). A specialist may be seen who may be more inclined to make accurate formal diagnoses of OA and RA than a general practitioner. A rheumatologist has specific expertise in rheumatic conditions and may be seen if individuals expect that they are suffering from a form of arthritis. University of Padova Division of Rheumatology researchers Doria and colleagues (2018) discussed rheumatology and the controversial diagnosing of various arthritic conditions in their review. Rheumatology was described as a field of trained experts in understanding the muscles, joints, ligaments, and related diseases. Rheumatologists have specialized knowledge of specific mechanisms, clinical symptom criteria, courses, and treatments of various rheumatic conditions. Typically, a formal diagnosis is warranted from an understanding of the key clinical indicators of OA, RA, and other forms of arthritis. Still, some forms may be able to be tested for by utilizing more objective methods, such as structural, functional, or biofluid analysis. It was encouraged that rheumatologists continue to develop knowledge of the most up-to-date procedures and treatments for these types of conditions, so they may stay abreast of the techniques of best practice.

Common forms of treatment for arthritic conditions might include practical and noninvasive self-care. Hot showers may be helpful to some, aiding in reducing mild, acute, and early exhibitions of pain and stiffness in the joints. Other methods used include increased exercise, slowing down the speed of completing work, wearing joint protection, and reducing one's weight. In terms of treating symptoms of either form of common arthropathy, anti-inflammatory medication may be prescribed. Commonly, this is a variant of acetaminophen, called "paracetamol" (Prince et al., 2015). OA also has had specific, nonsurgical treatment guidelines outlined by the *Osteoarthritis Research Society International* (OARSI). These were detailed by McAlindon et al. (2014). It was suggested that those with OA who were averse to receiving surgical treatment had several options available to them as alternatives. Thirteen experts from diverse backgrounds, such as primary care, rheumatology, orthopedics, physical therapy, rehabilitation, and evidence-based medicine, were gathered. These experts discussed osteoarthritis management by utilizing the most current, evidence-backed, and palliative methods available. The treatments outlined as the best practice by McAlindon et al. (2014) were as follows:

> …for all individuals with knee OA… biomechanical interventions, intra-articular corticosteroids, exercise (land-based and water-based), self-management and education, strength training, and weight management. Treatments appropriate for specific clinical sub-phenotypes included acetaminophen (*paracetamol*), balneotherapy, capsaicin, cane (walking stick), duloxetine, oral non-steroidal anti-inflammatory drugs (NSAIDs; COX-2 selective and non-selective), and topical NSAIDs. Treatments of uncertain appropriateness for specific clinical sub-phenotypes included acupuncture, avocado soybean unsaponifiables, chondroitin, crutches, diacerein, glucosamine, intra-articular hyaluronic acid, opioids (oral and transdermal), rosehip, transcutaneous electrical nerve stimulation, and ultrasound. (pp. 363–364)

Gout

Gout is a type of inflammatory arthritis which often presents in acute and recurring episodes over time. Gout episodes commonly present as swollen, warm, and red welts at the site of a swollen joint. These episodes are commonly associated with severe pain. It was estimated by Burke et al. (2015) that 13.3% of males and 6.2% of females over the age of 75 could expect to experience at least one episode of *gout*. Gout is especially common to older adults who have experienced, or are experiencing, acute kidney disease (Muangchan & Bhurihirun, 2018). Older adult populations suffering from gout were analyzed by Burke et al. (2015) in their survey of 5819 arthritis patients between 45 and 64 years of age who exhibited symptoms of gout and hyperuricemia, often followed by chronic arthritis. Most substantially, patients reported experiencing impaired functioning directly associated with gout flare-ups. Patients also commonly reported productivity losses and debility as well. It was estimated that 9% of men and 3.3% of women would experience gout by the time they turned 65.

Zhu, Pandya, and Choi (2011) discussed gout in their analysis of *the National Health and Nutrition Examination Survey* of 2007–2008. Gout was described as a unique form of arthropathy that is diagnostically associated with high levels of uric acid in the blood. This is a crystalline substance not typically present in high quantities in the bloodstream. Gout diagnoses are also highly comorbid and linked with metabolic syndrome, heart attacks, type 2 diabetes, and early mortality. Gout is more than doubled in the United States between the 1960s and 1990s, but the trend may have recently subsided. Still, it remains quite common in older sufferers. In gout, about 10% of case onset is due to an excess of urate produced in the body. The other 90% of gout cases are typically due to abnormally low urate elimination rates. The high uric acid in the blood serum is thought to lead to a heightened immunological response in most cases. This immunological response typically presents at the site of the afflicted joint or joints, where high white blood cell counts often present in the bloodstream adjacent to the flare site(s) (Keenan, 2017).

Pseudogout

Calcium pyrophosphate deposition (CPPD), which may be referred to as *pseudogout*, is marked by the common redness and warmth exhibited at the sites of inflammation in the afflicted joint or joints. Vele et al. (2016) covered the features of CPPD in an overview of the diseases. CPPD was described as common to older patients who suffer from arthritis. Pseudogout typically afflicts populations over the age of 60, at 65% of cases. It is also highly comorbid with osteoarthritis, which is present in four out of five cases of pseudogout. The administration of diuretics may leave a person at risk, as about one out of every five cases involved such medication use. CPPD may be unpredictable in its onset. It is sometimes diagnosed in isolation, sometimes with other forms of arthritis, and/or at times it is present with metabolic syndrome. Particular clinical presentations of CPPD include skin reddening, heat, and tenderness around the impacted area, similar to the cases of gout. In CPPD, as in many others forms of arthritis, a patient often presents with soft tissue swelling in the area surrounding the afflicted site(s). However, unlike gout, CPPD patients typically experience swelling at a surrounding area of a single joint site. The most typically afflicted areas are the joints of the knees, followed by those of the wrist. Symptoms may also include fevers and coinciding bouts of chills. Oftentimes, symptoms may last from weeks to months in those diagnosed with acute CPPD. Still, both patients may show similar signs and symptoms, and both conditions are considered crystalline forms of arthritis (Muangchan & Bhurihirun, 2018). CPPD disease was covered in an extensive review by Rosenthal and Ryan (2016) in the *New England Journal of Medicine*. Therein, the form of CPPD arthritis was discussed as being caused by a crystal referred to as “CPP” deposit formation due to calcium pyrophosphate, a calcium and pyrophosphate compound. Deposits of this crystal have hardening effects on several types of tissues. These crystals calcify the hyaline cartilage surrounding the joints, the collagen bundles within cartilage, and other pliable tissues in the impacted areas.

Diagnosing and Treating Gout and Pseudogout

Those who are experiencing gout typically have hyperuricemia or high contents of uric acid in the serum of the blood. This may lead to an inflammatory, red, and swollen presentation at the sites of a flare-up. Therefore, after a cursory exam wherein the swells are observed, a follow-up blood test can identify two key indicators of gout. An examination of the uric acid and white blood cell count in the blood serum often confirms a diagnosis of a gout flare-up (Nair et al., 2016). According to Muangchan and Bhurihirun (2018), a medical professional may separate the two diagnoses of gout and CPPD in a patient exhibiting hard-to-distinguish symptoms by several methods. Gout may be distinguished by using the standard best practice of analyzing the blood serum for the presence of uric acid in high concentrations. CPPD is typically confirmed or ruled out by a microscopic inspection of the synovial fluid. The presence of CPP crystals in the serum typically warrants a diagnosis of this particular form of arthritis. Methods of testing for signs of CPPD may be found in ultrasound or X-ray as alternatives to microscopy.

Microscopy, X-ray, and US technologies were analyzed by Filippou et al. (2016), with the aim of identifying the efficacy of each. In order to find out which was the most accurate, 42 patients exhibiting arthritic symptoms of the knee were compared with by using each technology in order to determine the presence or absence of the featured crystals of CPPD. After completion, it was found that ultrasound technology could effectively rule CPPD out with 96% accuracy and could identify CPPD with 87% accuracy. For X-ray technology, CPPD could effectively be ruled out with 75% accuracy, and it could identify CPPD with 93% accuracy. Microscopy technology could effectively rule out CPPD with 77% accuracy and could identify CPPD with 100% accuracy. Gout may be identified through a combination of methods. A physician should determine whether there is a patient history of gout attack incidences. Altered uric acid content, alcohol consumption, lack of hydration, diuretic and aspirin intake, and comorbid kidney failure and heart disease may precipitate a gout diagnosis. While a diagnosis is often obtained through synovial fluid testing, other methods do exist. These include a physician seeking out clinical symptoms exhibiting in their most severe form at 6–12 h post flair-up. Gout's identifying features include intense and throbbing pain, tenderness, and red formations of the afflicted area or areas (Nair et al., 2016).

Gout and pseudogout are highly painful and often debilitating forms of arthropathy. Therefore, it is recommended that the symptoms are addressed early and as often as needed. Xanthine oxidase inhibitors (XOIs) may be used as the first treatment to reduce the symptoms experienced by a gout sufferer. XOIs work by reducing the uric acid content present in the bloodstream that leads to the inflammatory response. It is possible, if all uric crystals are effectively removed, that gout may even be eliminated entirely in a suffering patient. Still, this is typically only temporary, and other flares often occur (Keenan, 2017). Gout episodes can be highly uncomfortable to those experiencing it, and often require pharmacological treatments to address the pain. The most preferred option in treating gout is by the use of the anti-inflammatory colchicine, as small doses can be highly effective and reduce the side effects experienced. Anti-inflammatory pain relievers (NSAID) are effective in treating about one-half of all cases within the first 2 days of a gout episode and in four out of five cases once 5 days have passed since the episode initiated (Nair et al., 2016). Finally, treatments for pseudogout were discussed in a recent review of therapies for CPPD completed by Andrés, Sivera, and Pascual (2018). The difficulty in treating the connective tissue crystals that are features of CPPD was described as the cause for maintenance therapies as the best practice for this condition. After the formation of pyrophosphate crystals, their elimination appears to be impossible. Therefore, management of aversive symptoms was described as the best available option to pseudogout patients. The most helpful pain management options available were similar to those for gout. NSAID pain relievers, the anti-inflammatory colchicine, and anti-inflammatory glucocorticosteroids have been found to be highly effective in reducing discomfort, swelling, and joint inflexibility.

Tendon Injury

A survey of 981 musculoskeletal disorder specialists revealed that three out of every ten cases of musculoskeletal consults involved an injury or chronic condition of the tendons (Lipman, Wang, Ting, Soo, & Zheng, 2018). Estimates for the exact prevalence of tendon injuries experienced in the elderly are not widely available. However, rough estimates on the proportion of the elderly who experience tendon injuries may be drawn from related data. Falling accounts for around three-quarters of all injuries suffered by older adults, with injuries to the arms and hands accounting for about 25% of trauma injuries, and injuries to the legs and feet accounting for about 50% of these injuries (Rosberg & Dahlin, 2018). The data gathered from the *World Health Organization* Study on global AGEing and adult health (SAGE) estimated that about one-third of adults over the age of 60, who are living independently, will experience a substantial fall in a given year (Williams et al., 2015). That prevalence was also said to increase with age and degeneration. It was also found that, worldwide, falling accounted for an average of 65.7% of all injuries. Broadly, unintentional injuries were listed as accounting for roughly 80% of all disabilities experienced in the elderly. Tendon conditions and related injuries of the connective tissue and muscle are often the result of such injuries.

The tendon plays a key role in the musculoskeletal system by connecting the bone to the muscle so that the limbs of the body can experience motion. Tendon injuries result from disturbances in this fibrous connective tissue at various sites of the body. Common sites of injury in the elderly are at the hands and feet. Tendon conditions typically result from insult and/or degeneration, commonly leading to inflammation and painful motor displays. Injury to a single site is common in tendon injuries (Nourissat, Berenbaum, & Duprez, 2015). Older adults may be more susceptible to tendon injury due to natural degeneration and progressive hardening of the tendons themselves. The lack of mobility caused by the toughening of the connective tissue has been found to reduce the amount of weight that the tissue can repeatedly hold. Different tendons appear more susceptible to such conditions in the elderly, with flexor tendons of the hands being the most common injury sites. These tendons have fiber bundles which require fluid motion adjacent to each other in the digits. The hardening here can lead to easy injury in older populations, as the hands are so frequently used (Thorpe et al., 2015).

Typical variants of tendon conditions were discussed in a handbook chapter on tendon injuries written by Ernlund and Vieira (2017). The injuries covered included tendonitis, tendinosis, paratenonitis, and broad tendinopathy. *Tendonitis* is a condition that results from a physical injury to the tendon, which leads to inflammation. The insult which leads to tendonitis is typically acute, and the resulting inflammation often reduces over time. *Tendinosis* is a long-term condition, often resulting from a sustained injury which results in neuropathy or degeneration of the nerves at the cellular level. Tendinosis, unlike tendonitis, does not involve inflammation. *Paratenonitis* is a condition which involves the outer layer of the tendon being damaged, often due to it rubbing on the bone. This results in inflammation of the tendon and an accumulation of fluids, such as blood in the affected area. When the tendon sheath soon tears as a result of the injury, fluid will fill the afflicted site, and a popping or crackling sound which follows movement, known as *crepitus*, commonly occurs. *Tendinopathy* describes a long-term condition which afflicts the nerves associated with the tendon which has no known origin or etiology.

Diagnosing and Treating Tendon Injuries

Unfortunately, diagnosing and effectively treating tendon conditions are difficult matters, as tendons are notoriously problematic to study and poorly understood (Lipman et al., 2018). Still, there are ways of effectively identifying the condition in many cases. Ernlund and Vieira (2017) discussed some of the key diagnostic features.

Common clinical presentations, such as rupture-related sensitivity, inflammation, pain, discomfort, and reduced mobility at the afflicted site, may be easily recognized by a physician. Also, the pain tends to be more aversive when the affected area is engaged in a wide range of motion and lighter when engaged in mild or no motion. Inflexibility of the joints at the injury site, indentations beneath the skin, and inability to perform strength tests may also be identified during examination. Typically, tendon injuries heal with time. There are some strategies that those afflicted with mild, and many moderate, tendon injuries may be able to implement. *RICE* is recommended by chapter authors Krabak, Johnson, Liem, Loveless, and Mallow (2017) in the text *Physical Medicine and Rehabilitation Oral Board Review.* It is a technique that individuals can use for injuries of the tendon and other muscle injuries. The method may expedite the process in tendon and muscle injuries that may just need time to heal. RICE, when taken apart, is an acronym that guides a common course of treatment for those suffering from tendon conditions. RICE stands for “rest,” “ice,” “compression,” and “elevation.” When describing rest, it is specified that individuals suffering a tendon injury keep the injured site from pressure of any kind and allow themselves healing time away from physically exertive activities of any nature for a period of several days to weeks or months, depending on the severity of the injury. Also, apply ice or a comparably cold item to the afflicted area for 2–3 h in order to reduce inflammation. A support to the injured site can further be applied by wrapping in bandages. This comprises the “c” portion of the RICE acronym, with the c standing for “compression” of the injured tendon site. Lastly, elevating the site will allow for proper blood flow needed in order for the healing time to be minimized and efficient (Peterson & Renstrom, 2016). Other potential useful treatments for tendon injuries include early active motion protocols, wherein a protective splint is typically worn for the first 6 weeks and flexibility and range of motion exercises of the afflicted area are typically controlled and timed by a monitoring physician (Frueh et al., 2014).

In their review of occupational therapies for adult sufferers of musculoskeletal conditions, Roll and Hardison (2017) discussed several potential treatments for tendon injuries, such as *dynamic splinting*. Dynamic splinting may be implemented for tendon injuries that are more severe in nature. Dynamic splinting involves a spring-loaded type of splint that controls the range of motion. Dynamic splinting may be more effective than traditional splinting in that it often increases joint mobility and stretch. Tendon-transfer surgeries are sometimes performed in the most severe tendon injury cases. This procedure may be most successful when followed up with an active motion protocol.

Carpal Tunnel Syndrome

Carpal tunnel syndrome is the most common upper extremity neuropathy which is estimated to affect 424 per 100,000 people annually (Gelfman et al., 2009). It is believed that repetitive demyelination from relative neural ischemia over a limited anatomic space causes the pathophysiology (Tang, Barbour, Davidge, Yee, & Mackinnon, 2015). Often, patients will have surgery performed to reduce, or fix, the pain brought about by carpal tunnel syndrome. However, this population is not homogenous, and treatment should vary depending on age, gender, or BMI of the patient involved (Zhang, Collins, Earp, & Blazar, 2017). Many adults suffer from *carpal tunnel syndrome* (CTS), a progressive and painful condition of the wrist that has unknown causes in about half of all cases (Saboor et al., 2015). Carpal tunnel syndrome (CTS) affects about 4% of individuals, making it the most common musculoskeletal disorder of the upper extremities. Older adults are considered at risk in developing the condition, along with those who are pregnant and those who are overweight. The most at-risk group for developing CTS is believed to be women above the age of 40 (Saboor et al., 2015). Those who are over the age of 55 comprise the group that is most likely to seek out the care of a physician for CTS. The most severe presentations of CTS symptoms are typically found in elderly sufferers (Fung, Tang, & Fung, 2015). This is thought to be related to a common exhibition in sufferers over the age of 65, called *thenar wasting* or *thenar muscle atrophy*. The condition describes the thumb(s) exhibiting deformation, reduced flexion, and lowered functional abilities following a lesion of the median nerve and the corresponding tendon deterioration (Cooke & Duncan, 2017). CTS is thought to account for about nine of every ten cases of *compression neuropathy* (Ghasemi-rad et al., 2014). Compression neuropathy describes pressure or entrapment of the nerve fibers. This type of nerve damage often results from one or more insults to the appendage. In the case of CTS, the wrist becomes damaged, which results in problems of functioning and amplified pain. The damaged area and resulting dysfunction of the wrist are contained and specific in carpal tunnel syndrome. Within the wrist is a tunnel, with a band of connective tissue serving as the base and the bones of the wrist serving as its top. Within this tunnellike passageway in the wrist is a network of blood vessels, connective tendons, and nerves. Those afflicted with CTS suffer from damage to a particular nerve within this tunnel, the *median nerve*. This nerve supplies the thumb with sensation and control and supplies additional sensation to the primary digits adjacent to the thumb. Damage to the median nerve may result in a diagnosis of CTS. A pinched or compressed *median nerve* is the most commonly reported cause of a CTS diagnosis (Hazani et al., 2016). The median nerve is the major nerve which descends to the wrist from the forearm. From the wrist, the nerves branch out to the fingers of the hand from an underlying junction of the wrist. At the site of the wrist, the median nerve travels underneath a carpal ligament, which is a connective tissue that allows for the flexing of the wrist.

Specific symptoms commonly reported from those suffering with CTS include intense pain, throbbing, numbness, burning, and/or prickling sensations of the affected area. These symptoms tend to be located within the wrist, palm, and/or fingers. The pain here may be thought of as similar in nature to that experienced with an acute trauma to an area of an appendage where there is a connection formed, such as the elbow or knee. When one suffers a blow to one of these areas, the pain can be intense, dull, or throbbing. This is often the nature of the pain experienced in a CTS sufferer. Tingling sensations may become increasingly painful over time, with acutely painful experiences often arising in the evening hours, as one typically is preparing to fall asleep. Weakness is typically localized to the thumb area, as damage to the median nerve impacts the amount of force capability extended to the thumb.

Diagnosing and Treating Carpal Tunnel Syndrome

It has been suggested that early diagnosis of carpal tunnel syndrome is important to address in order to alleviate the progressive suffering commonly present in those afflicted. As the common course of carpal tunnel syndrome involves the pain-associated symptoms becoming increasingly aggravated over time, seeking proper treatment early may be imperative. Carpal tunnel compression tests, wherein the wrist is pressed upon for indications of pain and flexibility, can be used in order to indicate whether or not someone may warrant a diagnosis. Also, the characteristic physical symptoms of the disorder are utilized for early assessment and diagnosis. Disturbed sleep due to pain (i.e., *nocturnal paresthesia*) and problems of discomfort and dysfunction of the wrist and hand are often being key identifiers (Wahab et al., 2017). *Nerve conduction studies* (NCSs) have often been used in order to confirm a preliminary diagnosis from the presenting physical signs of the condition. The electrical activity of one's median nerve is tested with a nerve conduction study. Electrodes are placed on the hand to gauge the activity of the median nerve, with the focus being on whether there is a problem of velocity of conduction. If the sensory median nerve is conducting at a speed of less than 45 meters per second and/or the motor median nerve is found to be conducting at less than 49 meters per second, the nerve is typically characterized as being damaged, and a confirmatory diagnosis of CTS may be made at this point. Identifying CTS accurately with nerve conduction studies has sometimes proven to be problematic; however, newer methods are proving to be quite effective (Bland, 2017). Ultrasonography, for example, is a diagnostic tool which is not only highly reliable but also relatively simple, inexpensive, painless, and efficient. Ultrasonography (US) has emerged as a simple, feasible, rapid, accurate, and noninvasive imaging tool for evaluating the median nerve in the CT. Not only it is able to detect changes in the nerve shape but also excludes other conditions that may initiate similar symptoms, such as tenosynovitis and ganglion cysts. Ultrasonography gives physicians and patients an understanding, not only the velocity but also the intensity, of the median nerve compression (El Miedany, 2015).

Treatments for CTS can range from simple medical interventions to corrective surgeries requiring anesthesia. Other treatments might include steroid injections at the site of discomfort in those who are diagnosed at early stages. Similarly, early diagnosis that involves intense pain and discomfort might warrant an elective surgical denervation of the median nerve (Hazani et al., 2016). Surgical release of the pinched nerve is another option and is often the most preferred, as those who undergo an effective decompression will have smaller surgical scars than after denervation and will return to work earlier. Fung et al. (2015) cautioned the use of a common surgical technique to alleviate CTS symptoms in elderly sufferers of *open-release* surgery in elderly patients in their review of the efficacy of the highly common surgical treatment for CTS sufferers. *Open release* has been described as the most high-quality treatment of CTS. It is often a last-resort surgery when other treatments have failed for a patient in the past. This form of treatment involves surgically transecting the transverse carpal ligament of the wrist. Immediately following the surgery, most CTS patients will report symptom relief of the pressure in their wrists. Most elderly patients had less predictable functional and symptomatic changes and reported less satisfaction with the results of the surgery than younger patients. Alternatives were suggested to be explored for those sufferers not in the early stages of the disease.

Steroid injections can also help to reduce the severity of pain. It was determined by Saboor et al. (2015) that most (69%) sufferers of CTS who received a shot administering steroid treatment reported it was effective at reducing or eliminating their symptoms. Within this same study, a small incision of the wrist was administered to other participants to gauge its efficacy in reducing or eliminating CTS symptoms. It was found that most (56.9%) sufferers of CTS reported this treatment as effective as well.

Review of Causal Theories/Models of Musculoskeletal Disorders

There are three broad categories of risk factors that may be associated with musculoskeletal pain and disability disorders: biomechanical, psychosocial, and individual. *Biomechanical risk* involves increased repetitive body part movements or improper/static posture demands. *Psychosocial risks* involve high work demands, low job control, and lack of workplace support. Lastly, *individual risks* involve gender, age, sedentary lifestyle, and personality characteristic variations that contribute to injuries (Hernandez and Peterson, 2012). One of the earlier models, proposed by Armstrong et al. (1993), included a number of individual characteristics (e.g., personality, coping skills, health status, and work experience) as important contributors that directly influenced the effects of work environments on stress and strain to the worker with neck and upper extremity musculoskeletal disorders. From this point, the models became more dynamic to accommodate the greater variations in musculoskeletal disorders. Shortly after, a *work-style model* incorporated three work-style factors in the model, similar to the factors discussed above: cognitive changes, behavioral changes, and physiological changes. If any factors were occupationally altered by psychosocial stress and/or ergonomic factors, then the probability of developing an upper extremity musculoskeletal injury increased (Feuerstein, 1996). This model initially brought attention to the interaction and feedback of physical and psychosocial stressors on the development and progression of upper extremity injuries. With this, Burton and Main (1999) subsequently introduced the inclusion of "yellow flags," which serve as obstacles in recovery (e.g., level of distress, depression, coping strategy, and beliefs), as well as "blue flags," which can work in tandem with "yellow flags." These "blue flags" refer to two categories of work-related obstacles in recovery. The first category is *individual worker-specific variables*, which refer to beliefs about the work/injury, attribution of blame, and levels of stress. The other is *work-specific issues*, which refer to the work environment (e.g., managerial attitudes toward workers, return-to-work policies, work organizational structure, and work demands). As the theories developed, they continued to specifically illustrate the factors that contributed to the causation of musculoskeletal injury.

In addition to the above, according to Kumar (2001), there are four different causal factor theories that account for the development of musculoskeletal injury and disorder. A combination of the theories theoretically could be enacting simultaneously, which can lead to injury depending on the particular worker and specifics of the job. Firstly, the *multivariate interaction theory* specifies the importance of the interactions among biomechanical, psychosocial, and genetic factors and specifically evaluating and understanding their effects on the musculoskeletal system. The second theory, *differential fatigue theory*, focused on the strain of various occupational activities on the musculoskeletal system, specifically the joints and muscle tissues. Thus, if the intensity of such strain surpasses the capability of the system, then short-term effects such as fatigue, and long-term effects such as injury to the system, can occur. The next theory, *cumulative load theory*, emphasizes the importance of the actual amount of strain that the musculoskeletal unit can tolerate before it loses the ability to accommodate the stress. By having a theoretical upper limit, it is accompanied with the idea that strain exceeding this limit can cause deteriorative effects on the joints and muscles which often results in injury. Finally, the *overexertion theory* states that if the physical stress factors (e.g., force, repetitive motion, and duration) exceed the level that the joints and muscles can tolerate, then injury will likely result.

The distinction between occupational and nonoccupational differences was earlier mentioned. This legal distinction is not specifically required for the physician but has an incredible impact on the patient. This becomes an important distinction because the litigation/processes "wrapped around" occupational injury or illness can weigh heavy on the patient during a period which is critical for recovery. Due to the structure of workers' compensation and insurance claims, disability claims rely on various examiner and patient response biases (Gatchel, 2005). Assessment of disability is usually based on observable impairment and self-report measures of restriction on activities of daily living and quality of life, which are typically separately assessed. Unfortunately, these measures are often not correlated with each other. A patient may express being severely disabled on a self-report measure, but not have that much observable impairment. In contrast, another patient may have severe observable impairment but report low interruption of daily living. This can create a legal/bureaucratic "nightmare" with how much compensation is to be paid to the injured employee, based on how much impairment and disability resulted from the personal occupational injury (Gatchel, Kishino, & Strizak, 2014). As a result, the experience can be emotionally tolling for the injured employee and the company. From a psychosocial standpoint, the presence of such financial reward following an occupational injury could motivate the worker to exaggerate physical and psychosocial symptoms in order to attain more from the legal dispute, which, earlier, was erroneously referred to as "malingering." However, the presence of true malingering in chronic occupational pain populations has been shown to be relatively low (Howard, Kishino, Johnston, Worzer, & Gatchel, 2010). Most people that are not found to be objectively ill, and do not return to work immediately, are heavily suspected of malingering even if they truly are not. This makes it difficult to get better; if you are having to prove you are ill, it is difficult to get well

(Hadler, 1996). These complications require the need to treat in a more integrated manner, using strengths from many disciplines to give the injured worker the best chance of recovery.

Biopsychosocial Model of Occupational Musculoskeletal Disorders

The biopsychosocial model focuses on the complex interactions among biological, psychological, and social factors that may be influencing the injured worker. These complex interactions may worsen the patient's medical condition and negatively affect various aspects of the patient's life (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). In contrast, the previously popular *biomedical reductionist approach* assumed that most medical and musculoskeletal disorders could be separated into distinct physical and psychosocial components. However, the interactions between the psychosocial and physical aspects of musculoskeletal disorders cause each patient to experience the complex injury uniquely. These factors are especially evident when the injury persists over time, as a barrage of psychological, social/occupational, and ergonomic factors become affected. Individual differences significantly affect the frequency with which one reports physical symptoms, one's tendency to seek physician aid, and one's responses to treatment approaches (Gatchel, 2006). Reinforcing the idea previously mentioned, this interaction and response variations of the patient make it difficult to objectively measure their objective physical condition. Therefore, the need for a biopsychosocial approach for treatment is evident in order to treat the patient on an interdisciplinary level for the best outcomes.

The biopsychosocial model has proven most useful in developing effective interdisciplinary assessment and treatment methods for complex chronic disorders (Gatchel, 2004, 2005), including musculoskeletal injuries. People have different socioeconomic and psychological factors that influence the chronic pain experience and moderate the patient's ability or impairment, along with their reported symptoms (Gatchel et al., 2007). Prior to chronic pain, many chronic pain patients have pre-existing and inactive characteristics that then become active and compounded from stress. These activated characteristics allow for the diagnosis of chronic pain (Dersh, Polatin, & Gatchel, 2002). One reason why pain patients end up being and remaining chronic pain patients is due to the psychosocial differences common to chronic pain. Chronic pain patients are less likely to adhere to their treatment largely in part to the negative affect associated with chronic pain. With the patient not adhering to a treatment regime, they rarely get better. Their pain will not be effectively managed without attending to a patient's emotional state as well (Gatchel et al., 2007). Chronic pain also acts as a significant stressor, which can take a toll on the stress system. This can cause physical decline which produces a vicious cycle of pain-stress reactivity (Gatchel, 2004). To summarize, chronic pain is typically preceded by a combination of psychosocial factors and is activated by the stress brought on by pain. A "sick role" is the mentality which further plays into the idea that they are sick, in which typical behavior is then modified which, in part, keeps the patient from recovering (Gatchel et al., 2007).

It is also important to understand and distinguish primary, secondary, and tertiary levels of musculoskeletal pain because each of these levels requires substantially different biopsychosocial approaches with assessment and treatment (Gatchel et al., 2014). On the primary level of care, treatment would be applied to the acute pain, which is noted for its limited severity. During the normal healing period, basic symptom control methods would be employed to assist the patient as they heal. Accompanied with that is the basic psychosocial reassurance that the acute pain is temporary and will soon be resolved, which typically proves effective and keeps the patient from developing a "sick role" mentality. While musculoskeletal pain is a very common problem, there are several episodes that people encounter and denote minor problems, with low pain intensity and little disability (Linton &

Ryberg, 2000). 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).

The secondary level of care represents the reactivation treatment for a patient whose musculoskeletal pain has not improved through the normal healing process. Secondary care is typically administered during the patients' return to work and resuming their typical daily living. This treatment is designed to minimize advanced physical deconditioning and promote a return to occupational productivity. If the patient's musculoskeletal pain still appears to be unwavering, then a more active psychosocial intervention may be needed (Turk and Gatchel, 2013). The third and final level, tertiary care, is intended for patients who are physically deconditioned and have chronic pain and disability. This stage typically requires a full comprehensive interdisciplinary intervention approach (Gatchel, 2005). Interdisciplinary care in response to the tertiary level of musculoskeletal injury, modeled after the pioneering functional restoration program developed by Mayer and colleagues (1988), has been shown to be incredibly efficient and cost-effective for treating patient with various forms of occupational musculoskeletal pain and disability disorders (Gatchel, 2005; Gatchel & Okifuji, 2006; Wright & Gatchel, 2002).

In contrast to interdisciplinary pain management programs, traditional unimodal medical treatment approaches have not been consistently therapeutic or cost-effective when treating musculoskeletal disorders. Interdisciplinary programs have shown to not only be effective for self-report of pain and disability but also for objective assessment of function (e.g., range of motion, aerobic ability, and strength). It has also been shown to have a positive outcome difference on important socioeconomic outcomes (i.e., surgery rates, subsequent healthcare usage, returning to work, and case closure) when compared to conventional unimodal medical treatment approaches (Gatchel & Okifuji, 2006). The interdisciplinary approach, such as functional restoration, has been proven to be efficacious not only in the United States but also 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). Even with markedly varying economic, occupational, social, and worker compensation programs, the interdisciplinary approach to treating musculoskeletal disorders has been independently confirmed as being an effective treatment method.

Key Research to Practice Recommendations

As we have discussed, there are a great number of musculoskeletal disorders in older adults that have different etiologies. Currently, many of the underlying pathophysiologies of some of these disorders cannot be successfully treated with simple unimodal techniques. In such cases, on interdisciplinary pain management, approaches (based on the biopsychosocial model) should be administered. Concurrently, especially in older adults, medication should be carefully monitored and reduced in order to eliminate possible negative side effects.

Future Directions in Practice and Research

Older adults suffer from many chronic musculoskeletal disorders. More research is needed to isolate which of these disorders can be successfully treated by a noninterventional, interdisciplinary pain management program. For those disorders that cannot be managed, empirical clinical research is still needed to determine "what type of treatment, at what dosage, and for what type of patient." *Precision Medicine* is "coming of age" (e.g., Ashley, 2015), and it will be a valuable method for determining what type of treatment will be most effective for specific patients. It should also be remembered that, if a treatment is effective for younger adults, it cannot be automatically assumed to be effective for older adults.

Summary and Conclusions

Musculoskeletal disorders, which typically involve the experience of persistent pain and reduced functional capabilities, have been found to be the most common diagnosis of those living on disability worldwide, comprising 61% of this population (Perruccio et al., 2017). Musculoskeletal disorders involve the musculoskeletal system and are a broad group of disorders that include any illness which impacts the skeletal muscles, connective fibers (i.e., the tendons, ligaments, and joints), supporting blood vessels of the skeletomuscular system, or any peripheral nerves (of the 43 pairs connecting the central nervous system to other sites of the body; Summers et al., 2015). Older adults are particularly at risk for the many different forms of musculoskeletal disorders that we have reviewed. Various treatment methods have been developed to effectively treat musculoskeletal disorders; however, because they are categorized as chronic illnesses, the most effective method should employ the principles from a biopsychosocial approach (Gatchel, 2005). Indeed, in contrast to interdisciplinary pain management programs based on the biopsychosocial model, traditional unimodal biomedical treatment approaches have not been consistently therapeutic or cost-effective when treating musculoskeletal disorders (Gatchel & Okifuji, 2006). Individual risks (e.g., gender, age, sedentary lifestyle, and personality characteristic variations) contribute to injuries (Hernandez & Peterson, 2012). With the biopsychosocial approach, treatments can be tailored to the individual patients and, when paired with the advantages of interdisciplinary treatment, empower patients with the best possible chance to managing their musculoskeletal disorders. Therefore, it is essential for treatments to incorporate biopsychosocial approaches with an interdisciplinary treatment management style, making such a symptom management approach more accessible to patients with musculoskeletal disorders.

> Perpetual optimism is a force multiplier. (Colin Powell)

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7 Aging with Spinal Cord Injury

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Introduction

Prior to World War II, a spinal cord injury (SCI) was considered a fatal condition (Ditunno, 2017). However, with medical advances, life expectancy following SCI has increased dramatically, and individuals with SCI are participating in their communities in later life (Mortenson et al., 2017). The world incidence rate of SCI is estimated to be 10–83 per million per person per year (Wyndaele & Wyndaele, 2006). Incidence rates have a bimodal distribution with incident rates peaking in late teens to early 20s largely due to traumatic injuries (e.g., motor vehicle accidents) and peaking again in older adulthood largely due to falls (De Vivo, 2012). Approximately, 285,000 people are living with SCI in the United States, and the average age has increased from 29 years old in the 1970s to 42 years old currently ("SCI Facts and Figures," 2017).

This chapter describes the key rehabilitation challenges facing adults aging with spinal cord injuries to equip the rehabilitation specialist with evidence-based knowledge to inform client care. It is important for individuals with SCI and clinicians to understand how the body ages with a SCI, particularly because they may not manifest typical signs and symptoms of the various health

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conditions for which they are at risk (Withers, Higgins, Ramakrishnan, Middleton, & Cameron, 2014). It is also important to recognize that health (body structures and function) and daily function (activities and participation) are reliant on a dynamic interaction between health conditions, environmental factors, and personal factors (Aldwin & Gilmer, 2004; Mortenson et al., 2017; World Health Organization, 2002).

Body Function and Structure

SCI Classification

Spinal cord injuries are classified and described by level and completeness, in accordance with the International Standards for Neurological Classification of Spinal Cord Injury (Kirshblum et al., 2011) as shown in Fig. 7.1. The SCI level is determined by the lowest spinal segment with normal neurological sensation and motor function. The American Spinal Cord Injury Association Impairment Scale provides a rating of A through D depending on the amount of motor and sensory function below the level of injury. Krassioukov et al. (2012) also provide further classification based on remaining autonomic nervous system (ANS) function, further informing the expected longitudinal course of aging with SCI.

Age-Related Changes in Body Structures/Function

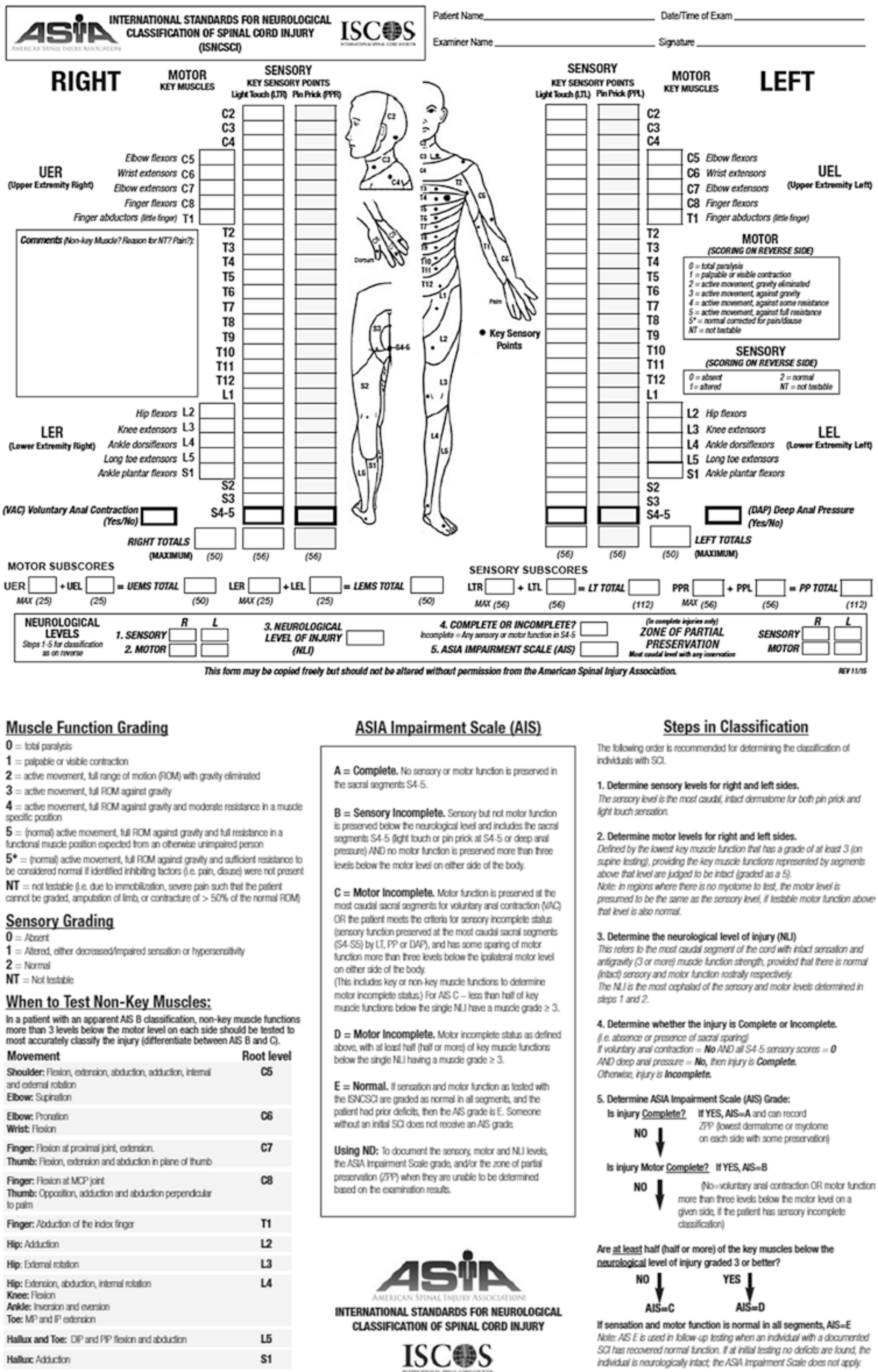
There is a paucity of longitudinal research examining the natural course of aging in SCI and its impact on function. The Spinal Cord Injury Research Evidence (SCIRE) Project has noted the challenge of understanding the topic of "Aging with SCI" given that research may be done through the lens of chronological age, years post-injury, or age at the time of injury (Mortenson et al., 2017). Jensen et al. (2013) conducted a review aimed at identifying the frequency and age effects of secondary health complications in SCI. Findings lend some empirical support to SCI being a "premature model of aging" for some body systems (Hitzig, Eng, Miller, Sakakibara, & SCIRE Research Team, 2011), as described in the following sections.

Cardiovascular

The level of preserved ANS function will be one of the determinants of cardiovascular dysfunction related to SCI as an individual ages. Typically, those who have injury levels at or above T6 have greater cardiovascular compromise. High plasma homocysteine levels (a risk factor for vascular disease) are a consistent finding in these individuals with highest discrepancy rates in older SCI individuals (>50 years) as compared to able-bodied controls. Furthermore, these individuals are at risk of episodes of autonomic dysreflexia (AD). AD is a state of hypertension, often experienced as facial flushing and headache, from a sensory stimulus occurring below the level of injury. Published case reports have correlated acute AD with myocardial infarction (Tan, Rahman, Fauzi, Latif, & Hasnan, 2016). Orthostatic hypotension may also be present, leading to reduced blood flow to watershed zones in the cerebral circulation.

Endocrine

Changes in the endocrine system are noted after SCI. Several studies reveal a greater risk for glucose intolerance/metabolic syndrome/diabetes mellitus in the cohort of people aging with SCI when compared to age-matched able-bodied individuals (Bauman & Spungen, 1994). Cross-sectional studies also identify that those living with SCI have a higher level of fat mass, have escalated age-related decline of lean tissue, and have alterations of serum insulin-like growth factor and testosterone (Nuhlicek et al., 1988; Tsitouras, Zhong, Spungen, & Bauman, 1995).



INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

Patient Name ______ Date/Time of Exam ______
Examiner Name ______ Signature ______

RIGHT — MOTOR KEY MUSCLES — SENSORY KEY SENSORY POINTS Light Touch (LTR) Pin Prick (PPR)

C2
C3
C4
UER (Upper Extremity Right): Elbow flexors C5; Wrist extensors C6; Elbow extensors C7; Finger flexors C8; Finger abductors (little finger) T1

Comments (Non-key Muscle? Reason for NT? Pain?):

T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 L1

LER (Lower Extremity Right): Hip flexors L2; Knee extensors L3; Ankle dorsiflexors L4; Long toe extensors L5; Ankle plantar flexors S1

S2 S3 S4-5

(VAC) Voluntary Anal Contraction (Yes/No)

RIGHT TOTALS (MAXIMUM) (50) (56) (56)

SENSORY KEY SENSORY POINTS Light Touch (LTL) Pin Prick (PPL) — MOTOR KEY MUSCLES — LEFT

C2
C3
C4
UEL (Upper Extremity Left): C5 Elbow flexors; C6 Wrist extensors; C7 Elbow extensors; C8 Finger flexors; T1 Finger abductors (little finger)

T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 L1

MOTOR (SCORING ON REVERSE SIDE)
0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
5* = normal corrected for pain/disuse
NT = not testable

SENSORY (SCORING ON REVERSE SIDE)
0 = absent 2 = normal
1 = altered NT = not testable

LEL (Lower Extremity Left): L2 Hip flexors; L3 Knee extensors; L4 Ankle dorsiflexors; L5 Long toe extensors; S1 Ankle plantar flexors

S2 S3 S4-5

(DAP) Deep Anal Pressure (Yes/No)

LEFT TOTALS (MAXIMUM) (56) (56) (50)

Key Sensory Points

MOTOR SUBSCORES
UER ___ + UEL ___ = UEMS TOTAL ___ MAX (25) (25) (50)
LER ___ + LEL ___ = LEMS TOTAL ___ MAX (25) (25) (50)

SENSORY SUBSCORES
LTR ___ + LTL ___ = LT TOTAL ___ MAX (56) (56) (112)
PPR ___ + PPL ___ = PP TOTAL ___ MAX (56) (56) (112)

NEUROLOGICAL LEVELS — Steps 1-5 for classification as on reverse
R L
1. SENSORY
2. MOTOR
3. NEUROLOGICAL LEVEL OF INJURY (NLI)
4. COMPLETE OR INCOMPLETE? Incomplete = Any sensory or motor function in S4-5
5. ASIA IMPAIRMENT SCALE (AIS)
ZONE OF PARTIAL PRESERVATION (In complete injuries only) Most caudal level with any innervation — SENSORY R L; MOTOR R L

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REV 11/15

Muscle Function Grading

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, full range of motion (ROM) with gravity eliminated
3 = active movement, full ROM against gravity
4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position
5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
5* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present
NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)

Sensory Grading

0 = Absent
1 = Altered, either decreased/impaired sensation or hypersensitivity
2 = Normal
NT = Not testable

When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement	Root level
Shoulder: Flexion, extension, abduction, adduction, internal and external rotation **Elbow:** Supination	C5
Elbow: Pronation **Wrist:** Flexion	C6
Finger: Flexion at proximal joint, extension. **Thumb:** Flexion, extension and abduction in plane of thumb	C7
Finger: Flexion at MCP joint **Thumb:** Opposition, adduction and abduction perpendicular to palm	C8
Finger: Abduction of the index finger	T1
Hip: Adduction	L2
Hip: External rotation	L3
Hip: Extension, abduction, internal rotation **Knee:** Flexion **Ankle:** Inversion and eversion **Toe:** MP and IP extension	L4
Hallux and Toe: DIP and PIP flexion and abduction	L5
Hallux: Adduction	S1

ASIA Impairment Scale (AIS)

A = Complete. No sensory or motor function is preserved in the sacral segments S4-5.

B = Sensory Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = Motor Incomplete. Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments (S4-S5) by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body.
(This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade ≥ 3.

D = Motor Incomplete. Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having a muscle grade ≥ 3.

E = Normal. If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

Using ND: To document the sensory, motor and NLI levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

Steps in Classification

The following order is recommended for determining the classification of individuals with SCI.

1. Determine sensory levels for right and left sides.
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

2. Determine motor levels for right and left sides.
Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).
Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.

3. Determine the neurological level of injury (NLI)
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.
The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is Complete or Incomplete.
(i.e. absence or presence of sacral sparing)
*If voluntary anal contraction = **No** AND all S4-5 sensory scores = **0** AND deep anal pressure = **No**, then injury is **Complete**.*
*Otherwise, injury is **Incomplete**.*

5. Determine ASIA Impairment Scale (AIS) Grade:
Is injury Complete? **If YES, AIS=A** and can record ZPP (lowest dermatome or myotome on each side with some preservation)
NO ↓
Is injury Motor Complete? **If YES, AIS=B**
NO ↓ (No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?
NO ↓ AIS=C
YES ↓ AIS=D

If sensation and motor function is normal in all segments, AIS=E
Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.

Fig. 7.1 International standards for neurological classification of SCI worksheet

Neurology

A post-traumatic syringomyelia (“syrinx”) is a complication that may occur over time creating new neurologic impairment due to a cyst formation obstructing cerebrospinal fluid and causing pressure on the spinal cord (Biyani & Masry, 1994). With paralysis and altered sensation, those living with SCI may have a higher exposure to postures and positions that increase their risk for peripheral compression neuropathies, such as carpal tunnel syndrome from long-term wheelchair use and ulnar nerve compression from long-term gait aid use (Asheghan, Hollisaz, Taheri, Kazemi, & Aghda, 2016).

Respiratory

In the SCI population, there is greater prevalence of sleep-disordered breathing: sleep apnea, oxygen desaturation, and snoring. With aging, this pattern persists and may increase. Chronically, sleep-disordered breathing has a prevalence of 40–91% in those with a cervical level of injury (Biering-Sørensen & Biering-Sørensen, 2001). Low lung volumes and a weak cough will be present if muscles of respiration are paralyzed and/or spastic. Aging with SCI has an increased risk for lung collapse and pneumonia over time (Van Silfhout et al., 2016).

Musculoskeletal

The development of osteoporosis below the neurologic level of injury has been well documented. Once the initial bone density decline has occurred, the rate of bone loss may be less for the person aging with SCI when compared to able-bodied controls, though actual bone density will be lower at any single point in time (Dauty, Perrouin Verbe, Maugars, Dubois, & Mathe, 2000; Garland, Adkins, Stewart, Ashford, & Vigil, 2001). With osteoporosis comes the increased risk of fracture. The risk for non-union is higher in the aging SCI population when compared to able-bodied controls.

Skin

Changes to skin and subcutaneous tissue volume and elasticity with aging increase risk of breakdown. Unrelieved pressure to tissues overlying bony prominences leads to ischemia, cell death, and tissue necrosis. Clinically, pressure injuries are related not only to pressure but also to friction, shear forces, immobility, and moisture imbalance (Kruger, Pires, Ngann, Sterling, & Rubayi, 2013). Many factors influence these risks: vascular status, spasticity, incontinence, pain, contractures, weakness, smoking, medications, access to appropriate pressure reducing surfaces, capacity to monitor skin, and more.

Genitourinary and Gastrointestinal System

Decades ago, renal failure post-SCI was a major cause of mortality. Since the 1970s, renal causes of death markedly decreased as neurogenic bladder management and renal function monitoring improved. As deterioration in genitourinary function can occur at any stage post-SCI, ongoing monitoring is necessary (Elmelund, Oturai, Toson, & Biering-Sørensen, 2016).

Constipation in SCI worsens with age. In a longitudinal study, 20% of one sample required surgical intervention over a period of 19 years (Faaborg, Christensen, Finnerup, Laurberg, & Krogh, 2008; Nielsen, Faaborg, Finnerup, Christensen, & Krogh, 2017). Bowel dysfunction was cited as having a negative effect on quality of life in up to 78% of individuals with mean SCI duration of 17 years (Inskip, Lucci, McGrath, Willms, & Claydon, 2018).

Men with SCI do not seem to be at a higher risk for developing prostate cancer, but at the time of diagnosis, they are more likely to have advanced disease when compared to able-bodied controls (Scott, Perkash, Mode, Wolfe, & Terris, 2004).

Pain

Pain in SCI is classified as nociceptive (musculoskeletal and visceral) and neuropathic (lesions of the nervous system) (Craig & Tran, 2008; Siddall & Loeser, 2001; Siddall, Yezierski, & Loeser, 2002). Persistent neuropathic pain usually has an onset within the first year of injury, whereas musculoskeletal pain often occurs later with more chances of resolution (Finnerup et al., 2016).

Chronic pain occurs in approximately 65% of individuals with SCI (Perry, Middleton, Siddall, & Nicholas, 2008). Individuals aging with SCI are at particular risk for overuse syndromes and pain in the upper limbs due to a combination of the daily toll of functional tasks (e.g., transfers) that strain the muscles, tendons, and joints, as well as the degenerative changes associated with normal aging (Withers et al., 2014). Incidence of shoulder pain increases over time in people with SCI (Jensen, Hoffman, & Cardenas, 2005). Rates of distress about chronic pain are comparable in both younger and older SCI cohorts, suggesting that chronic pain management is an important rehabilitation intervention along the age continuum (Molton, Hirsh, Smith, & Jensen, 2014).

Sexual Function

Sexuality remains one of the highest priorities in quality of life studies for individuals after SCI (Anderson, 2004; New, 2016; Simpson, Eng, Hsieh, Wolfe, & Spinal Cord Injury Rehabilitation Evidence Scire Research Team, 2012). Men with SCI are at higher risk for low testosterone levels (hypogonadism), affecting primarily libido and ejaculation (Corona et al., 2008), as well as energy levels, muscle mass, and bone strength. About ¾ of men with SCI can attain erections, but erectile maintenance is often a problem (Elliott, Hocaloski, & Carlson, 2017).

For women with SCI, postmenopausal changes associated with low estrogen levels can decrease vaginal lubrication and sexual arousal and also increase the risk of urinary tract infections and incontinence, affecting sexuality. The use of vaginal lubricants, hormonal replacement, catheter management, and bladder emptying prior to sexual times are important to female sexuality as women age. In one study, aging women with SCI felt isolated and sensed that many of their key concerns were ignored or dismissed by healthcare and service providers (Pentland et al., 2002).

For both men and women with SCI, time, sexual experience, having a trusted partner, less focus on sexual intercourse, and remaining open to new experiences increase the chance of orgasm after SCI for both sexes (Lombardi, Macchiarella, Cecconi, Aito, & Del Popolo, 2008; Tepper, Whipple, Richards, & Komisaruk, 2001). In this light, the positive sexual neuroplastic changes resulting from aging may have an advantage.

Psychological Function

Most older adults with SCI have good mental health and cope better than younger counterparts, likely due to experience coping with disability (Jörgensen, Ginis, Iwarsson, & Lexell, 2017; Krause & Broderick, 2005; Sakakibara, Hitzig, Miller, Eng, & SCIRE Research Team, 2012). Major depressive disorder is the most common mental health diagnosis following SCI, ranging from 10% to 15% (Elliott & Frank, 1996). Depression appears to peak in the early years following SCI and again in later life when there are significant declines in function and/or end of life issues (Krause, Kemp, & Coker, 2000). Suicide rates in SCI are five times higher than the general population (Middleton & Craig, 2008). Additionally, suicide rates are highest in white males over the age of 65 in the general population (Kochanek, Xu, Murphy, Miniño, & Kung, 2011).

Older adults are more likely to seek mental health treatment in primary medical care settings (Byers, Arean, & Yaffe, 2012). When engaged in mental health treatment, coping effectiveness training has been validated to reduce depression and anxiety, change negative self-perceptions, and improve self-efficacy in SCI (Kennedy, Duff, Evans, & Beedie, 2003). Cognitive behavioral therapy (CBT) has been validated as an effective treatment in older adults and individuals with disabilities (Thompson, Coon, Gallagher-Thompson, Sommer, & Koin, 2001; Tirch & Radnitz, 2000). Important behavioral targets for CBT include exercise, time spent out of bed, and time out of the house, since these are associated with lower rates of depression in SCI (Saunders, Krause & Focht, 2012).

Rates of depression are higher in individuals with SCI suffering from chronic pain, likely owing to pain interfering with participation in valued activities (Krause et al., 2000). Psychological factors such as "catastrophizing" have also been linked to pain intensity, psychological distress, and pain-related disability among individuals with chronic pain after SCI (Turner, Jensen, Warms, & Cardenas, 2002). A large portion of SCI pain is not helped with medications or surgical intervention, and thus, a multidisciplinary approach to pain is often most effective, including evidence-based psychotherapy (Hadjipavlou, Cortese, & Ramaswamy, 2016). Collaboration with a physician is often necessary to titrate opioid medications since long-term opioid use is associated with serious, adverse medication-related symptoms in body functions already compromised by SCI such as constipation, sleep-disordered breathing, fractures, and hypothalamic-pituitary-adrenal dysregulation (Baldini, Von Korff, & Lin, 2012).

Neuropsychological Function

Rates of comorbid traumatic brain injury in SCI are 24–59% (Elovic & Kirschblum, 1999). The risk of cognitive impairment in SCI is 13 times higher than able-bodied controls (Craig, Guest, Tran, & Middleton, 2017). The rate of acquired brain injury in older adults with SCI is not known but is likely to be significant given that older adults with recent SCI are often related to falls or vascular disease. Cognitive difficulties can slow rehabilitation gains and present safety risks for learning important skills such as transfers or bladder care. Behavioral difficulties can be mistaken as challenging personality traits. Neuropsychological assessment can assist with identifying and managing these issues (Cohen et al., 2017; Cotter, 2008). In addition to traditional neuropsychological measures, The National Institutes of Health Toolbox Cognition Battery (NIHTB-CB) may hold promise in the neuropsychological assessment of individuals with spinal cord injuries, and recent motor-free normative data has been published for spinal cord injury patients (Carlozzi et al., 2017).

Neurodegenerative diseases such as Alzheimer's disease or vascular dementia increase in frequency in relation to age. In a recent population-based cohort study, rates of dementia in SCI patients were significantly higher as compared to age- and sex-matched controls (Huang, Wang, Chou, Liou, & Lin, 2017). A recent serial imaging study documented progressive neurodegeneration following SCI, possibly due to trauma-induced neuroplastic processes (Ziegler et al., 2018). There appears to be a relationship between neurodegenerative processes and persistent neuroinflammation in the spinal cord and brain, but clinical trials and intervention are still in their infancy (Faden, Wu, Stoica, & Loane, 2016).

Activities and Participation

Preface

Functional decline with aging is inevitable but not everyone with SCI ages in the same way or the same rate (Winkler, 2016). Menter and Hudson (1995) suggested a model of function over the lifespan for individuals aging with SCI: (1) acute restoration phase, (2) maintenance phase, and (3) declination phase. Studies validating Menter and Hudson's (1995) model have documented that age at injury is important but that number of years post-injury is more predictive of decline, likely owing to overuse syndromes which are common in aging SCI populations. Other studies emphasize that this model does not account for individuals with SCI occurring in later life, which is associated with more rapid decline (Rodakowski et al., 2014).

Self-Management

Self-management is having the knowledge, skills, and confidence to manage the physical, psychological, and psychosocial consequences of living with a chronic disease (Franek, 2013). Munce et al. (2016) argue that self-management is an important skill in SCI, particularly in light of the decreasing lengths of stay in hospital. Despite the clear rationale, self-management in SCI has limited support in the literature (Kooijmans et al., 2017) and may be owing to the unique challenges of self-management in SCI such as greater reliance on caregivers and accessibility issues (Munce et al., 2014). Numerous government agencies and research collaborations on the topic of self-management have proliferated in recent years.

Activities of Daily Living

Activities of daily living (ADLs) are the self-care tasks such as feeding, grooming, dressing, toileting, and bathing. Given studies that predict functional decline owing to age and years post-injury (Amsters, Pershouse, Price, & Kendall, 2005; Liem, McColl, King, & Smith, 2004), it is necessary to consider the long-term physical, psychological, and medical effects of SCI in informing functional interventions.

In the past, rehabilitation professionals taught SCI clients to push their bodies to complete tasks and maintain independence. This resulted in long-term upper extremity damage, pain, body deformations, and skin problems. Many "old" injuries necessitate readmission to rehabilitation centers due to secondary complications and declining function from clients pushing their bodies to unreasonable lengths. Pershouse et al. (2012) suggest that those individuals who were higher functioning 1-year post-injury have more of a decrease in function than those who were initially lower functioning. This suggests that clinicians should implement more preventative treatments that promote long-term planning for the prevention of secondary complications associated with aging and SCI (Chase, 2004).

For occupational therapists, in particular, the philosophy has evolved for clinicians recommending clients to "conserve to preserve." A therapist may recommend using a ceiling lift for daily transfers, even if the client can manually transfer. This preserves shoulder function for times when manual transfers are needed, such as transferring into a vehicle. Similarly, equipment can assist with reducing the number of transfers in a day. For example, a wheeled, padded commode can reduce the number of transfers from seven (bed-wheelchair-raised toilet seat-wheelchair-tub transfer bench-wheelchair-bed-wheelchair) to three (bed-commode-bed-wheelchair) during a bowel routine and shower. This offers more independence in the long term.

Instrumental Activities of Daily Living (Domestic Life)

Instrumental activities of daily living (IADLs) refer to tasks that are required to live independently in the community, such as cooking, cleaning, laundry, driving, financial management, and medication management. Typically, people living with SCIs require assistance with IADLs due to both physical and environmental reasons. Often, these tasks are completed with assistance from family, as there is limited community support. For clients who could perform some of these duties in the earlier stages post-injury, they are more likely to require assistance earlier in life as compared to able-bodied counterparts due to the more rapid effects of aging on the SCI population (Mitchell & Adkins, 2010).

Interpersonal Relationships

Sakakibara et al. (2012) reviewed published articles over a 30-year period and concluded that aging with SCI has been associated with decreased satisfaction with social and sex lives. Caregiver burnout may contribute to this finding as family members take on more involvement with ADLs and IADLs over time (Baker, Barker, Sampson, & Martin, 2017). Factors that enhance quality of life in the SCI individual and protect against caregiver burnout include good family functioning, adequate coping skills, strong social support, and effective problem solving (Baker et al., 2017; McPherson, 2004). Divorce rates are higher in the early years following SCI (De Vivo, Richards, Stover, & Go, 1991). Education about balancing the roles of being a caregiver versus family member should be incorporated into education provided by the rehabilitation team in order to prevent long-term damage to relationships. Peer support provides individuals aging with SCI an opportunity for both social support and for learning from peers about resources and adaptations that they may have not considered (Levins, Redenbach, & Dyck, 2004).

Communication

A decrease in one's ability to communicate post-SCI can have a negative impact on ADLs, mental health, reintegration into the community, and quality of life and, therefore, should be explored in the rehabilitation setting (Hartley, 2015). Cervical injuries, in particular, often affect one's respiratory muscles causing secondary complications of reduced voice volume, voice quality, and rate of speech (Ward, Jarman, Cornwell, & Amsters, 2016). With age, respiratory function also decreases; therefore, it is important for SCI clients to work with respiratory therapists, physiotherapists, and speech-language pathologists in a rehabilitation setting to improve these functions. Regular breathing exercises (e.g., breath stacking) and treatments are recommended in order to prevent deterioration of verbal function. Communication devices can be adapted with voice commands, "sip and puff," or a universal cuff with stylus for clients with limited hand function.

Mobility

A systematic decrease in independence for mobility is associated with advancing age in SCI (Hinrichs et al., 2016). As such, clinicians need to consider the aging process when prescribing equipment. It is paramount to consider features such as a four-point seatbelt, chest harness, laterals, and thigh guides to maintain the neutral posture over the long term to mitigate post-SCI spinal deformities, which are found in approximately 21% of SCI clients (Yagi et al., 2015). Spasticity can change with age (Hwang, Zebracki, Chlan, & Vogel, 2014), so a flexible seating system can help to accommodate these changes in the future. A seating system that considers these preventative features can result in better long-term skin health, posture, and decreased medical complications.

Individuals with SCI have increased upper extremity pain and dysfunction associated with manual wheelchair use over time (Waters, Sie, & Adkins, 1993). Clinicians are beginning to prescribe extra equipment items (e.g., power assist) for manual wheelchairs or recommend power wheelchairs for longer distances to prevent overuse injuries. Some individuals are resistant to using power wheelchairs due to perceived stigma of increased disability and/or the practicalities of owning a larger wheelchair (e.g., unable to collapse into a vehicle trunk). Furthermore, clinical guidelines have moved away from weight shifting with shoulders ("chair push-ups") in wheelchairs to leaning forward and laterally or using power seat functions (e.g., recline) to reduce the risk of strain injuries (Vos-Draper & Morrow, 2016). Individuals with SCI who are many years post-injury may not be aware of newer clinical guidelines or equipment options to maintain mobility and reduce risk of overuse injuries.

An important practical consideration is the financial cost of equipment. Power wheelchairs can cost as much as 30,000 US dollars, and insurance coverage may only provide partial coverage, once every 5 years. For individuals without insurance coverage and/or living on fixed incomes, cost can contribute to delays in purchasing needed equipment and contribute to injuries. As such, the longitudinal SCI aging effects of muscle atrophy, fatigue, and decreased skin tolerance should be considered.

Products and Technology

Advancements in technology have opened up opportunities for increased independence and better quality of life for individuals living with SCI. Voice activation, for example, not only provides access to those who are physically limited, but it also offers an option for energy conservation, fatigue management, and joint protection. More importantly, electronics can be accessed via one's wheelchair through Bluetooth or infrared technology, providing an individual with SC with easy access in their supportive seating system. Assistive technology and home modifications in individuals aging with SCI have been found to slow functional decline and reduce personal assistance (Wilson, Mitchell, Kemp, Adkins, & Mann, 2009). These products and technology should be provided earlier in the aging process to support independence.

Recreation, Leisure, and Community Participation

Physical activity and social connectedness in later life contribute to overall enhanced physical, cognitive, psychological, and social well-being (Dupuis & Alzheimer, 2008). For most older adults, qualitative leisure is more important than quantitative leisure (McPherson, 2004). Exercise improves areas of function important for maintaining independence in SCI such as bone density, physical endurance, muscle strength, stress reduction, pain reduction, and psychological well-being (Scelza, Kalpakjian, Zemper, & Tate, 2005). In light of the evidence for premature aging in SCI and risk of secondary health complications, a multicenter research program in the Netherlands has been launched to examine the impact of activity and fitness in persons aging with SCI (van der Woude et al., 2013). Results from this research program are pending.

Barriers to community participation include individual influences (e.g., loss of "able identity," lack of awareness of resources), social influences (e.g., attitudes of society, lack of social support), and physical influences (e.g., equipment, lack of physical access, transportation, finances) (Piatt, Compton, Wells, & Bennett, 2012). When individuals with SCI struggle to engage in the community due to the social and physical barriers, it reinforces the negative perception they may have of their own abilities (Piatt et al., 2012). Barriers to community participation are also largely influenced by country (e.g., varying legislation), region (e.g., inclement weather), and setting (e.g., urban versus rural).

Practice Directions

A summary of recommended rehabilitation interventions is summarized in the table below. Given the important interplay of clinical treatment and self-management for positive health outcomes, rehabilitation interventions are described as a collaboration between the specific skills of the clinician and the self-management skills of the individual living with SCI (Table 7.1).

Table 7.1 Summary of rehabilitation interventions for individuals aging with SCI (Adapted from Withers, Higgins, Ramakrishnan, Middleton, & Cameron, 2014)

	Clinician	SCI individual
Cardiovascular	Cardiovascular assessment as needed: bloodwork, ECG, echocardiogram, nuclear medicine evaluation Measure blood pressure Evaluate for orthostatic hypotension Measure weight Ask about episodes of autonomic dysreflexia Consider fasting glucose and lipid profile Refer for peripheral vascular studies when indicated	Increase activity Eat a balanced diet Maintain a healthy weight Know symptoms and management of autonomic dysreflexia Quit smoking Consider use of compression stockings and/or abdominal binders if dealing with symptomatic low blood pressure
Endocrine	Evaluate fasting glucose/glucose tolerance test Check pituitary function and bioavailable testosterone levels	Eat a balanced diet Review exercise guidelines for individuals with SCI
Neurology/ neuropsychology	Repeat neurological exam if concerns of new sensation or motor function loss/decline Inquire about ascending neurological decline Check for common compression neuropathies Ask about episodes of transient ischemic attacks If concerns about cognition, administer mental screening tasks Rule out other factors that might mimic neurologic dysfunction (e.g., infection, medication side effects) Consider referring for neuropsychological assessment Consider brain imaging	See your physician if you notice new sensation or motor function loss/decline Report changes in thinking abilities Know the signs of stroke and present to the emergency room with any sudden change in motor, sensory, or cognitive function (language, confusion, etc.) Take the least but effective dose of any of your medications Have an annual medication review
Respiratory	Assess respiratory function and measure lung vital capacity Assess and treat sleep-disordered breathing Treat infections	Quit smoking Flu shot/pneumococcal vaccination Breathing exercises such as lung volume recruitment or incentive spirometry Use CPAP or BiPAP to treat sleep-disordered breathing Use cough assistance as needed
Musculoskeletal	Bone mineral density assessment Discuss fracture risk Joint and strength assessment Pharmacological intervention for treatment and prevention Monitor for heterotopic ossification Advocate for appropriate equipment	"Conserve to preserve" Weight shift with leans, not shoulders Reduce the number of manual transfers per day with equipment Safe transfers to eliminate risk of bone fracture or other musculoskeletal injury Exercise and weight training to preserve muscle strength Ensure adequate vitamin D and calcium intake Consider weight-bearing activities (e.g., standing frame)
Skin	Assess skin for redness and pressure injuries Annual seating assessment Teaching as prevention Pressure reducing surfaces: mattresses and cushions Look for and mitigate initiating/perpetuating causes of skin breakdown Consider spasticity and contractures as contributors to pressure injuries Manage edema	Daily skin checks Keep skin clean, dry, and moisturized Avoid excessive pressure, friction/shear forces Weight shift with leans Quit smoking Check equipment integrity, and ensure it is still setup appropriately: wheelchair cushion, backrest, commode chair, mattress, vehicle seats, and other contact surfaces Use tilt features in seating systems

(continued)

Table 7.1 (continued)

	Clinician	SCI individual
Genitourinary and gastrointestinal	Prevent/treat urinary tract infections Routine colorectal cancer screening Monitor/treat neurogenic bowel and bladder	Regular bowel routine Regular maintenance of catheters Diet, hydration, medication, suppositories, and/or reflex-based technique to manage bowel and increased risk of constipation with age Minimize constipating medications when possible
Pain	Pharmacological treatment of pain and spasticity Determine if pain is neuropathic, somatic (mechanical), or visceral Physiotherapy including range of motion Refer to mental health for management of stressors and triggers Refer to occupational therapy for posture, seating, and alignment	Take the least but effective dose of any of your prescribed pain medications Speak with your doctor about your use of over the counter pain medications Psychological treatment Relaxation and meditation practice Remain active Aim for optimum function recognizing that pain may still be present
Sexual	Take a sexual history of sexual interest, genital arousal (erection and vaginal lubrication), orgasm, and ejaculation regardless of the sexual concern presented, and consider normal aging changes Consider bloodwork for erection dysfunction risk factors Replace testosterone in men and estrogen in women, if appropriate Manage factors confounding the sexual issue (e.g., medications, depression, change in medical status) Alter medication appropriately (switch to “sex-friendly” antidepressants, etc.) Ask about weight gain, aging issues (e.g., loss of muscle mass), and sexual self-esteem/view	Inform clinician of medication changes Inform clinician of changes to health status and/or changes to sexual function abilities Inform clinician of changes to relationship status, role changes within existing relationship, stressors within relationship Communicate with partner about dual roles of caregiving and intimacy Sexual health treatment to understand changing experience of sexuality Explore adaptive devices to enhance and promote sexual pleasure
Psychological	Mental health assessment and risk of suicide Pharmacological treatment of mood Referred to specialized mental health treatment	Maintain social life Limit hours in bed Get outside the home as much as possible Exercise Stay engaged in enjoyable activities and vocational role Learn effective ways to cope Consider cognitive behavioral therapy
Activities and participation	Discuss the role of clinician versus SCI to maintain health Refer to occupational therapy periodically to review equipment, seating, transfers, and technology Refer to assistive technology specialists As care needs increase, advocate for resources Advocate to reduce/eliminate accessibility barriers	Adopt a self-management approach to promoting health and minimizing secondary health complications Conserve to preserve: (1) reduce transfers per day, (2) consider additional equipment and power mobility before needed, (3) weight shift with leans, not shoulders Consider the long-term view when purchasing expensive equipment As care needs increase, consider using attendants rather than family to reduce caregiver burden and preserve family roles Use technology, such as voice activation, to increase independence and reduce fatigue With increasing levels of dependence, problem solve and advocate to reduce barriers to remaining active and engaged in community life

Future Research

The majority of studies on SCI and aging focus on chronological age and years post-injury but do not provide a clear picture of the natural course of SCI across the lifespan, particularly in later life. More longitudinal research is needed, especially studies including able-bodied controls and those injured earlier and later in life, to identify problems associated with aging that can be anticipated or prevented. The goal is to promote life satisfaction, quality of life, and independence as long as possible in SCI.

Appendix

Rehabilitation Resources

Education

American Spinal Injury Association: http://asia-spinalinjury.org

SCI Classification: http://asia-spinalinjury.org/wp-content/uploads/2016/02/International_Stds_Diagram_Worksheet.pdf

SCI and Aging overview from New South Wales (Australia) Government and Agency for Clinical Innovation: https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0003/224679/ACI-Ageing-with-SCI-FINAL.pdf

Self-paced learning modules on American Spinal Injury Association (ASIA) website: http://asia-spinalinjury.org/learning/.

Care for Persons with SCI for Family Physicians from the Department of Family Medicine (Ontario, Canada) and the Ontario Neurotrauma Foundation: http://eprimarycare.onf.org/HealthPromotionAndMaintenance.html

A multidisciplinary framework for assessing sexual health in SCI: Elliott, S., Hocaloski, S., & Carlson, M. (2017). A Multidisciplinary Approach to Sexual and Fertility Rehabilitation: The Sexual Rehabilitation Framework. *Topics in Spinal Cord Injury Rehabilitation*, *23*(1), 49–56.

Self-Management

Aging and SCI Self-Management Information from Craig Hospital (Colorado, United States): https://craighospital.org/resources/aging-and-spinal-cord-injury

Spinal Cord Resources from the New South Wales (Australia) Government and Agency for Clinical Innovation: https://www.aci.health.nsw.gov.au/networks/spinal-cord-injury/resources

SCI checklist for use by patients in family practice from the Centre for Family Medicine (Ontario, Canada): http://www.family-medicine.ca/files/SCI_Toolkit[1]_with_Additions_for_Jamie%20Revised.pdf

Development of a Self-Management Mobile App for SCI from ICORD, a SCI research center of the University of British Columbia (Canada): http://icord.org/studies/2017/08/sci-self-management-mobile-app/

Information on self-management for both the general public and health professionals: http://www.selfmanagementbc.ca/

Peer health mentorship: http://sci-and-u.ca/users/sign_in

Patient Advocacy and Resources

The Rick Hansen Institute: http://www.rickhanseninstitute.org

Christopher Reeve and Dana Foundation: https://www.christopherreeve.org

SCI Action Canada: http://sciactioncanada.ca/sciu#

Research Centers

International Collaboration on Research Discoveries: http://icord.org

SCI Research Evidence: https://scireproject.com

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8 Aging with Parkinson's Disease

Joe R. Nocera and Keith M. McGregor

Parkinson's Disease and the Brain

It was not until over 100 years following Dr. James Parkinson's description of "shaking palsy" that PD was linked to the degeneration of the substantia nigra in the midbrain. The substantia nigra pars compacta produces the neurotransmitter dopamine, an extremely important modulatory neurotransmitter that is involved with all aspects of movement and cognition. Dopamine is essential for the proper transmission of signals throughout the basal ganglia to control movement (National Institute of Neurological Disorders and Stroke, NINDS, 2017). In the regulation of movement, dopamine has direct action within subcortical structures of the basal ganglia. The basal ganglia are comprised of the caudate, putamen, and globus pallidus (interna and externa). A primary function of the basal ganglia in motor control is the regulation of selective neural patterns, such that coordinated descending muscle control follows smooth intentional contraction. This is accomplished by a complex interplay of inhibitory interconnections within the structures of the basal ganglia (Lanciego, Luquin, & Obeso, 2012). These connections can be subtyped into three broad categories: (1) input nuclei, (2) output nuclei, and (3) intrinsic nuclei. Input nuclei receive information from three primary sources: cortical, thalamic, and nigrostriatal. In general terms, the specific basal ganglia structures associated with input nuclei are the caudate, the putamen, and portions of the nucleus accumbens (which is also a key limbic structure). Output nuclei consist of the internal portion of the globus pallidus (GPi) and portions of the substantia nigra pars reticulata. Especially important in the pathophysiology of Parkinson's disease, however, are the intrinsic nuclei. These consist of the subthalamic nucleus, the external portion of the globus pallidus (Gpe), and the substantia nigra pars compacta (SNpc). Dysregulation of dopamine in the input nuclei, such as the putamen, has an aggregate effect on total basal ganglia function, as the intrinsic structures are also highly sensitive to dopamine through multiple receptor systems.

Of clinical relevance, the onset of motor features of Parkinson's disease does not occur until over 70% of dopaminergic neurons in the SNpc have died (Bernheimer, Birkmayer, Hornykiewicz, Jellinger, & Seitelberger, 1973). The term substantia nigra derives from Latin for

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"black substance," referring to the dark phenotype of the cell bodies due to the presence of neuromelanin. This dark pigment, which increases with age, is visible as a black stripe in brain sections post-mortem and is now measurable in vivo with the use of neuromelanin magnetic resonance imaging (Ward, Zucca, Duyn, Crichton, & Zecca, 2014). The loss of SNpc neurons occurs in synchrony with the decrease of the expression of dopamine transporter density in the putamen (Bernheimer et al., 1973). In addition, proteinaceous cytoplasmic structures begin to develop in SNpc neurons. These structures are known as "Lewy bodies" and are characterized as having increased levels of the protein alpha-synuclein. It is currently unknown if the presence of Lewy bodies are neurotoxic in Parkinsonism, but their presence is a hallmark finding in the histological profile of the disorder. Clinically, there is no set density profile for Lewy bodies that determine Parkinsonism; however, case reports show progression of the disease is associated with propagation of Lewy bodies from the posterior midbrain to limbic regions (Dickson et al., 2009).

Cause, Pathogenesis, and Detection

While the underlying cause of PD is unknown, the disease is associated with the decline of pigmented neurons in the substantia nigra. Importantly, aging plays a significant role in this process, as adults over 50 have lower levels of dopaminergic neuron in the SNpc even in the absence of pathology (Lee, Tran, & Tansey, 2009; McGeer, McGeer, & Suzuki, 1977; Olanow, 1992). A consequence of the death of these neurons is the decline in supportive metabolism of dopamine production and conversion. Two examples of this are the severe loss in striatal tyrosine hydroxylase and dopamine transporter density in both human and animal models of PD (Haavik & Toska, 1998; Zhu, Zhang, & Zeng, 2012). However, more recent evidence has focused on the role of oxidative stress on mitochondrial function in substantia nigra pars compacta dopamine neurons (SNpcDN), which have a particular phenotype that makes them more vulnerable to damage than other neuron species in the basal ganglia. As a result of mitochondrial dysfunction, SNpcDN aggregate reactive oxygen species that trigger cellular apoptosis (Perier & Vila, 2012; Subramaniam & Chesselet, 2013). Oxidative stress can be brought on by an initiation factor such as a toxin or viral infection, which trigger chronic neuroinflammation. This inflammation causes a progressive buildup of microglia surrounding the dopaminergic neuron (Burbulla et al., 2017; Thomas, Francescutti-Verbeem, & Kuhn, 2006). This accumulation of microglia causes a metabolic imbalance surrounding the cell and results in cell death. While enjoying increasing support, the oxidative stress model is still one of a few hypotheses related to the fragility of SNpcDN, and the direct mechanism of cell death still has yet to be determined.

Although the rates of PD increase with age, aging is not accepted as the sole cause of the disease. However, it is possible that characteristics of neuronal aging make dopaminergic cells more vulnerable. For instance, recent work by Branch, Sharma, and Beckstead (2014) has directly investigated characteristics of cellular aging in dopaminergic neurons in a rodent model using numerous neurophysiological techniques. The group took old and young mice and extracted midbrain slices for in vitro preparation of index firing rates in the excised cells. When the group compared similar presentations of neurons from younger mice, they showed that older dopaminergic cells had significantly lower spontaneous firing rates and a high degree of variability in spiking intervals (irregular spiking). In addition, the authors found a specific membrane current that was affected by age called the L-type calcium current. Aged L-type currents were three times smaller in amplitude than younger neurons. The group used a pharmacological agent (nimodipine) to block L-type calcium currents in both younger and older mice. The results showed that the L-type calcium channels may act as a pacemaker for cellular regulation and that aging causes a dysregulation of this paced firing potentially leading to abnormal metabolic response (Branch et al., 2014). Much more work is required to understand the pathophysiology of this mechanism.

Due to the fact that the underlying cause of PD is unknown, the process of making a PD diagnosis can be difficult. A definite diagnosis of PD requires an autopsy (Samii, Nutt, & Ransom, 2004), a time at which rehabilitation is less effective, so earlier detection methods are preferred. Most often blood tests and brain scans involving magnetic resonance imaging (MRI) are performed to rule out other pathological conditions having similar symptoms such as essential tremor, supranuclear palsy, or Shy-Drager syndrome. A neurologist arrives at the diagnosis after a thorough examination relying heavily on history and a physical examination.

Cardinal Signs of Parkinson's Disease

The previously discussed changes in the basal ganglia functioning result in the primary signs of PD: bradykinesia, rigidity, tremor, and postural instability. Bradykinesia refers to the difficulty in initiating movements as well as slowness of movements. Both automatic and voluntary movements are affected, resulting in a reduction of the range and amplitude of movements (Chahine et al., 2017). This results in impairment of overall coordination, particularly in fine motor tasks like writing (e.g., micrographia) and handling small objects (Wiesendanger & Serrien, 2001). The cause of bradykinesia is believed to be from alterations in motor planning due to the reduction of basal ganglia integration. As a result, movements are cortically controlled causing intense mental effort (Maidan et al., 2016). The unfortunate sequelae to the requirement of increased cortical control of movement relate to the aging component of the disease. Recent data has shown that older adults have a great deal of difficulty performing cognitive tasks during overland walking (Nocera et al., 2013). The increased cognitive burden due to the disease and the aging process itself make individuals with PD vulnerable to fall risk (Fasano, Canning, Hausdorff, Lord, & Rochester, 2017; Gray & Hildebrand, 2000).

Rigidity is an increased resistance to passive motion that affects all striated muscles resulting from an increase in the static stretch reflexes and excess activation of alpha motoneurons in both the agonist and antagonist muscle groups (Magrinelli et al., 2016). The simultaneous engagement of agonist and antagonist muscles is typically first denoted in PD patients in the upper extremity during flexion and extension of the elbow joint. This "cogwheel" rigidity appears spastic and is so named because it resembles the movement of interlocking wheels of a clock. Cogwheel rigidity prevents smooth movements during flexion as instead of remaining inhibited, the antagonist muscle is recruited by the stretch of the agonist. This results in a progressive stop-go type of presentation and severely impairs dexterity and fine motor control.

Tremor is an involuntary, rhythmic, or alternating burst of movement of the antagonist muscle groups. One of the earliest symptoms in the PD pathology, resting tremor in PD patients, typically begins at the distal upper extremity unilaterally. This is known as a "pill rolling" tremor as the movement is similar to that of a pharmacist's technician rolling a pill in a circular motion from a paste. A resting tremor with a frequency of 3 to 6 Hz is often the first symptom in 70% of PD patients (Samii et al., 2004). More than a simple annoyance, tremor can severely affect quality of life in PD patients even in its earliest presentation. The circuitry responsible for this tremor is believed to be the dysregulation of the striatal input at rest due to the disinhibition caused by the lack of dopamine at the D2 dopamine receptor subtype (Alexander, 1990; Alexander, DeLong, & Strick, 1986; Middleton & Strick, 2000). Tremor can be temporarily extinguished by the administration of levodopa, but the efficacy of this dopamine precursor tends to lessen with the progression of the disease over time (Bastide et al., 2015). Tremor is usually more severe during emotional tension and completely absent during sleep.

Bradykinesia, rigidity, and tremor have a dramatic effect on the individual's independence and quality of life by reducing their capability to perform acts of daily living (ADLs). In addition to the cardinal signs of PD, other secondary physiological and psychological factors can attribute

Table 8.1 Effects of Parkinson's disease

Impairment	
Physiological	Psychological
Bradykinesia	Depression
Rigidity	Anxiety
Tremor	Dementia
Muscle weakness	Decreased motivation
Postural instability	Public embarrassment

to overall diminishment of individuals with PD (see Table 8.1). Taken together, function and independence begin to decline due to the physiological factors and the individual's emotional and psychological well-being becoming negatively affected.

Postural Instability and Falls

An important component of function that debilitates individuals with PD is postural stability, particularly as the disease progresses. Postural instability refers to the gradual development of poor balance, leading to an increased risk of falls. Postural instability can be demonstrated by an impaired response to perturbation during static balance and an inability to make the necessary postural adjustments during dynamic movements including gait (Horak, 2017). The gait pattern in PD patients is characterized by limited balance, shuffling steps, and difficulties in gait initiation (Barbosa et al., 2016; Del Olmo & Cudeiro, 2005; Horak & Mancini, 2013). Individuals with PD also have difficulty maintaining steady upright posture and responding to external and internal perturbations (Debaere, Wenderoth, Sunaert, Van Hecke, & Swinnen, 2003; Hackney, Lee, Battisto, Crosson, & McGregor, 2015; Jackson, Jackson, Harrison, Henderson, & Kennard, 1995). Falls are the most serious complication of both static and dynamic postural instability in PD, and reports have documented individuals with PD who fall vary from 38 to 90% (Fasano et al., 2017; Nocera et al., 2013; Plotnik, Giladi, Dagan, & Hausdorff, 2011). These falls are the leading cause of physical trauma and restriction of day-to-day activity in individuals with PD (Rudzinska et al., 2013). In addition to problems with balance and falls, postural instability restricts overall mobility, gait, and the ability to initiate movement. These components then lead to loss of overall function and decreased independence.

Based on the work done by Horak, Nutt, and Nashner (1992) and Bronte-Stewart (2002), three processes required for functional postural stability were identified: (1) sensory organization, in which one or more of the orientation senses (somatosensory, visual, and vestibular) are involved and integrated with the central nervous system; (2) a motor adjustment process involved with executing coordinated and properly scaled neuromuscular responses; and (3) adequate tone of muscles, through which adjustments in postural control are achieved. Because PD is a multifactorial problem, individuals with the disease may have deficiencies in one or more of the three processes required for postural stability (Bronte-Stewart, 2002; Horak et al., 1992). For example, in terms of sensory organization, visual and proprioceptive dysfunction has been documented in individual with PD (Bronstein, Hood, Gresty, & Panagi, 1990; Reichert, Doolittle, & McDowell, 1982). Additionally, Marsden and others have demonstrated that motor planning and the corresponding motor adjustments are severely affected in persons with PD (Horak et al., 1992; Marsden, 1984). Lastly, the lack of muscular strength has been well documented in individuals with PD (Inkster & Eng, 2004).

An important feature of postural instability is the strong association of the symptom with the age of the patient. Few individuals with early-onset PD report postural instability within the first 5 years of the diagnosis, and many younger PD patients may not report the symptom at all. However, patients over the age of 60 have a 50% likelihood of postural instability with higher rates as the disease progresses (Samii et al., 2004). This has serious implications for the outcome of falls in this population. Up to 10% of individuals over 60 with postural instability report greater than 52 falls per year. Since these individuals have decreased bone and muscle density, and a slower recovery from peripheral vascular damage, health outcomes in older PD patients with high fall risk include longer bed rest, increased fracture rate with longer knit time, higher fear of falling (self-efficacy), and decreased overall movement. Unfortunately, all of these outcomes themselves increase fall risk (Shen, Wong-Yu, & Mak, 2016).

Movement efficiency refers to the ability of the central and peripheral nervous systems to perform tasks of daily living in an expedient and mature manner to produce efficient movement patterns and provide stability during movement (Barbosa et al., 2016). Similar to postural stability, movement efficiency utilizes visual, somatosensory, vestibular perception, and motor adjustment processes as well as muscular strength to complete the needed adjustments. These systems are not only used to provide feedback to maintain balance but also initiate the movement (Blasch, Wiener, & Welsh, 1997). The combination of these senses is required to produce efficient movement patterns, such as walking, and provide stability during ambulation or during the performance of activities of daily living.

Other studies have examined the disruption of one or more of the systems causing disturbances in both postural stability and movement efficiency. For example, researchers evaluated center of pressure and center of mass as an overall indicator of dynamic balance control during gait in individuals with PD at different levels of involvement based on the Hoehn and Yahr scale. They found that those individuals further along in the progress of the disease (Hoehn and Yahr score greater than 2.5) demonstrated clinically detectable balance impairment as measured by group reaction forces. Additionally, their findings suggested that dynamic postural control (i.e., locomotion) may be more affected than static postural control (Hass, Waddell, Fleming, Juncos, & Gregor, 2017).

Muscular Strength in Individuals with Parkinson's Disease

Muscular fitness, including muscular strength, is a key component to overall health in aging and has been documented as deficient in individuals with PD (Corcos, Chen, Quinn, McAuley, & Rothwell, 1996; Inkster, Eng, MacIntyre, & Stoessl, 2003). This vital aspect of health is important for integrity of both tendons and muscles, which is related to falls and other associated risks of injuries. Likewise, increased muscular strength (i.e., greater lean muscle mass) is important for resting metabolic rate, which is negatively correlated to weight gain and obesity. Lastly, the work capacity of the large muscles, particularly in the lower extremity, is directly related to an individual's ability to perform activities of daily living (Reuter, Engelhardt, Stecker, & Baas, 1999).

As mentioned previously, a reduction of muscular strength was shown to cause postural instability and decrease in overall function (Nallegowda et al., 2004). Other studies evaluating strength in PD have found similar results. For example, Inkster and colleagues evaluated leg muscle strength, as it relates to the ability to rise from a chair, in individuals with PD (Inkster et al., 2003). They found mean hip and knee extensor torques to be lower in individuals with PD when compared to age- and sex-matched non-PD participants. They concluded that this reduction in strength might be a factor that contributes to the difficulty of persons with PD to rise from a seated position.

Cognitive and Nonmotor Symptomatology

In patients with PD, diminished cognitive-executive function is consistently implicated as a significant contributor in the deleterious physical manifestation (Aarsland, Ehrt, & Rektorova, 2011; Puente, Cohen, Aita, & Brandt, 2016). In fact, recent evidence demonstrates that the physical and cognitive-executive function deficits of PD are not dissociable, as aspects of executive function directly impact physical function (Parker, Lamichhane, Caetano, & Narayanan, 2013; Uekermann et al., 2003). By the time diagnosis of PD is possible, there are degenerative changes not only in substantia nigra but also in a variety of limbic structures that serve as conduits for information flow between posterior temporal, parietal association cortices and the prefrontal cortex (Braak & Braak, 2000; Braak, Ghebremedhin, Rüb, Bratzke, & Del Tredici, 2004). These changes affect pathways carrying information in both directions and are responsible for the early cognitive changes in PD (Cropley, Fujita, Innis, & Nathan, 2006). Consequently, executive tasks requiring complex processing are impaired, as higher-level cognition requires coordination of processing between temporal and parietal association cortices and prefrontal regions.

Indeed, cognitive and psychological symptoms in PD are present in almost 100% of patients with motor symptoms (Kim et al., 2013). Moreover, cognitive symptoms are the presenting feature in over 20% of individuals prior to eventual diagnosis of the disorder (O'Sullivan et al., 2008). Specifically, these changes in PD affect working memory (Altgassen, Phillips, Kopp, & Kliegel, 2007) and abilities that tap into the intentional control processes (e.g., inhibitory function and fluency). Subsequent degenerative changes due to PD spread to posterior association areas (Braak et al., 2004), further impairing functions crucial for complex cognitive-executive functioning.

Dual Tasking in PD

Highly related to the communication between temporal, parietal, and prefrontal regions is the ability to perform multiple tasks simultaneously or "dual task." Activities of daily living often require performing multiple tasks at one time, and, as such, dual tasking is an intrinsic part of everyday life. The rationale for "dual-task interference" is that performing simultaneous tasks requires more executive control resources, which are inherently limited. Thus, when tasks are performed simultaneously, available cognitive resources are insufficient to perform each task optimally. Evidence suggests that dual-task interference between cognitive and motor tasks increases with age (Kemper, Herman, & Lian, 2003) and with PD (O'Shea, Morris, & Iansek, 2002; Peterson et al., 2015; Plotnik et al., 2011; Yogev et al., 2005). For example, in PD the declining executive functioning highlighted above is compounded in a dual-task scenario in which an individual is performing an executive task (working memory) while initiating gait (Nocera et al., 2013). While gait deficiencies are well-known in PD, dual-task performance may provide a more accurate assessment of the effects of PD on activities of daily living. Importantly, "real-life" dual-tasking activities are implicated in fall events.

Pharmacology and Surgical Interventions

Medications for PD fall into three categories. First are those that work directly or indirectly to increase the level of dopamine in the brain. The most common of these includes levodopa. Arvid Carlsson first discovered the clinical potential for levodopa in the late 1950s. While dopamine depletion was widely attributed as a cause of Parkinsonism at the time, delivery of the neurotransmitter was not possible due to the blood-brain barrier, which is the tightly bound endothelial cells lining cerebral arteries that prevent toxicity. Using animal models, Carlsson found that levodopa is an effective way to treat early motor symptoms of PD, as it can cross the blood-brain barrier (1959). The second category of drugs includes those that affect other neurotransmitters in the body to reduce symptoms of the disease. An example of these drugs includes anticholinergic drugs that alter the ratio of acetylcholine to dopamine resulting in reduced tremors and muscle stiffness. Lastly, there are medications that target the nonmotor symptoms of the disease, such as antidepressants or antianxiety medications (NINDS, 2017). Importantly, certain medications (benzodiazepines, anticholinergics) that may be prescribed for cognitive complaints such as anxiety or dizziness should not be prescribed to patients with PD, as these increase the incidence of confusion in this population and as a result increase risk of falls.

There are also surgical options for PD including pallidotomy and deep brain stimulation (DBS). Due to risks involved with an invasive surgical procedure, these treatments are usually reserved for those who are severely affected and unresponsive to drug treatment. Pallidotomy, one early form of surgery for PD, involves destroying parts of the brain that are "misfiring," namely, parts of the basal ganglia (NINDS, 2017). By destroying these parts of the brain, some symptoms of the disease are alleviated; however, oftentimes this leads to irreversible complications (Blomstedt, Hariz, & Hariz, 2017).

Exercise Interventions

A wide variety of complementary and supportive therapies, including exercise interventions, have been used to benefit those with PD. Among these are standard rehabilitation techniques used to improve gait, decrease tremor and rigidity, as well as assist with limiting cognitive decline. Additionally, exercise is often used to improve mobility, increase muscular strength, as well as improve range of motion and balance while concurrently improving overall function.

Many studies have demonstrated the benefits of physical function following programs of general exercise. Toole and colleagues evaluated a 10-week balance and strength training program on equilibrium as measured by the NeuroCom EquiTest (Toole, Hirsch, Forkink, Lehman, & Maitland, 2000). They found that the program produced positive changes in equilibrium on two controlling mechanisms. Firstly, mechanism that training altered was the ability to control the motor system when vestibular cues were the primary source of reliable feedback. Secondly, they concluded that training helped subjects override faulty proprioceptive feedback and utilize reliable visual or vestibular cues.

A similar study evaluated the use of resistance training program on gait function in individuals with PD (Scandalis, Bosak, Berliner, Helman, & Wells, 2001). This study concluded not only that the resistance training program increased strength, stride length, and walking velocity in individuals with PD but also that the gains seen in the PD population were similar to that of the non-PD controls.

A study conducted by Ellis examined the effect of therapeutic interventions on individuals with PD (2005). This study, conducted in a physical therapy setting, used strengthening exercises, functional training, and gait training on individuals with PD. Following the intervention, they found increases in mobility, walking speed, and activities of daily living.

Exercise interventions have proven to benefit individuals with PD as measured by overall physical function. However, much of these therapies previously discussed were conducted in a laboratory, health facility, or physical therapy setting. With the difficulties associated with this disease (i.e., health care, medication cost, and travel limitations), these types of interventions may not be accessible to all individuals living with PD. Therefore, it is hypothesized that a well-designed home-based exercise intervention program will allow for accessibility of all PD patients as well as demonstrate improvements in overall physical function.

Cognitive/Structural Improvements as a Result of Aerobic Exercise in Aging and PD

Aerobic exercise improves function and structure of the central nervous system in aged humans (Nocera, McGregor, Hass, & Crosson, 2015; Uc et al., 2014; Voss, Nagamatsu, Liu-Ambrose, & Kramer, 2011; Voss, Vivar, Kramer, & van Praag, 2013). For example, older adults who participated in a 6-month aerobic fitness training program showed significantly increased volume of both gray and white matter in areas of the frontal, parietal, and temporal lobes (Colcombe et al., 2004; Colcombe, Kramer, McAuley, Erickson, & Scalf, 2004; Kramer, Colcombe, McAuley, Scalf, & Erickson, 2005). Importantly, as noted above, these areas are susceptible to PD-related degeneration. Aerobic exercise is also associated with improved hippocampal function and structure in older adults (Erickson et al., 2009; Kramer &

Erickson, 2007; Prakash et al., 2007; Voss et al., 2013). Similarly, increased cardiovascular fitness resulted in sparing of age-related deterioration of white matter tracts (Hayes, Salat, Forman, Sperling, & Verfaellie, 2015; Johnson, Kim, Clasey, Bailey, & Gold, 2012), and our recent work suggests that fitness serves as a buffer for gray matter density loss (Zlatar et al., 2015).

Equally important, the demonstrated enhancement in central nervous system integrity and structure is highly correlated with behavioral research demonstrating that aerobic fitness has a beneficial impact on cognitive-executive-related outcomes. To this point, research over the last few decades suggests that aerobic exercise and/or cardiovascular fitness may impede or reverse age-related cognitive-executive decline in older adults. A seminal work by Kramer et al. (1999) demonstrated that 124 older adults randomly assigned to receive aerobic training experienced substantial improvement on tasks dependent on executive control processes and the integrity of the prefrontal and frontal cortex. Since this early work, much research has demonstrated a significant influence of aerobic exercise on the preservation and/or the enhancement of executive outcomes in older adults. For reviews please see Prakash, Voss, Erickson, and Kramer (2015) and Voss et al. (2013).

Early reports of cognitive improvements brought on via exercise in humans with PD have been reported, but additional study is needed. For example, in a recent meta-analysis, 9 out of 12 studies investigating cognitive outcome and exercise in PD demonstrated significant improvement; however, the total effect was nonsignificant. The meta-analysis concluded that the efficacy of exercise on cognition in PD has potential, but definitive conclusions are lacking due to the absence of commonality between measures, training sequences, and intervention period (Kalron & Zeilig, 2015). David et al. (2015) recently demonstrated that exercise improved attention and working memory in a cohort of 38 mild-to-moderate PD participants. It is important to note, however, this study was not investigating an aerobic exercise intervention, which has repeatedly demonstrated to be robust in terms of cognitive benefit (David et al., 2015). A case series investigating aerobic exercise on cognition in PD found preliminary evidence that exercise training improved multiple domains of executive function but concluded larger studies are needed to confirm the findings (Tabak, Aquije, & Fisher, 2013). Uc et al. (2014) utilized a walking intervention and demonstrated improved fitness, motor function, and executive control as measured by the flanker task in 43 participants with PD. More recently, Duchesne et al. (2015) documented improved inhibition and motor skill learning following aerobic exercise training in early PD and in healthy controls. Interestingly, the PD group improved to a similar degree to that of the healthy controls. Altmann et al. (2016) compared three groups of PD patients who were enrolled in 16 weeks with the following conditions: (1) aerobic exercise (treadmill walking), (2) stretch/balance, or (3) a no-contact control. Results demonstrated that only the aerobic group improved on measures of executive function and related aspects of language production. Together, these studies provide exciting early data that support the notion that aerobic exercise combats some of the effects of PD on executive function and the related physical dysfunction commonly observed.

Implications for Clinical Practice

While exercise interventions continue to show powerful effects on alleviating the symptoms of PD, there currently exist few clinical guidelines for engaging patients suffering from the disorder with evidence-based exercise programs. Current practice in prescribing an exercise regimen relies greatly on modifications of the American College of Sports Medicine (ACSM) *Guidelines for Exercise Testing and Prescription.* In summary of this report, individuals are encouraged to engage in 40–60 min of vigorous intensity weight bearing exercise at least 3 days per week. As an alternative, the ACSM recommends exercising at light intensity to moderate intensity at least 5 days per week.

However, these guidelines require special consideration for patients with Parkinson's disease. Motor deficits can limit mobility and make it difficult to perform standard exercise programs designed for people who are neurologically intact. In consideration of this, adaptable programs of exercise are recommended for PD patients based on individual severity of cognition. Although antiparkinsonian medications can improve some motor function, their effectiveness often decreases as PD progresses. And while DBS has been demonstrated to be effective at relieving motor complication, the secondary complication can be significant. Therefore, maintaining adequate levels of strength in the presence of disease and/or aging is important for functional ability and the prevention of falls, especially in a population like PD in which balance and motor coordination are impaired. Consequently, there have been many interventions aimed at increasing overall health and function in the PD population. Increased activity levels have been encouraged through physical therapy and other interventions to minimize functional loss associated with secondary impairment and improve quality of life. For example, Tai Chi/martial arts, gait/balance training, strength training, and aerobic exercise have been explored in PD. Historically, these interventions have focused on improving functional limitations (e.g., gait, reach, sit to stand, range of motion), balance, cardiovascular training, and muscular strength. For example, Kluding and McGinnis (2006) demonstrated that there were improvements following 3 months of physiotherapy in functional reach, the time to stand from a sitting position, and balance. Similarly, Ashburn et al. (2007) found a reduction in falls as a result of an intervention consisting of strength training, range of motion exercises, balance, and gait training. Palmer and colleagues documented that PD patients who participated in a 12-week karate program showed improvement in walking and grip strength (Lauzé, Daneault, & Duval, 2016). Tai Chi exercise has been shown to improve and reduce fall in PD patients (Amano et al., 2013; Choi, 2016; Hackney & Earhart, 2008). Further, the use of a combined physical/exercise therapy intervention on PD motor symptoms has been studied on multiple occasions. Interventions ranged from traditional physical therapy activities, performance of sports training, unsupported treadmill walking, and partial body weight-supported treadmill walking to a combination of endurance exercise activities (Hirsch & Farley, 2009; Shulman et al., 2013; Tabak et al., 2013).

Future Directions in Practice and Research

As noted above, our team and others have documented that patients with PD demonstrate declines in executive functions that negatively impact motor functioning (gait, balance, and dual tasking). Unfortunately, current treatment options to address these cognitive issues are lacking. Importantly, early research suggests that exercise can improve executive function in PD; however, more work is needed. We believe a critical next step is a randomized controlled trial investigating if exercise interventions can positively impact executive language and motor function in PD.

In terms of future direction, our lab has repeatedly shown that changes brought on by aging and disease may not be inevitable or immutable. We have new evidence that indicates increased levels of physical fitness through aerobic activity may mitigate losses in interhemispheric inhibition (McGregor et al., 2012, 2013). We would anticipate that both cognitive and motor performances in aging are linked to levels of interhemispheric inhibition and both will improve over the course of our exercise intervention, a concept we wish to explore further among PD participants. Indeed, this "healthy" aging work is quite relevant to PD, as the dominant inhibitory neurotransmitter gamma-aminobutyric acid (GABA) is highly modulated by dopamine in the striatum and cortex. Furthermore, there is growing evidence that PD is related to a loss of interhemispheric inhibition (Spagnolo et al., 2013; Rothwell & Edwards, 2013), a condition we are confident can be altered by exercise (McGregor et al., 2012, 2013). We believe this continuum of research investigating the relationship between disease, GABA, and physical activity will be critical to the understanding of how the disease progresses and how treatment can be optimized.

Final Discussion

In summary, Parkinson's disease is increasingly being treated as the multifaceted disorder that it is with respect to progression of symptoms in both motor and cognitive domains. This requires the treatment of the disease to focus on the individual differences in presentation of the disorder, as symptom manifestation varies greatly between individuals, particularly at later stages. This is particularly important given the realization that administration of pharmacological treatments only transiently masks certain symptoms of PD. Stem cell replacement and genetic therapies may have promise for offering restoration of dopamine after diagnosis of the disorder, but presently, the best strategy for ensuring health outcomes in PD is prevention. Other than genetic disposition, at current, it appears that lifestyle choices (e.g., healthy diet, regular engagement in physical activity, and regular sleep) are the only methods that may assist in the prevention of the disorder.

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9 Cardiovascular Aging

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Overview

Aging is associated with significant changes in cardiac, autonomic, and vascular structure and function that all increase the risk for cardiovascular disease, morbidity, and mortality (Lakatta, 2003; Lakatta & Levy, 2003a, 2003b; Shih, Lee, Lee, & Boyle, 2011). This chapter highlights the effect of age on cardiac, autonomic, and vascular function and their adaptations to exercise, by providing physiological, molecular, and cellular mechanisms that underlie cardiovascular changes which occur along the aging spectrum. Indeed, age-related maladaptations have been observed as early as the fifth and sixth decades of life (middle age) and can progress with advanced age (>65 years old). We will discuss age-related left ventricular (LV) remodeling, which can be marked by cardiac atrophy and diffuse fibrosis, and examine how these structural adaptations lead to age-related diastolic dysfunction, electrical conduction abnormalities, and systolic impairments. This chapter will also explore age-related changes in the parasympathetic and sympathetic branches of the autonomic nervous system, both under resting conditions and during exercise and simulated activities of daily living. Finally, we will examine age-related vascular remodeling and changes in vascular function and blood flow regulation. This section will also help to integrate key concepts, by examining the way the autonomic nervous system and skeletal muscle vasculature interact during exercise and the influence of age on this important interaction. We conclude each of these sections by describing how exercise training can attenuate many of these age-related cardiovascular adaptations and thus reduce the risk of cardiovascular morbidity and mortality. For the purpose of this chapter, exercise training has been defined as aerobic exercise, and these findings should not be extrapolated to all modalities of exercise training (e.g., resistance training) or rehabilitation.

The Aging Heart

In the young, healthy heart, depolarization of the myocardium spreads along the left and right atria to the atrioventricular node, down the *bundle of His* and *Purkinje fibers*, and throughout the left and right ventricles. This highly coordinated process leads to perfectly timed *systolic* contraction of the left and right atria, followed by contraction of the left and right ventricles. Such contraction generates the internal pressure necessary to propel the blood forward, from one chamber to the next and from the left ventricle to the rest of the

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organs in the body. Following contraction, the chambers of the heart relax and refill with blood. Given the highly compliant nature of the young healthy heart and its elastic properties, this process has been related to a "spring or tennis ball." Indeed, much like the way a compressed tennis ball recoils back to its equilibrium volume, the young healthy heart is able to convert the potential energy created during systole to kinetic energy during *diastole* (the filling phase of the cardiac cycle) and "spring back" to its equilibrium volume and fill with blood, which accounts for ≈80% of ventricular filling. Because the young healthy heart is compliant, it easily receives the blood entering it. Atrial contraction pushes the final ≈20% of blood into the ventricles, priming the heart for ejection of blood and the next cardiac cycle.

Aging is associated with several important cellular and molecular processes that can lead to adverse cardiac structural adaptations, ultimately compromising normal cardiac function. Most notably, aging is associated with *cardiac atrophy* and increased *myocardial fibrosis*. These structural adaptations lead to age-related diastolic dysfunction, electrical conduction abnormalities, and systolic impairments. The following sections will summarize the cellular and molecular changes that occur in the heart with aging and the role that exercise training can play in attenuating these age-related changes.

Age-Related Cellular and Molecular Changes

Aging is associated with progressive neurohumoral dysfunction, including upregulation of angiotensin-II, increased *target of rapamycin* (TOR), decreased insulin-like growth factor I, and a progressive decline in the *antifibrotic C-type natriuretic peptide*, all of which contribute to *myocardial apoptosis*, *necrosis*, and *autophagy* – *mechanisms* of cell death and turnover – which ultimately result in a reduction in cardiac myocyte number (Basso et al., 2007; Benigni et al., 2009; Li, Ceylan-Isik, Li, & Ren, 2008; Luong et al., 2006; Sangaralingham et al., 2011; Vasan et al., 2003). Despite this pronounced decline in myocyte numbers, LV mass is often preserved, particularly in elderly females (Hees, Fleg, Lakatta, & Shapiro, 2002; Kitzman, Scholz, Hagen, Ilstrup, & Edwards, 1988). This is achieved by hypertrophy of the remaining cardiac myocytes and a significant increase in extracellular matrix and fibrosis (*as illustrated in* Fig. 9.1) (Boyle et al., 2011; Donekal et al., 2014; Lakatta & Levy, 2003a; Lakatta, Mitchell, Pomerance, & Rowe, 1987). These phenotypic changes have been linked to age-related diastolic dysfunction, electrical conduction abnormalities, and impaired systolic contraction. As the extent of diastolic filling is critically dependent on the compliance of the ventricle (i.e., the ability of the ventricle to "accept" the inflowing blood), an increase in myocardial stiffness has severe implications for diastolic function. Indeed, aging is known to alter the ratio of blood entering the left ventricle during early and late diastole (Benjamin et al., 1992; Lakatta et al., 1987; Lakatta & Levy, 2003a; Schulman et al., 1992), which is a strong predictor of heart failure development and all-cause mortality (Redfield et al., 2003). Moreover, increased LV stiffness, when coupled with elevations in cardiac output during exercise (i.e., during activities of daily living), can lead to marked elevations in end-diastolic filling pressures (Fujimoto et al., 2010). This is important because increased LV end-diastolic filling pressures transmit to the left atrium and pulmonary veins and, in extreme cases, may lead to pulmonary edema and dyspnea upon exertion (as in heart failure with preserved ejection fraction, a disease of the aging).

In addition to elevated myocardial diastolic stiffness, elderly individuals have impaired LV active relaxation, which contributes to an altered LV-filling pattern. The most compelling evidence of depressed early active relaxation comes from Doppler ultrasound data primarily examining early diastolic tissue velocities and early mitral valve filling velocities (Carrick-Ranson et al., 2012). While the exact mechanism remains incompletely understood, it is possible that changes in oxidative metabolism can explain at least some of the impairment. Indeed, active relaxation depends on fast and efficient extrusion

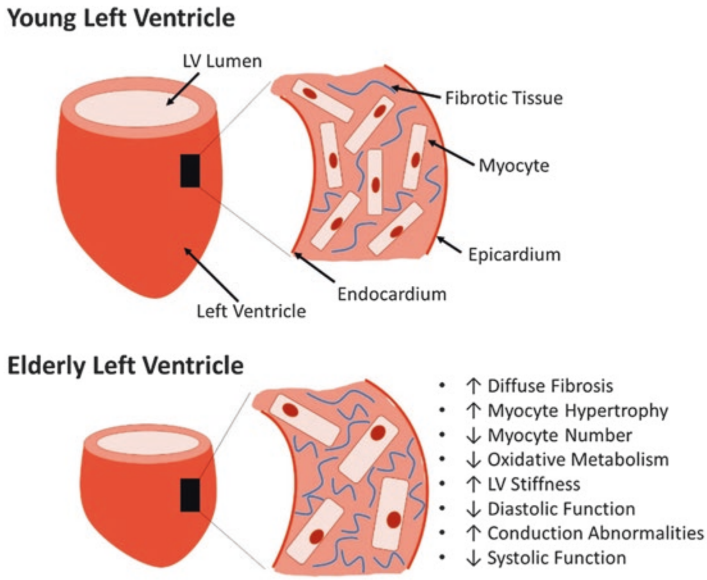

Fig. 9.1 Conceptual figure demonstrating the molecular and whole-organ changes in left ventricular structure and function with aging. LV - left ventricle

of calcium from the myocardium, which is a highly energy-dependent process (Hunter, 2000). Emerging evidence suggests that aging myocytes become less oxidative, employing more anaerobic metabolic pathways (Fares & Howlett, 2010). However, more work is needed to determine the exact role of this fiber-type shift on active ventricular relaxation.

Aging is also associated with a number of electrical conduction abnormalities, including increased prevalence of atrial fibrillation. Results from the large population-based Framingham Study identified that ~12% of individuals developed atrial fibrillation over 38 years of follow-up (Benjamin et al., 1994). Some have speculated that the increased reliance on late atrial contraction with age leads to enlargement of the left atria (known as adverse eccentric remodeling) and that this may trigger atrial fibrillation (Van de Veire et al., 2006). More work is needed in this area, however, as limited data exist associating age (independent of overt heart disease) with a clear increase in left atrial area. Calcification of the aortic and mitral valves, together with age-associated increases in LV fibrosis, may also disrupt *electrical action potential propagation* in both the atria and the ventricles (Deedwania & Lardizabal, 2010; Psaty et al., 1997; Tresch, 2001). Avoidance of electrical conduction abnormalities is imperative, as many arrhythmias can be fatal, leading to *thromboembolisms* (in the case of atrial fibrillation) and improper coordination of the cardiac cycle, which can impair both systolic and diastolic function.

Increasing evidence also suggests that aging compromises cardiac systolic contraction, particularly during exercise (Ferrara et al., 2014; Lakatta et al., 1987; Rengo et al., 2012). Indeed, the end-systolic volume reserve (exercise end-systolic volume minus resting end-systolic volume, divided by the resting end-systolic volume) of an 85-year-old individual is ~80% lower than that of a healthy 20-year-old (Lakatta et al., 1987). Furthermore, the elderly often present with an attenuated ejection fraction at submaximal and maximal exercise (Lakatta et al., 1987). The underlying mechanism(s) contributing to impaired systolic function in the elderly remain to be elucidated but are likely related to many of the factors already described (Chia et al., 2014; Jones & Killian, 2000). Indeed, age-associated cardiac *myocyte apoptosis/necrosis* and associated expansion of the extracellular matrix and myocardial fibrosis, together with changes in oxidative metabolism and electrical conduction abnormalities, likely converge to impair systolic function, particularly when the system is stressed (e.g., during activities of daily living).

Exercise Training for the Aging Hearts

Chronic exercise training is often advocated for the prevention and/or attenuation of the age-associated processes described above. Indeed, aerobic exercise stimulates a number of mechanistic pathways that improve cardiac function and promote positive cardiac adaptation in the young (for review see Vega, Konhilas, Kelly, and Leinwand, 2017). However, very little is known about whether exercise rehabilitation can actually reverse or slow age-related cardiac dysfunction. To date, the majority of work performed in this area originates at the Institute of Exercise and Environmental Medicine in Dallas, Texas. These investigations have provided invaluable insight into the role exercise training plays in the aging heart, with the majority of work focused on LV end-diastolic pressure-volume relationship (i.e., diastolic compliance).

In their seminal paper, Levine and colleagues demonstrated that the left ventricles of master athletes, who participated in lifelong intense exercise training, are significantly more compliant than their sedentary counterparts and were indistinguishable to those of sedentary young individuals (Fig. 9.2) (Arbab-Zadeh et al., 2004). This cross-sectional finding begged the question: Can exercise rehabilitation, when started late in life, reduce or reverse age-associated cardiac impairments? To address this question, Levine et al. trained nine elderly volunteers (71 ± 3 years old) for an entire year (3 times per week, ~200 min per week, at ~75–85% of maximal heart rate). Despite the rigor of the training program, LV compliance remained unchanged and was significantly lower than the master athletes and the young sedentary controls (Fujimoto et al., 2010). These findings suggest either that the exercise training duration and intensity were not sufficient or that the population they investigated was too old and had *remodeled* beyond the point of return. Similar results have been found in patients suffering from heart failure with preserved ejection fraction, who are predominantly elderly (>65 years old) (Fujimoto et al., 2012). Indeed, chronic exercise training in this population has minimal effect on cardiac structure and function, particularly diastolic function (Tucker et al., 2016).

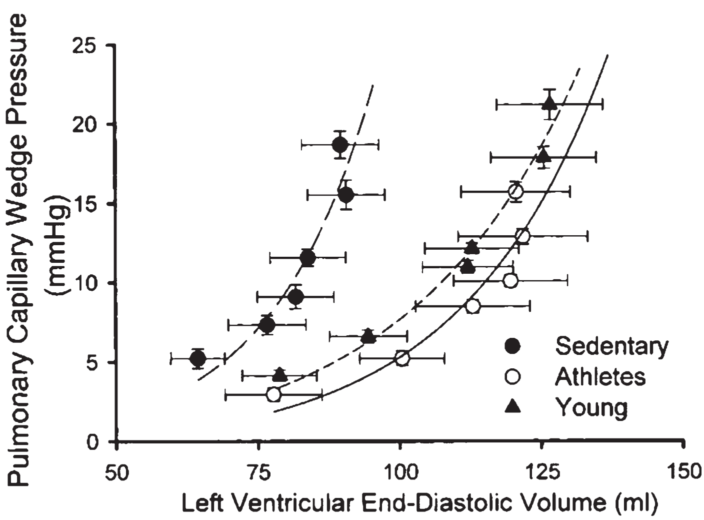

Fig. 9.2 Data modified with permission from Arbab-Zadeh et al. (2004), demonstrating the end-diastolic pressure-volume relationship in 12 sedentary elderly, 12 master athletes, and 14 young sedentary control subjects. Each data point was derived from a range of volume manipulations including 2 degrees of lower body negative pressure (to reduce preload and EDV), 2 baseline measures, and following 2 levels of saline infusion (to increase preload and EDV). The leftward shift and steeper slope of the sedentary elderly participants compared to both other groups a stiffer left ventricle and reduced chamber compliance. EDV - end-diastolic volume

In an attempt to overcome the above mentioned potential limitations from their previous investigation, Levine and co-workers recently completed a 2-year exercise training program in a middle-aged population (53 ± 5 years old). The findings from this study were very promising, as they showed clear reductions in LV stiffness, compared to an active control group (Fig. 9.3) (Howden et al., 2018). Additionally, this study demonstrated that exercise training increased end-diastolic volumes while preserving pulmonary capillary wedge pressure, suggestive of a greater LV contractility resulting in an augmented stroke volume for a given filling pressure (Howden et al., 2018). The mechanisms involved in attenuating the aging response on the heart were, however, not fully elucidated and should be the focus of future work. For example, with newer more sophisticated imaging technology (like MRI-derived T1 mapping and tissue tagging), myocardial fibrosis, extracellular volume fraction, and active relaxation can now be quantified noninvasively. Such measurements would significantly add to the interpretation of these findings.

Aging and the Autonomic Nervous System

The autonomic nervous system contributes considerably to cardiovascular regulation, both at rest and during exercise. The autonomic nervous system is comprised of two branches: the parasympathetic nervous system and the sympathetic nervous system. Both branches are tonically active at rest, with parasympathetic nervous system (vagal) activity predominant for heart rate (HR) control and sympathetic nervous system activity (SNA) primary for vascular regulation. Parasympathetic nervous system activity (PSNA) suppresses HR through release of *acetylcholine*, which binds to muscarinic receptors on the heart. The sympathetic nervous system innervates the heart and peripheral vasculature (i.e., blood vessels). SNA targeted to the peripheral vasculature releases norepinephrine onto *α_1 and α_2 adrenergic receptors* and confers vasoconstriction through contraction of vascular smooth muscle. In addition, α_2 adrenergic receptors are also located on presynaptic nerve terminals and can negatively regulate norepinephrine

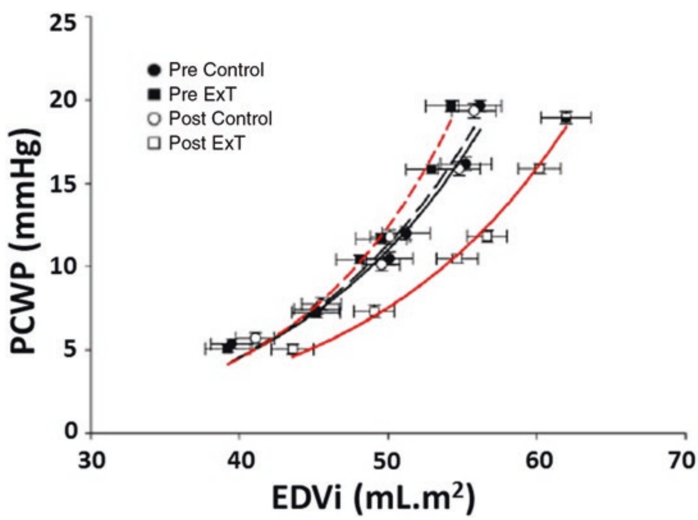

Fig. 9.3 End-diastolic pressure-volume relationship data from two groups of middle-aged individuals adapted from Howden et al. (2018). ExT group underwent an intense exercise training protocol for 2 years, while control subjects regularly practiced yoga. Pre- and post-exercise training program data are presented for each group. A rightward shift and flattening of the slope in the exercise-trained group suggest a marked improvement in left ventricular compliance and reduced chamber stiffness. EDVi - end-diastolic volume index; PCWP - pulmonary capillary wedge pressure

release (Brock, Cunnane, Starke, & Wardell, 1990). Sympathetic nerve terminals also release a number of other neurotransmitters that can cause vasoconstriction. The two most abundant co-transmitters released are *adenosine triphosphate* (ATP) and *neuropeptide Y* (NPY; Fig. 9.4). ATP binds to purinergic P2X receptors, while NPY binds to Y1 receptors. Both ATP and NPY can contribute to vascular smooth muscle contraction, which has been reviewed thoroughly elsewhere (Brock et al., 1990; Brock & Cunnane, 1990; Holwerda, Restaino, & Fadel, 2015). Sympathetically-mediated vasoconstriction contributes importantly to resting vascular tone and, thus, resting blood pressure (BP). SNA also has direct effects on the heart to increase HR and contractility through norepinephrine release onto β_1-adrenergic receptors, as well as via stimulation of the adrenal medulla and release of epinephrine.

During exercise, PSNA is rapidly withdrawn in an exercise intensity-dependent manner. The increase in HR contributes to increases in cardiac output that are important for blood flow delivery to active skeletal muscle. Early reports suggested that PSNA withdrawal aids in the HR response up to 100 beats/min. However, some more recent investigations have suggested PSNA contributes to the HR response up to 180 beats/min (White & Raven, 2014). On the other hand, SNA increases with increasing exercise intensity, which results in a further increase in HR. In addition to an increase in HR, however, SNA directed to the heart also increases cardiac contractility, contributing importantly to increases in stroke volume. Moreover, increased SNA directed to the periphery causes vasoconstriction of vascular beds, such as inactive skeletal muscle and the splanchnic vasculature. This peripheral vasoconstriction is imperative for the redistribution of blood flow toward the active skeletal muscles during exercise. Paradoxically, SNA directed toward the active skeletal muscle also increases; however, there is an attenuation of sympathetically-mediated vasoconstriction in active skeletal muscle to facilitate blood flow delivery. This concept, termed *functional sympatholysis*, will be described in detail in later sections of this chapter.

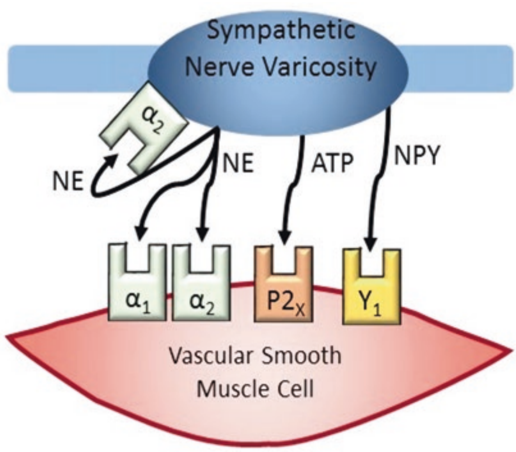

Fig. 9.4 Sympathetic nerve activity targeted to the peripheral vasculature releases norepinephrine onto α_1 and α_2 adrenergic receptors and confers vasoconstriction through contraction of vascular smooth muscle. In addition, α_2 adrenergic receptors on the pre-synapse can negatively regulate norepinephrine release. Sympathetic nerve terminals also release adenosine triphosphate (ATP) and neuropeptide Y (NPY), which can bind to purinergic P2X receptors, and Y1 receptors on the post-synapse, respectively, to cause vasoconstriction

Aging is associated with alterations in both branches of the autonomic nervous system. Under resting conditions, aging is associated with reduced vagal tone (PSNA) and increased SNA (Abhishekh et al., 2013; Briant et al., 2016; Vianna et al., 2012) (Fig. 9.5). During exercise, PSNA is still withdrawn in an intensity-dependent manner but to a lesser extent in aged humans compared to younger controls (Taylor, Hayano, & Seals, 1995). On the other hand, alterations in sympathetic responsiveness during exercise are less clear in aged humans. Indeed, direct recordings of muscle sympathetic nerve activity (MSNA) have been shown to be similar during exercise in both young and aged humans (Greaney, Schwartz, Edwards, Fadel, & Farquhar, 2013; Ng, Callister, Johnson, & Seals, 1994a). In contrast, venous norepinephrine concentrations are increased more during dynamic exercise in older humans compared to younger adults (Taylor, Hand, Johnson, & Seals, 1992). The mechanism behind greater venous norepinephrine in older humans is incompletely understood.

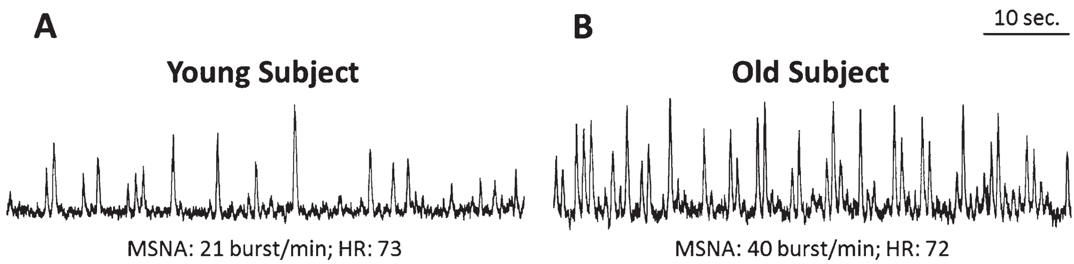

Fig. 9.5 Original recordings of muscle sympathetic nerve activity (MSNA) in a young (**a**) and an old (**b**) male subject, demonstrating the well-known increase in resting MSNA with age

However, some work has suggested that, while norepinephrine spillover into the bloodstream is not different, clearance (i.e., rate of disappearance) of plasma norepinephrine is markedly reduced in aged humans, compared to their younger counterparts (Mazzeo, Rajkumar, Jennings, & Esler, 1997). These data suggest that, while aging is not associated with an increased sympathetic outflow during exercise *per se*, alterations in neurotransmitter kinetics independent of sympathetic neural outflow from the brainstem may differ with age.

There are several neural cardiovascular reflex mechanisms that are responsible for the autonomic adjustment to exercise (i.e., withdrawal of PSNA, increase in SNA, Fig. 9.6). Primary feedback mechanisms include the arterial baroreflex (ABR), cardiopulmonary baroreflex (CPBR), and the exercise pressor reflex (EPR). Each reflex has both an afferent (ascending) and efferent (descending) arm. The afferent arm is comprised of neurons sending information from each of their respective sensors to cardiovascular control centers in the medulla oblongata of the brainstem. The efferent arm of each reflex is both parasympathetic and sympathetic neurons that synapse on the heart and, in the case of sympathetic neurons, also on the vasculature. The net integration of these afferent signals in the cardiovascular control centers of the brainstem ultimately determines the autonomic response to exercise, along with feed-forward signals arising from higher brain centers. Termed *central command*, this feed-forward mechanism represents descending signals that activate cardiovascular centers in parallel with skeletal muscle motor unit recruitment. The following sections will highlight the salient information regarding these neural cardiovascular reflex mechanisms, the impact of age on their function, and how exercise training might help prevent autonomic dysfunction with aging.

Effect of Aging on the Arterial Baroreflex

The ABR is arguably the most influential neural cardiovascular *reflex arc* at rest and is the predominant beat-to-beat regulator of resting arterial BP. Mechanically sensitive receptors (*baroreceptors*) located in the carotid sinus and aortic arch dynamically sense changes in BP. Carotid and aortic baroreceptors are comprised of free nerve endings which directly innervate the blood vessel wall within the aortic arch and carotid artery. Stretch/deformation of the vessel wall caused by heartbeat-to-heartbeat changes in BP are sensed by the baroreceptors, resulting in changes in afferent neuronal firing. When BP increases, arterial baroreceptors trigger increases in afferent nerve firing to *cardiovascular control centers* in the medulla oblongata of the brainstem. The result is an increase in PSNA and a reduction in SNA. In contrast, when BP falls and the baroreceptors are "unloaded," a decrease in PSNA and an increase in SNA occur. These reflex-mediated adjustments modulate the heart and peripheral vasculature to alter cardiac output and total vascular conductance, respectively, to return BP to its resting set point.

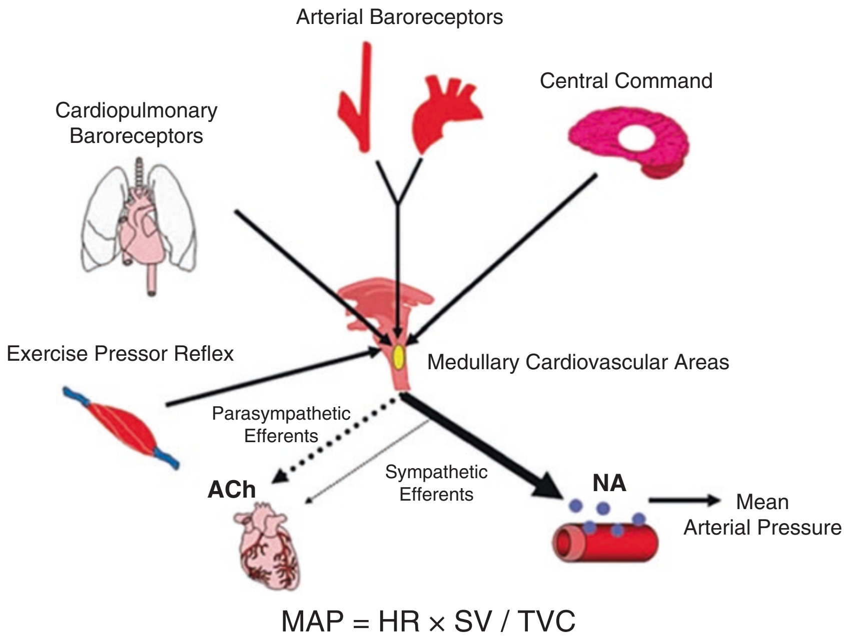

Fig. 9.6 A schematic representation of the neural mechanisms mediating the neural cardiovascular adjustments to exercise. Neural signals originating from the brain (central command) and afferent feedback from the aortic and carotid arteries (arterial baroreflex), the heart and lungs (cardiopulmonary baroreflex) and skeletal muscle (exercise pressor reflex) contribute to the intensity-dependent modulation of sympathetic and parasympathetic nerve activity during exercise. These signals converge centrally within cardiovascular control areas in the medulla oblongata of the brainstem. The ensuing alterations in autonomic outflow mediate changes in heart rate (HR) and contractility, as well as the diameter of resistance and capacitance vessels within various tissue beds to modulate cardiac output [HR x stroke volume (SV)] and total vascular conductance (TVC), respectively. These changes then lead to alterations in mean arterial pressure (MAP) appropriate for the intensity and modality of the exercise. Acetylcholine (ACh) is the primary neurotransmitter of parasympathetic efferent nerves innervating the heart. Noradrenaline (NA), also known as norepinephrine, is the primary neurotransmitter of sympathetic efferent nerves innervating the peripheral vasculature. (Adapted from Fadel and Raven, 2012, with permission)

Aging-induced alterations in ABR function at rest have been extensively studied because impaired ABR sensitivity may be a mechanism contributing to MSNA increases and vagal tone decreases with age (Taylor & Tan, 2014). Under resting conditions, the ABR control of HR is primarily driven by changes in vagal tone, verified by administration of atropine [parasympathetic nerve block (Eckberg, Drabinsky, & Braunwald, 1971)]. Thus, the term *"cardiovagal" baroreflex* has been used to describe the ABR control of HR. Several investigations have demonstrated an impairment in cardiovagal baroreflex sensitivity with age, indicating that, for a given decrease in BP, there is a smaller increase in HR and vice versa (Bristow, Gribbin, Honour, Pickering, & Sleight, 1969; Ebert, Morgan, Barney, Denahan, & Smith, 1992; Fisher, Kim, et al., 2009; Gribbin, Pickering, Sleight, & Peto, 1971; Monahan et al., 2000; Monahan et al., 2001; Monahan, Eskurza, & Seals, 2004; Parati et al., 1995; Rudas et al., 1999). Collectively, there is strong support that aging is associated with reductions in cardiovagal baroreflex sensitivity (Fig. 9.7). Interestingly, studies suggest that aging-induced increases in BP variability may be mediated, in part, by reductions in cardiovagal baroreflex sensitivity (Mancia et al., 1983; Watson, Stallard, Flinn, & Littler, 1980). This is important given recent work suggesting BP variability is an independent risk factor for all-cause mortality and cardiovascular disease-related mortality (Stevens et al., 2016) and associated with functional decline in older adults (Ogliari et al., 2016). In addition to

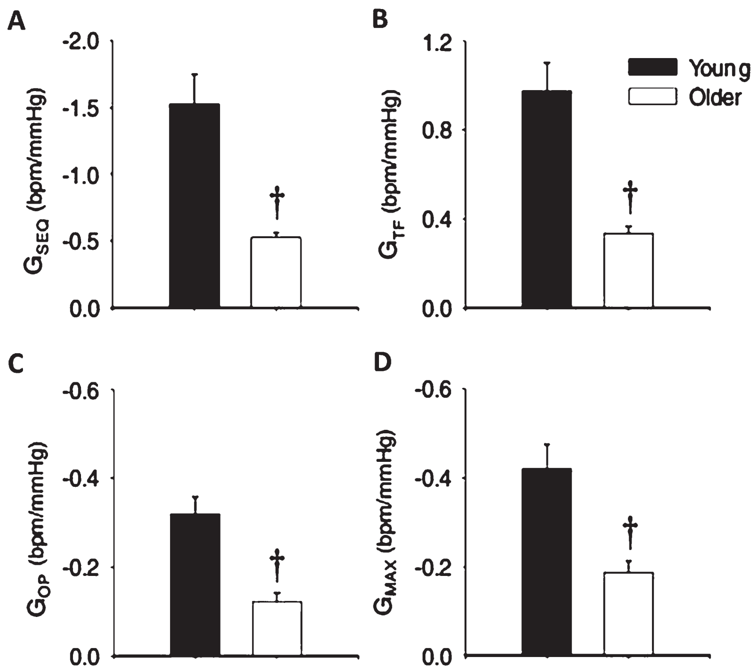

Fig. 9.7 Measures of spontaneous cardiac baroreflex sensitivity in young and older subjects estimated using sequence analysis (G_{SEQ}; A), transfer function analysis (G_{TF}; B), and operating point gain (G_{OP}) derived from variable pressure neck chamber technique (C). Such measures represent the gain of the cardiac baroreflex around spontaneously occurring fluctuations in blood pressure. Panel D is the maximal cardiac baroreflex gain (G_{MAX}) derived from the variable pressure neck chamber technique which represents the point of highest gain along the baroreflex function curve (i.e., gain at the centering point). All four analysis methodologies demonstrate clear reductions in cardiac baroreflex sensitivity with aging. Filled bars represent young subjects and open bars denote older subjects. † $P < 0.05$ versus young. (Adapted from Fisher, Ogoh, et al., 2009, with permission)

contributing to resting BP variability, studies also suggest impaired resting cardiovagal baroreflex sensitivity may have prognostic value for the prediction of sudden cardiac death, as well as cardiovascular morbidity and mortality (Billman, 2006; La Rovere, 2000; La Rovere, Bigger, Marcus, Mortara, & Schwartz, 1998; La Rovere et al., 2001; La Rovere, Specchia, Mortara, & Schwartz, 1988).

Studies examining ABR control of SNA at rest are equivocal, reporting no change, preserved, or enhanced, ABR control of SNA with aging (Davy, Tanaka, Andros, Gerber, & Seals, 1998; Ebert et al., 1992; Jones et al., 2001; Matsukawa, Sugiyama, Iwase, & Mano, 1994; Matsukawa, Sugiyama, & Mano, 1996; Matsukawa, Sugiyama, Watanabe, Kobayashi, & Mano, 1998; Studinger, Goldstein, & Taylor, 2009). Recently, Studinger et al. (2009) reported that older subjects compared to younger subjects had less of an increase in MSNA following intravenous infusion of sodium nitroprusside (used to decrease BP). On the other hand, older subjects demonstrated greater reductions in MSNA, relative to younger participants in response to infusion of phenylephrine (used to raise BP). Interestingly, the investigators also utilized Doppler ultrasound imaging of the common carotid artery during these infusions to investigate the mechanical (change in carotid artery diameter per change in mean arterial pressure), and neural (change in MSNA per change in carotid artery diameter), components of the ABR. This analysis accounts for (A) the mechanical stimuli to the baroreceptor and (B) the integration of that information in the medulla oblongata and resultant sympathetic response. The authors demonstrated a reduced mechanical component to the ABR but an exaggerated neural component during the phenylephrine trial. Thus, in response to hypertension, attenuations in the mechanical component of the ABR are offset by a greater neural component, resulting in a net normal or augmented baroreflex response to hypertensive stimuli in aged individuals. In contrast, during the sodium nitroprusside trial, both the mechanical and neural components of the ABR were attenuated in older adults, indicating that aging is associated with reduced ABR responsiveness to hypotensive stimuli due to reductions in both the mechanical and neural components of the ABR.

The study of ABR control of BP in aged populations has also yielded equivocal results, wherein some studies report impaired ABR control of BP (Fisher, Kim, Young, & Fadel, 2010; Jones, Christou, Jordan, & Seals, 2003) and others intact ABR control of BP (Brown, Hecht, Weih, Neundorfer, & Hilz, 2003; Shi, Gallagher, Welch-O'Connor, & Foresman, 1996). Most recently, Fisher and colleagues (Fisher et al., 2010) used a variable pressure neck chamber technique to isolate the carotid baroreceptors. Using this technique, the authors examined the magnitude of the BP response to simulated hypotension (neck pressure) and simulated hypertension (neck suction). In agreement with the work of Studinger et al. (2009) noted above, the authors demonstrated a reduced BP response to hypotensive stimuli with neck pressure and an augmented BP response to hypertensive stimuli with neck suction in older individuals, providing further support that older subjects exhibit a reduced ability to respond to hypotensive stimuli and a greater ability to respond to hypertensive stimuli. In addition, the same group of investigators has demonstrated that the latency to peak BP and HR responses to neck suction were delayed in older humans (Fisher, Ogoh, et al., 2009). These data suggest that a slower response time may contribute to ABR impairments with aging; however, peak response latencies to neck pressure were similar between younger and older humans. Taken together, these data indicate that aged individuals have an impaired responsiveness to hypotensive stimuli and an increased latency (time) to peak BP/HR response to hypertensive stimuli. Reduced responsiveness to hypotensive stimuli may explain, at least in part, why orthostatic hypotension and syncope (i.e., fainting) are more prevalent in older adults. Furthermore, orthostatic hypotension, or an abnormally low BP within minutes following transition from sitting to standing, has been associated with greater risk for stroke (Eigenbrodt et al., 2000) and all-cause mortality (Masaki et al., 1998) in aged populations. However, to date, the role of an impaired ABR in the etiology of orthostatic hypotension with aging remains incompletely understood.

Due to the nature of the ABR, exercise-induced increases in BP should result in reflex-mediated reductions in HR; however, during exercise, there is an intensity-dependent increase in both BP and HR. This led to the early suggestion that the ABR was "turned off" during exercise and contributed very little to the pressor response induced by exercise (Mancia et al., 1978; Pickering, Gribbin, Petersen, Cunningham, & Sleight, 1972). Indeed, several investigators questioned the role of the ABR during exercise (Joyner, 2006; Raven, Potts, & Shi, 1997). However, subsequent investigations have convincingly reported that carotid baroreflex function is maintained during exercise and have demonstrated that the ABR resets to operate around the exercise-induced increase in BP (Melcher & Donald, 1981; Potts, Shi, & Raven, 1993). In fact, resetting of the ABR occurs in an exercise intensity-dependent manner. In young, healthy humans, the slope of the ABR does not change from rest to exercise, suggesting the sensitivity of the ABR is preserved during exercise (Potts et al., 1993; Raven et al., 1997). Additional evidence has demonstrated that the ABR interacts with other neural reflex arcs in the medulla oblongata of the brainstem, which contributes to ABR resetting. Indeed, central command and the exercise pressor reflex have been shown to contribute to resetting of the ABR during exercise (Gallagher et al., 2001; Iellamo, Legramante, Raimondi, & Peruzzi, 1997; McIlveen, Hayes, & Kaufman, 2001). For a comprehensive review of ABR resetting and experimental evidence supporting neural interaction between the ABR and other neural reflex arcs, see previously published reviews (Fadel & Raven, 2012; Fu & Levine, 2013; Michelini, O'Leary, Raven, & Nobrega, 2015).

Only a few studies have investigated ABR control of BP during exercise in older adults (Fisher et al., 2010; Lucini, Cerchiello, & Pagani, 2004). Fisher et al. (2010) demonstrated that a similar impairment found in resting ABR control persists during exercise, wherein aged subjects had a reduced responsiveness to hypotensive stimuli but an augmented responsiveness to hypertensive stimuli (Fig. 9.8). The balance between an impaired responsiveness to simulated hypotension, but exaggerated responsiveness to simulated hypertension, appears to lead to a maintained overall sensitivity of the ABR at rest and during exercise in older subjects. In addition, the ABR resetting that occurs in young humans during exercise was still present in older adults, but the magnitude of the resetting was augmented, resulting in the ABR resetting to operate around a greater BP. This suggests that alterations in neural reflexes responsible for ABR resetting (i.e., central command and exercise pressor reflex) may underlie this greater ABR resetting with aging. Furthermore, due to the greater ability of the ABR to respond to hypertensive stimuli in older adults, these data suggest that an impaired ABR control of BP does not likely underlie the exaggerated pressor responses during exercise reported in older subjects.

Effect of Aging on the Cardiopulmonary Baroreflex

The cardiopulmonary baroreflex (CPBR) regulates central blood volume (CBV) through modulation of the sympathetic nervous system. Low pressure baroreceptors within the great veins and pulmonary circulation sense changes in CBV, commonly denoted as filling pressure or "preload." Cardiopulmonary baroreceptors respond to changes in preload/filling pressure

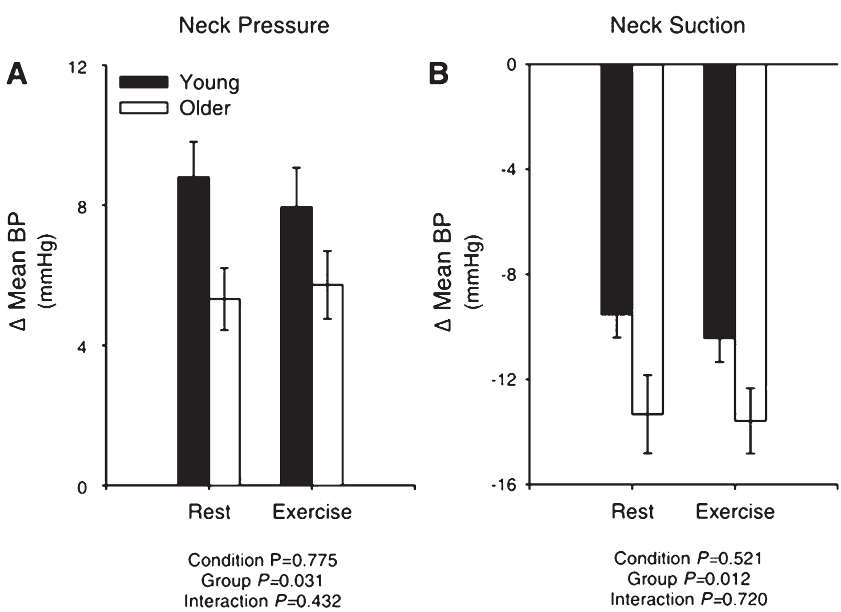

Fig. 9.8 Blood pressure (BP) responses to neck pressure (**a**) and neck suction (**b**) using the variable neck pressure technique at rest and during dynamic cycling exercise. These data demonstrate the reduced responsiveness to hypotensive stimuli (neck pressure) and augmented responsiveness to hypertensive stimuli (neck suction) in older subjects, both at rest and during exercise. Filled bars represent young subjects and open bars denote older subjects. (Adapted from Fisher et al. (2010) with permission)

such that increases in preload/filling pressure elicit reflex-mediated reductions in SNA, whereas a reduction in preload will evoke increases in sympathetic outflow. Investigations into resting CPBR function with age have yielded equivocal results (Cleroux et al., 1989; Davy, Seals, & Tanaka, 1998; Jingu, Takeshita, Imaizumi, Sakai, & Nakamura, 1989; Niimi, Iwase, Fu, Kamiya, & Mano, 2000; Shi et al., 1996; Tanaka, Davy, & Seals, 1999). Only a few of these studies have investigated CPBR control of sympathetic outflow directly, but it seems that CPBR control of MSNA is preserved in healthy-aged humans (Davy et al., 1998; Niimi et al., 2000; Tanaka et al., 1999). However, despite intact CPBR control of MSNA, these studies have documented reduced peripheral vasoconstriction in response to CPBR activation, which may suggest alterations in peripheral vasoconstrictor responsiveness to increased MSNA with age (Cleroux et al., 1989; Davy et al., 1998; Jingu et al., 1989).

During dynamic exercise, rhythmic skeletal muscle contraction facilitates the movement of blood from the venous circulation back to the heart (i.e., *skeletal muscle pump*), which results in an appreciable increase in venous return and, thus, preload. This would presumably activate the CPBR. Indeed, at mild to moderate intensity exercise, reductions in MSNA (Ray, Rea, Clary, & Mark, 1993; Saito, Tsukanaka, Yanagihara, & Mano, 1993) have been reported at the onset of exercise that have been attributed to the CPBR. However, as exercise intensity increases, this CPBR-mediated reduction in MSNA would be overcome by greater sympathetic drive from other neural mechanisms (i.e., central command and exercise pressor reflex), resulting in graded increases in MSNA. To our knowledge, no studies have directly examined the influence of aging on CPBR control of MSNA during exercise.

Effect of Aging on the Exercise Pressor Reflex

Afferent C fibers, arising from skeletal muscle, also elicit reflex-mediated increases in sympathetic outflow during exercise (termed the *exercise pressor reflex* [EPR]). The EPR has two afferent arms, named for the sensory stimuli that activate each arm of the reflex and provide neural afferent feedback to cardiovascular centers in the medulla oblongata. These afferent fibers sense changes in mechanical and metabolic stimuli (Coote, Hilton, & Perez-Gonzalez, 1971; McCloskey & Mitchell, 1972). The *mechanoreflex*, comprised primarily of group III afferent neurons, is activated when their receptors sense stretch and/or mechanical deformation. In contrast, the muscle *metaboreflex*, comprised primarily of group IV afferent neurons, is activated in response to accumulation of metabolic by-products produced by muscle contraction during exercise. At the onset of exercise, and during light-intensity exercise, there is relatively little muscle metaboreflex activation, compared to mechanoreflex activation. As exercise intensity increases, however, the influence of the muscle metaboreflex progressively increases, particularly during isometric exercise. However, it is important to note that some group III afferent fibers respond to metabolic changes, while some group IV afferent fibers respond to mechanical deformation. In addition, increasing metabolic by-products in the muscle interstitial space can enhance the sensitivity of both afferent fiber groups (i.e., sensitization) during exercise (Smith, Mitchell, & Garry, 2006).

The EPR plays little to no role in cardiovascular regulation under resting conditions. However, during exercise, the integration of EPR with other neural reflex arcs within the brainstem is integral for the cardiovascular adjustment to exercise. To date, only a few studies have investigated alterations in the EPR in older subjects. Two studies have reported on the isolation of the muscle metaboreflex in aging, with a period of post-exercise ischemia to trap metabolic products following the cessation of exercise. One study reported a blunted muscle metaboreflex control of MSNA (Houssiere et al., 2006), and the other reported no change in muscle metaboreflex control of MSNA with age (Greaney et al., 2013). In regard to mechanoreflex activation, electrically stimulated muscle contractions resulted in smaller BP responses in elderly humans (Carrington & White, 2002; White & Carrington, 1993), suggesting an attenuated muscle mechanoreflex in aged subjects. One study has investigated the EPR as a whole in older subjects, using graded ischemic handgrip. These investigators reported an attenuated EPR (Markel et al., 2003). Overall, the extent to which aging affects the EPR and its metabolic and mechanical afferents currently remains incompletely understood, and future research is needed to examine each arm of the EPR alone, and in concert, in older humans. Interestingly, there is one study that has examined the interaction between the muscle metaboreflex and the ABR in aging. This is important because the muscle metaboreflex can enhance the sensitivity for the ABR control of MSNA to assist in the regulation of blood pressure during high-intensity exercise (Ichinose et al., 2002, 2004; Ichinose & Nishiyasu, 2005). The findings from this study indicated that the interaction between the muscle metaboreflex and the ABR is intact in aged men (Greaney et al., 2013), suggesting that the muscle metaboreflex still has the ability to enhance the ABR control of MSNA in older subjects. This work infers that an overall intact central neural integration from these skeletal muscle afferents is maintained with aging, which is interesting given known changes in skeletal muscle with aging (e.g., fiber-type shifts, mitochondrial and enzymatic changes, sarcopenia; for review, see (Frontera, 2017; Marty, Liu, Samuel, Or, & Lane, 2017; Sebastian, Palacin, & Zorzano, 2017)).

Effect of Aging on Central Command

Central command is a feed-forward neural mechanism originating from higher brain centers, which directly activates centers in the medulla oblongata responsible for cardiovascular regulation. This occurs in parallel with skeletal muscle motor unit recruitment. Central command contributes to cardiovascular and hemodynamic regulation at the immediate onset of exercise and can even have cardiovascular effects such as increasing HR in the anticipation of exercise. As exercise continues, central command increases in relation to exercise intensity (Friedman, Johnson, Mitchell, & Secher, 1991; Goodwin, McCloskey, & Mitchell, 1972; Pawelczyk, Pawelczyk, Warberg, Mitchell, & Secher, 1997; Victor, Pryor, Secher, & Mitchell, 1989; Victor, Secher, Lyson, & Mitchell, 1995). Experimental evidence for central command in humans has been primarily limited to young healthy subjects, utilizing curare administration for partial neuromuscular blockade (Friedman et al., 1991; Pawelczyk et al., 1997; Victor et al., 1989; Victor et al., 1995). Partial neuromuscular blockade increases the amount of effort (i.e., central command) required to complete an action due to a greater demand for motor unit recruitment in order to maintain the same absolute workload. To our knowledge, central command has not been directly studied in older subjects, so the influence of aging on central command remains unclear.

Influence of Endurance Exercise Training on Autonomic Function

The protective cardiovascular effects of exercise training are well documented (Powers, Quindry, & Hamilton, 2004; Ross, Malone, & Florida-James, 2016; Wang, Li, Dong, Zhang, & Zhang, 2015). Several groups have investigated the autonomic changes associated with aerobic exercise training, as alterations in autonomic function with exercise training may be a putative mechanism for this cardioprotection. The prevailing body of literature has focused on the influence of exercise training on resting autonomic function, most likely because the vast majority of the literature supports the notion that improvements in autonomic function at rest are critical for cardiovascular health. As such, the focus of this section is confined solely to autonomic function at rest and does not necessarily represent autonomic function during exercise.

The vast majority of work supports an association between aerobic exercise training and increases in vagal tone (i.e., parasympathetic nerve activity) (Guiraud et al., 2013; Soares-Miranda et al., 2009; Tsai et al., 2006).

Importantly, both longitudinal and cross-sectional investigations suggest that cardiac baroreflex sensitivity, which is influenced heavily by vagal tone, is increased in older adults who are exercise-trained, compared to their sedentary counterparts (Davy, DeSouza, Jones, & Seals, 1998; Monahan et al., 2000; Okazaki et al., 2005). Taken together, these results represent an improvement in parasympathetic control and cardiac baroreflex sensitivity following exercise training in older adults.

The effect of exercise training on resting MSNA is less clear. In young humans, most (Cooke et al., 2002; Ray, 1999; Ray & Carter, 2010; Svedenhag, Wallin, Sundlof, & Henriksson, 1984), but not all (Grassi, Seravalle, Calhoun, & Mancia, 1994), studies have reported no change in MSNA following exercise training. In agreement, studies have reported no change in MSNA following aerobic exercise training in middle-aged subjects (Laterza et al., 2007; Roveda et al., 2003; Sheldahl, Ebert, Cox, & Tristani, 1994; Ueno et al., 2009). However, greater resting MSNA has been reported in older master athletes, compared to sedentary controls (Ng, Callister, Johnson, & Seals, 1994b). Whether the increased MSNA was a function of exercise training, or some other factor, remains incompletely understood. In contrast to the work in healthy subjects, the vast majority of investigations completed in disease populations report marked reductions in resting MSNA following aerobic exercise training. Studies in heart failure (Antunes-Correa et al., 2012; Fraga et al., 2007; Martinez et al., 2011; Roveda et al., 2003; Ueno et al., 2009) and hypertension (Laterza et al., 2007) patients both demonstrated substantial reductions in MSNA following aerobic exercise training, suggesting a role of exercise training in the treatment of resting sympathetic overactivity.

The influence of exercise training on ABR sensitivity has yielded equivocal results. One study reported that 12 weeks of endurance exercise training was insufficient to change sympathetic baroreflex sensitivity in an aged population (Sheldahl et al., 1994). However, the authors also demonstrated no improvement in cardiac baroreflex sensitivity, a training adaptation seen in the majority of other training studies performed in older adults. One plausible conclusion is that the exercise training stimulus was insufficient to elicit autonomic nervous system adaptations. In contrast, in untreated hypertension patients (Laterza et al., 2007) and in heart failure patients (Groehs et al., 2015; Martinez et al., 2011), exercise training was associated with improved sympathetic baroreflex sensitivity under resting conditions, suggesting that exercise training may play a role in preserving ABR control of sympathetic outflow in diseased populations.

Exercise training-induced changes in the CPBR, EPR, and central command are less clear. The authors are unaware of any studies in older adults investigating the influence of exercise training on these neural reflexes. Future studies might reasonably examine the influence of exercise training on each of these neural cardiovascular reflexes in isolation.

The Aging Vascular System

Thus far, we have discussed the impact of aging on the heart, as well as the sympathetic and parasympathetic nervous systems. This section will now discuss the impact of aging on the arterial vasculature (our body's "super highway" for delivering oxygen and nutrients to each organ). Given the strong association between aging and cardiovascular disease, few physiological systems have been as rigorously investigated as the arterial vasculature. As such, several key mechanisms have been identified which contribute to vascular dysfunction with age and have been reviewed in detail elsewhere (Hearon & Dinenno, 2016; Kovacic, Moreno, Nabel, Hachinski, & Fuster, 2011; Kovacic, Moreno, Hachinski, Nabel, & Fuster, 2011; Lacolley, Regnault, Segers, & Laurent, 2017; Seals, Desouza, Donato, & Tanaka, 2008; Seals, Jablonski, & Donato, 2011; Seals, Walker, Pierce, & Lesniewski, 2009; Wagenseil & Mecham, 2012; Wang & Bennett, 2012). Here, we will focus on vascular stiffening, endothelial dysfunction, and blunted alpha-adrenergic vascular responsiveness at rest and during exercise.

Vascular Stiffening

Vascular stiffening is the process wherein blood vessels lose their elastic properties and become less compliant. As stiffness increases, vessels become less capable of adapting to changes in blood flow and fluctuations in blood pressure, which leads to further declines in vascular health and function. While the exact mechanism for age-related vascular stiffness remains incompletely understood, vascular calcification and disruption of the collagen-elastin balance play important roles (Kovacic, Moreno, Nabel, et al., 2011; Wang & Bennett, 2012) (Fig. 9.9).

Under normal conditions, large blood vessels like the aorta are inherently "elastic." This elasticity allows the blood vessels to distend with each heartbeat (i.e., stroke volume), dampening velocity and pressure fluctuations and maintaining consistent unidirectional blood flow. The energy stored during this elastic phase also facilitates forward movement of blood during diastole, as the vessel recoils and pushes blood forward (Fig. 9.10). Vascular elasticity is predominantly mediated by the balance between *collagen* – a stiff scaffolding protein – and *elastin*, an elastic protein designed to facilitate the repetitive distention of the vessel. As illustrated in Fig. 9.9, aging is associated with a progressive shift in the collagen-elastin ratio, whereby elastin is degraded with age and collagen expression is increased (Jacob, 2003; Li, Froehlich, Galis, & Lakatta, 1999; O'Rourke & Hashimoto, 2007). Ultimately, this progressive shift in the collagen-elastin ratio leads to an increase in vascular resistance and arterial blood pressure (Kovacic, Moreno, Nabel, et al., 2011; Wagenseil & Mecham, 2012).

While increased vascular stiffness is itself a maladaptation, its effects contribute to further degradation of cardiovascular health. The resulting elevations in blood pressure are known to cause damage to the endothelial cells lining the lumen of blood vessels (Laurent & Boutouyrie, 2007), which is considered a crucial instigator of atherogenesis (Huynh et al., 2011). As vascular stiffness increases and cells sustain more

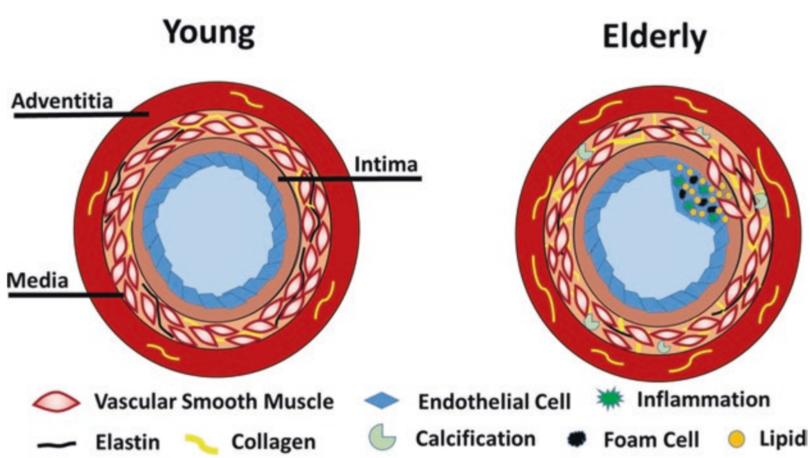

Fig. 9.9 Left: Schematic diagram of a healthy young artery, composed of three layers (adventitia, media, and intima) and endothelial cells lining the lumen wall. Collagen (yellow) is found in both the media and adventitia. Elastin is found throughout the media. Right: Note the changes observed with aging, including (1) atherosclerotic calcification, marked by endothelial lipid accumulation, foam cell accumulation, and inflammation; (2) arteriosclerosis, marked by transdifferentiation of endothelial cells into bone-like cells and calcification of the media; and (3) imbalance of the elastin-collagen ratio, favoring collagen deposition. Together, these age-related changes lead to plaque formation, luminal stenosis, and arterial stiffening

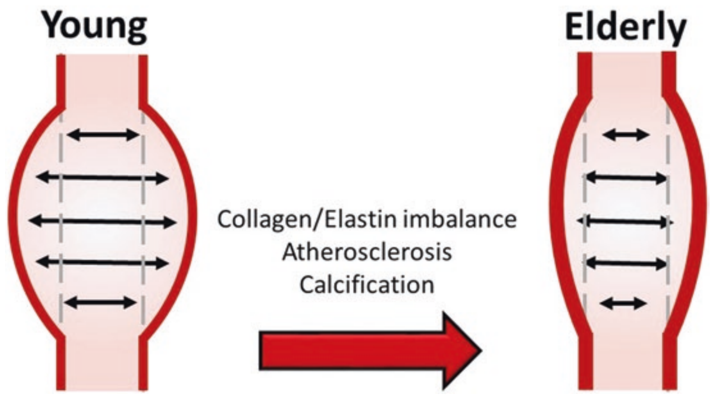

Fig. 9.10 In health, arteries are distensible, elastic, and adaptive to changes in blood pressure and blood flow. Age-related degradation in vascular health – including shifts in the collagen/elastin protein balance, development of atherosclerosis, and calcification of vascular smooth muscle – causes the vessels to become stiff and inelastic, rendering the arteries less capable of accommodating fluctuations in blood flow and blood pressure, contributing to vascular dysfunction and cardiovascular decline

damage, cell-to-cell junctions become compromised, increasing vascular wall permeability to LDL and immune cells (Kohn, Lampi, & Reinhart-King, 2015; Rafieian-Kopaei, Setorki, Doudi, Baradaran, & Nasri, 2014). As fatty deposits accumulate, transmigrated monocytes differentiate into macrophages, take in lipids, and eventually become foam cells (Fig. 9.9). In addition, vascular smooth muscle cells emigrate from the medial to the intimal layer of the arterial wall, where they will produce collagen and form a fibrous cap that stabilizes the growing plaque (Wang & Bennett, 2012). As these atherosclerotic plaques develop, they decrease the elasticity of the local vasculature, further degrading its natural functionality.

Age-related vascular stiffness also disrupts the balance between forward (anterograde) and backward (retrograde) flow, leading to increased oscillatory blood flow (which is another contributor to vascular calcification (Sorescu et al., 2003) and atherogenesis (Hwang et al., 2003)). Indeed, oscillatory blood flow increases signaling of bone morphogenetic protein-4 (BMP-4), a pro-inflammatory signaling molecule (Sorescu et al., 2003). This protein can then bind to activin-like kinase-2 (ALK2), stimulating endothelial-to-mesenchymal transition (EndMT), a phenomenon in which vascular endothelial cells revert to a stem-like cell state (Medici et al., 2010). Once this transition has occurred, these cells can then behave like osteoblasts and chondroblasts, calcifying the surrounding tissue (Abedin, Tintut, & Demer, 2004; Watson et al., 1994). This mechanism has been strongly implicated in the calcification of atherosclerotic plaques and mineralization of the tunica media, two key central features in cardiovascular disease (Golledge, McCann, Mangan, Lam, & Karan, 2004; Van Campenhout & Golledge, 2009).

Endothelial Dysfunction

The vascular *endothelium* – a thin monolayer of cells lining the inner lumen of all blood vessels – plays a vital role in regulating blood flow and vascular health through autocrine and paracrine signaling. In this section, we will focus on two of the most potent vasoactive substances produced by the endothelium: nitric oxide (NO), a powerful vasodilator, and endothelin-1 (ET-1), a strong vasoconstrictor.

Nitric oxide is a gaseous substance produced by three different enzymes: endothelial nitric oxide synthase (eNOS), neuronal nitric oxide synthase (nNOS), and inducible nitric oxide synthase (iNOS). As its name suggests, eNOS is expressed in endothelial cells and is activated by the movement of blood across the endothelium (i.e., *shear stress*). Once produced, NO diffuses out of the endothelium and activates guanylyl cyclase in the vascular smooth muscle to produce cyclic guanosine monophosphate (cGMP) and cause vasodilation (Fig. 9.11).

Some studies have reported a frank reduction in eNOS expression with age (Csiszar et al., 2002; Tanabe et al., 2003); however, this finding is not universal, with other studies showing eNOS expression is both increased or unchanged with age (Cernadas et al., 1998; Donato et al., 2009; Spier et al., 2004). Again, more research in this area is needed to fully elucidate the impact of age on eNOS expression. Nonetheless, aging does appear to decrease the responsiveness of the endothelium to shear stress, the major stimulus for eNOS production of NO (Sun, Huang, & Kaley, 2003). While the mechanism for this response is likely multifactorial, age-associated shifts in oscillatory blood flow likely contribute (Padilla et al., 2011). Finally, age is also associated with increased oxidative stress (Taddei et al., 2001), which can reduce overall NO bioavailability.

Endothelin-1 (ET-1) is a powerful vasoconstrictor formed by endothelin-converting enzyme (ECE) in endothelial cells and has been shown to be elevated with age (Donato et al., 2009). This potent peptide is then secreted to nearby vascular smooth muscle cells, where it binds to one of two surface receptor isoforms: ET_A or ET_B. Binding of ET_A receptors activates an internal G-protein system, resulting in the conversion of phosphatidylinositol bisphosphate (PIP_2) into inositol triphosphate (IP_3). This signaling molecule then stimulates the release of calcium from internal stores, leading to smooth muscle contraction (Emori et al., 1991) (Fig. 9.12). Exactly why ET-1 is elevated with age remains incompletely understood but is likely related to vascular calcification and atherosclerosis (described above), as well as reduced NO bioavailability. Indeed, ET-1 activity is inhibited by NO at multiple levels (Barrett-O'Keefe et al., 2015; Wray et al., 2007), including the binding of ET-1 to the vascular smooth muscle (VSM) cells (Bourque, Davidge, & Adams, 2011; Emori et al., 1991; Rapoport, 2014). Importantly, Wray et al. have shown that ET-1-mediated vasoconstriction is elevated during exercise in the elderly and thus may be responsible for impaired exercise hyperemia observed with age (Barrett-O'Keefe et al., 2015).

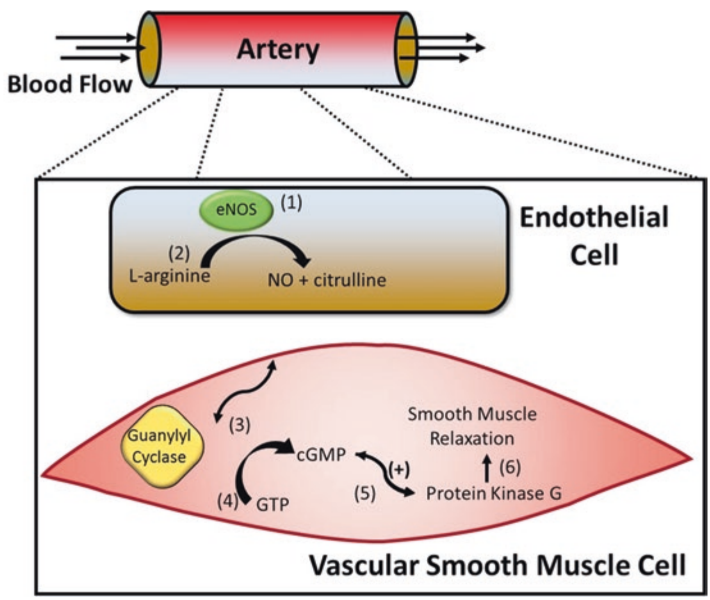

Fig. 9.11 (1) Endothelial nitric oxide synthase (eNOS) detects shear stress from blood flowing through the lumen of the vessel. (2) Activated eNOS converts L-arginine into nitric oxide (NO) and citrulline. (3) NO diffuses from the endothelial cell into the nearby vascular smooth muscle cell where it activates guanylyl cyclase, which (4) converts GTP into cyclic GMP. This second messenger then activates protein kinase G (5), which mediates vascular relaxation

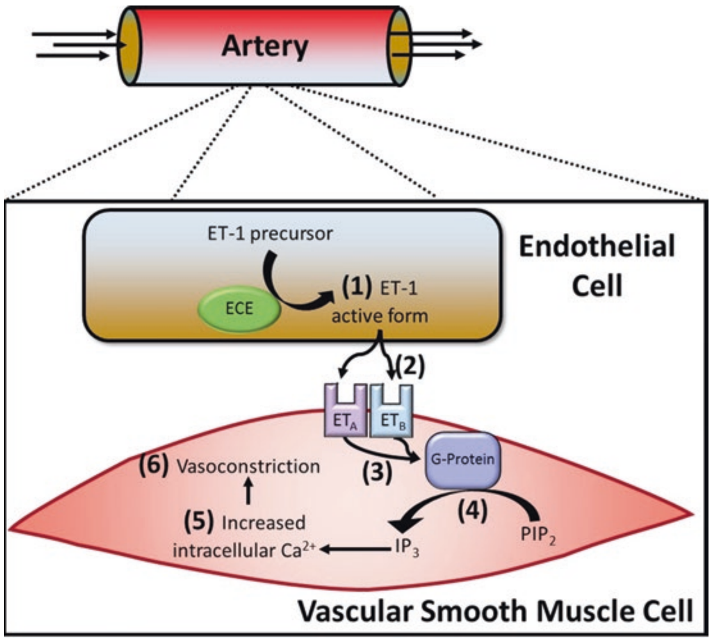

Fig. 9.12 (1) The inactive precursor of ET-1 is converted into the active, mature form of ET-1 by endothelin-converting enzyme (ECE). (2) Endothelin can then bind to ET-1 receptors (ET_A and ET_B). (3) These activate a G-protein cascade resulting in the conversion of PIP_2 into IP_3 (4) which then stimulates the release of calcium from intracellular stores (5). Rising intracellular calcium concentration leads to vascular smooth muscle contraction (i.e., vasoconstriction)

Alpha-Adrenergic Vascular Responsiveness

As introduced in the autonomic nervous system section of this chapter, resting MSNA increases with age. However, this elevation in resting sympathetic outflow does not appear to result in greater vasoconstrictor tone (Davy et al., 1998; Ng, Callister, Johnson, & Seals, 1993; Sundlof & Wallin, 1978). While this phenomenon remained debated for some time, it is now generally accepted that aging reduces postjunctional alpha-adrenergic responsiveness (Dinenno, Dietz, & Joyner, 2002; Handa & Duckles, 1987; Hogikyan & Supiano, 1994; Nielsen, Hasenkam, Pilegaard, Aalkjaer, & Mortensen, 1992). Importantly, the work of Davy and colleagues demonstrated that reflex control of MSNA is not impaired with age but, rather, older adults exhibit attenuated vasoconstrictor responsiveness to elevated MSNA compared to younger subjects (Davy et al., 1998).

During exercise, sympathetic outflow increases in an intensity-dependent manner (Clifford & Hellsten, 2004), causing vasoconstriction in both active and inactive vascular beds (including the exercising skeletal muscle). However, in order to maintain adequate perfusion to exercising muscles, this vasoconstrictor signal is attenuated through the synthesis and secretion of local vasodilating substances. This attenuation of sympathetic vasoconstriction in active skeletal muscle is termed *functional sympatholysis*. Failure to attenuate sympathetic vasoconstriction in active skeletal muscle results in functional muscle ischemia and has been implicated in exercise intolerance and myocellular damage (Nelson et al., 2014; Nelson et al., 2015). The exact substance responsible for attenuating sympathetic vasoconstriction remains debated, with ATP (Kirby, Voyles, Carlson, & Dinenno, 2008; McCullough, Collins, & Ellsworth, 1997; Rosenmeier, Yegutkin, & Gonzalez-Alonso, 2008; Winter & Dora, 2007), acetylcholine (Kurjiaka & Segal, 1995), and NO having all been implicated (Chavoshan et al., 2002; Hansen, Thomas, Harris, Parsons, & Victor, 1996; Nelson et al., 2014; Nelson et al., 2015; Sander et al., 2000; Thomas, Hansen, & Victor, 1994; Thomas, Shaul, Yuhanna, Froehner, & Adams, 2003; Thomas & Victor, 1998; Thomas, Zhang, & Victor, 2001) (Fig. 9.13).

Emerging evidence suggests that functional sympatholysis may be impaired with age (Hearon & Dinenno, 2016; Kirby, Crecelius, Voyles, &

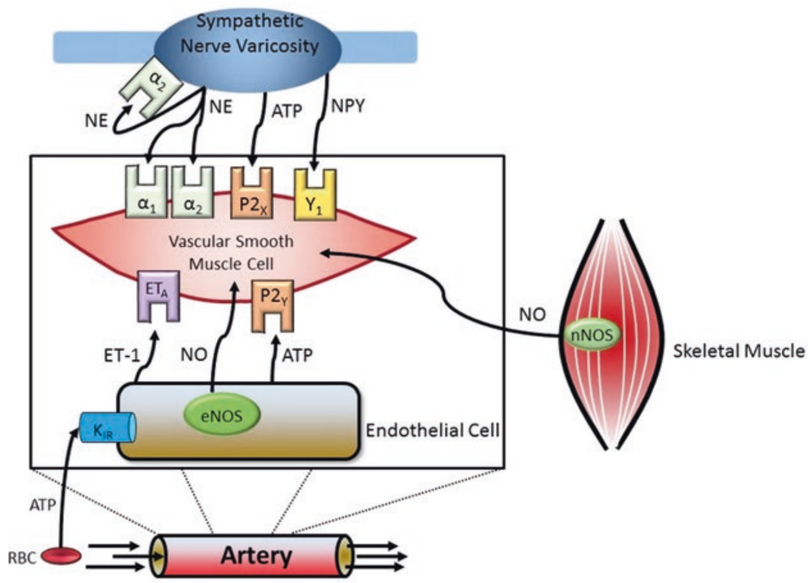

Fig. 9.13 Functional sympatholysis. Multiple mechanisms have been implicated in the exercise-mediated attenuation of alpha-adrenergic vasoconstriction. Adenosine triphosphate (ATP) release from the red blood cell remains heavily studied. Under this paradigm, ATP is released from the RBC during periods of low partial pressure of oxygen. The ATP causes endothelial hyperpolarization through activation of inward rectifying potassium channels (K_{IR}), leading to relaxation of vascular smooth muscle cells (i.e., vasodilation). Likewise, ATP can be released from the endothelium itself, which binds to P2Y receptors on vascular smooth muscle, causing vasodilation. Finally, nitric oxide (NO) is produced by both neuronal nitric oxide synthase in skeletal muscle and endothelial nitric oxide synthase in the endothelium, which can diffuse to the vascular smooth muscle to cause vasodilation

Dinenno, 2012; Saltin & Mortensen, 2012), although the exact mechanism responsible remains unclear. Several studies suggest greater sympathetic vasoconstrictor responsiveness with age, during exercise (Dinenno, Masuki, & Joyner, 2005; Fadel et al., 2004; Kirby, Crecelius, Voyles, & Dinenno, 2011; Koch, Leuenberger, & Proctor, 2003; Mortensen, Nyberg, Winding, & Saltin, 2012). While direct recordings of MSNA have been shown to be similar during exercise in both young and older humans (Greaney et al., 2013; Ng et al., 1994a), venous norepinephrine concentrations are increased to a greater extent during exercise in older adults (Taylor et al., 1992). Because absolute norepinephrine "spillover" into the bloodstream is not different between older and younger adults, impaired norepinephrine clearance has been implicated as a potential mechanism for the heightened vasoconstrictor responsiveness during exercise with age (Mazzeo et al., 1997). Impairments in local vasodilation may also contribute to functional muscle ischemia with age. As aging is associated with an elevation in oxidative stress, it is possible that overproduction of reactive oxygen species, and subsequent scavenging of NO, may be contributing to impaired functional sympatholysis (as seen in pathophysiological states (Price et al., 2013; Thomas et al., 2001; Zhao et al., 2006)). Likewise, age-associated reductions in plasma ATP and erythrocyte-mediated ATP release have been implicated (Kirby et al., 2012). More work in this area is still needed to define the exact mechanism(s) responsible for age-related impairments in functional sympatholysis.

Effect of Exercise Training on Vascular Function in Aging

The majority of work to date, evaluating the beneficial role of exercise training on vascular function in elderly individuals, has focused on aerobic training. Table 9.1 summarizes the available

Table 9.1 Effects of exercise on vascular function

Endothelial function		Effect	Min/day	Days/week	Period	Intensity	n = m/f	Age
Martin et al. (1990)	Aerobic	Increased calf vasodilatory capacity	30–60	3	16 weeks	70–90% 70–90% VO_{2max}	n = 13/13	60–72
DeSouza et al. (2000)	Aerobic	Preserved endothelium dependent vasodilation and improved forearm blood flow	30–45	3–4	3 months	70–75% HR_{max}	n = 12 m	22–35
							n = 24 m	50–76
Rinder et al. (2000)	Aerobic	Improved endothelium dependent vasodilation	–	–	–	–	n = 10 m endurance trained	68 ± 1.4
							n = 10 m sedentary	64.5 ± 2.3
Fujita et al. (2007)	Aerobic	Decreased plasma ET-1 and increased leg blood flow	45	1 bout	–	70% HR_{max}	n = 10/3	70 ± 2/68 ± 5
Maeda et al. (2009)	Aerobic	Decreased plasma ET-1	30–45	4–5	12 weeks	65–75% HR_{max}	n = 7 m	60 ± 3
Van Guilder et al. (2007)	Aerobic	Decreased ET-1 mediated vasoconstriction and improved foearm blood flow	40–50	5–7	3 months	65–75% HR_{max}	n = 13 m	26 ± 1
							n = 15 m	62 ± 2
Anton et al. (2006)	Resistance	No change in plasma ET-1	–	3	13 weeks	1 set × 75% of 1RM	n = 7/19	53 ± 2/52 ± 2
Maeda et al. (2006)	Resistance	Increased NO production	–	2	12 weeks	3 sets × 10RM	n = 11 m	60–67
Maeda et al. (2003)	Resistance	Decreased plasma ET-1	30	5	3 months	80% VT	n = 16 m	24 ± 1
							n = 16 m	31 ± 1
							n = 7 m	64 ± 1
Vascular stiffness								
Tanaka et al. (2000)	Aerobic	Improved central arterial compliance	25–45	3–6	3 months	60–75% HR_{max}	n = 20 m	53 ± 2
Tanaka et al. (1998)	Aerobic	Improved pulse-wave velocity	–	–	–	–	n = 25 f exercise trained	? 31–59
							n = 28 f sedentary	? 28–59
Seals et al. (2001)	Aerobic	No change in arterial stiffness	30–45	7	13 weeks	40–80% HR_{max}	n = 35 f	62–65
Vaitkevicius et al. (1993)	Aerobic	Improved pulse-wave velocity and carotid augmentation index	–	–	–	–	n = 14 m endurance trained	69 ± 2.5
							n = 96/60 sedentary	55 ± 17/53 ± 18
Functional sympatholysis								

Endothelial function		Effect	Min/day	Days/week	Period	Intensity	n = m/f	Age
Mortensen et al. (2012)	Aerobic (lifelong activity)	Preserved functional sympatholysis	–	–	–	–	n = 8 m young sedentary	23 ± 1
							n = 8 m aging sedentary	66 ± 2
							n = 8 m aging exercise trained	76 ± 3
Mortensen et al. (2014)	Aerobic (8-week training program)	Preserved functional sympatholysis	60	2–3	8 weeks	60–80% HR_{max}	n = 4/4 normotensive	46 ± 1
							n = 4/5 hypertensive	47 ± 2

literature in this area. Overall, aerobic exercise training improves vascular stiffness (Seals et al., 2001; Tanaka et al., 2000; Tanaka, DeSouza, & Seals, 1998; Vaitkevicius et al., 1993), endothelial function (DeSouza et al., 2000; Martin, Kohrt, Malley, Korte, & Stoltz, 1990; Rinder, Spina, & Ehsani, 2000), and functional sympatholysis (Mortensen et al., 2012; Mortensen et al., 2014). Several mechanisms likely contribute to the positive vascular changes observed with exercise training, including reductions in oxidative stress (increasing NO bioavailability) (Maeda et al., 2006), increased eNOS production (Tanabe et al., 2003), lower ET-1 production (Anton et al., 2006; Fujita et al., 2007; Maeda et al., 2003; Maeda et al., 2009; Van Guilder, Westby, Greiner, Stauffer, & DeSouza, 2007), and promotion of a positive collagen-elastin relationship (Tanaka et al., 2000). While direct evidence does not exist to support the latter claim, vascular stiffness is indeed improved with lifelong exercise, suggesting that exercise may attenuate the shift in elastin to collagen that occurs with advancing age.

Research to Practice Implications

Age is a primary risk factor for cardiovascular disease. Both exercise rehabilitation and lifelong exercise adherence/participation play an important role in mitigating age-related cardiovascular dysfunction. Indeed, participating in lifelong endurance exercise seems to abrogate age-related increases in left ventricular stiffness, while chronic exercise training (>2 years) appears to be an effective intervention for reversing age-related increases in ventricular stiffness. Likewise, both lifelong exercise and chronic exercise training increase vagal tone and cardiac baroreflex sensitivity. Also, resting MSNA (particularly in the presence of disease) can be reduced with chronic exercise training. There is also increasing evidence to support the role of exercise (either lifelong adherence or chronic training interventions) for improving vascular stiffness, endothelial function, and vascular control. Taken together, these data overwhelmingly support a role for exercise for both cardiovascular disease prevention and the treatment of cardiovascular disease/dysfunction.

Future Directions in Practice and Research

Throughout this chapter we have highlighted several knowledge gaps with respect to the aging cardiovascular system. For example, while it is well established that the aging heart has impaired systolic and diastolic function, the exact mechanism driving these impairments remains incompletely understood. Moreover, while we know that chronic (>2 years) exercise training improves left ventricular stiffness, the exact morphologic and/or cellular mechanisms contributing to this positive adaptation remain unclear. Likewise, much of our understanding of how age affects neural cardiovascular reflexes at rest, and during exercise, remains incomplete. It is important that we broaden our understanding in this area, as impairments in cardiovascular control are likely driving much of the disease risk in the aging population. Finally, while we seem to have a fairly strong understanding of how age impacts the vasculature at rest, we still do not understand several key mechanisms driving vascular dysregulation or how the potential imbalance between sympathetic vasoconstriction and metabolic vasodilation affects age-related alterations in exercise hyperemia. Accordingly, more work is needed to better understand each of these key areas.

Summary

Advancing age is major risk factor for cardiovascular morbidity and mortality, adversely affecting the cardiac, autonomic, and vascular systems. Cardiac aging is associated with progressive loss of cardiomyocytes with compensating mild hypertrophy, diffuse myocardial fibrosis, and conduction abnormalities that compromise both systolic and diastolic function. Aging is also associated with autonomic dysfunction, characterized by reduced vagal tone and increased sympathetic nerve activity at rest. Moreover, aging arteries become stiffer due to collagen and calcium deposition and fragmentation of the elastic fibers. Aging arteries also lose their vasoreactivity due to marked endothelial dysfunction, together with marked reductions in the bioavailability of key vasoactive substances (i.e., NO and ATP). Throughout this chapter, we have provided several examples and a detailed summary of how physical activity and exercise can attenuate age-related decline in cardiovascular function. In many sections of this chapter, we have also emphasized the great need for additional research in various important areas related to cardiovascular aging.

> Age is a major risk factor for cardiovascular diseases, not only because it prolongs exposure to several other cardiovascular risks, but also owing to intrinsic cardiac aging, which reduces cardiac functional reserve, predisposes the heart to stress and contributes to increased cardiovascular mortality in the elderly. (Dai & Rabinovitch, 2009)

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Cancer Rehabilitation in Geriatric Patients

10

Sarah Wittry, Diana Molinares, and Susan Maltser

Definition and Scope of Cancer Rehabilitation

Cancer rehabilitation is medical care integrated throughout the oncology care continuum and delivered by trained rehabilitation professionals to diagnose and treat patients' physical, psychological, and cognitive impairments. The goals of cancer rehabilitation are to restore function, reduce symptom burden, maximize independence, and improve quality of life in a medically complex population while decreasing caregiver burden and honoring patient-centered care and shared decision-making (Cheville, 2017; Parry, Kent, Mariotto, Alfano, & Rowland, 2011). Given the physiologic changes of aging, older cancer survivors are particularly vulnerable to developing short- and long-term disabilities when stressed with cancer burden and treatments (Stubblefield, Schmitz, & Ness, 2013). Cancer-related functional impairments and their associated economic burdens are likely to continue to increase in the coming decades (Cheville, 2017). By forming dynamic and clinically appropriate goals with patients and their families, health-related outcomes can be improved.

Epidemiology of Cancer Rehabilitation in Older Adults

Cancer rehabilitation is becoming an increasingly relevant public health issue as the mean patient age and overall survivorship continue to increase. Currently, there are approximately 15.5 million cancer survivors in the United States, estimated to approach 20 million in the next decade (Chang et al., 2004). By 2020, about three-quarters of cancer survivors may be age 65 or older. Older cancer survivors have more multimorbidities, premorbid disability, and cancer treatment-related toxicities (Silver, Baima, & Mayer, 2013). There is a high prevalence of physical impairments and disability among cancer survivors, with 53% reporting limitations in their daily functioning (Silver et al., 2013). Rates of physical impairments increase among patients with metastatic cancer. Physical impairments increase healthcare

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utilization and reduce quality of life and participation in family, work, and society (Silver et al., 2017).

Despite the high prevalence of disabilities related to cancer, adequate treatment of stated impairments has been estimated as low as 1–2% (Cheville, 2017). Physiatrists are in an ideal position to be the champions of cancer rehabilitation efforts. Rehabilitation interventions range from simple educational activities to complex and integrated programs that include diagnostic, pharmacologic, manual, and procedural interventions (Stubblefield et al., 2013).

Misconceptions exist regarding the nature of rehabilitation for oncology patients. Patients and/or providers may believe exercise is inappropriate or not feasible for cancer patients or that certain conditions such as cytopenias and bony metastatic disease are contraindications to all rehabilitation interventions. Such attitudes likely contribute to underutilizing rehabilitation in long-term survivors, patients with advanced disease, and geriatric cancer patients (Stubblefield et al., 2013). There is a paucity of research on effectiveness of cancer rehabilitation in patients with advanced disease or at end of life. Tools to help more accurately prognosticate life expectancy and improve communication among oncologists and rehabilitation team members are greatly needed.

Cancer Rehabilitation Care Delivery Models and Financial Considerations

Cancer rehabilitation can improve patients' functional status at any point during the treatment of cancer, from diagnosis until end of life. Multiple model systems have been established to offer patients the services that they need at different stages of their disease. Cancer rehabilitation services range from prehabilitation, prior to treatment, maintenance programs, and palliative care services (Table 10.1).

Prehabilitation

Rehabilitation services can be started as soon as the diagnosis of cancer is made. At that point, the focus of the rehabilitation process is to determine any premorbid functional impairment as well as to identify risk factors that could result in future functional deficits. Additionally, rehabilitation services at the time of diagnosis can improve patients' ability to tolerate oncologic treatment. These concepts are fundamental elements of cancer prehabilitation, which is defined as "[A] process on the cancer continuum of care that occurs between the time of cancer diagnosis and the beginning of acute treatment and includes physical and psychological assessments that establish a baseline functional level, identify impairments, and provide interventions that promote physical and psychological health to reduce the incidence and/or severity of future impairments"(Silver et al., 2013, p. 716).

Prehabilitation programs have shown to improve mortality and functional outcomes while reducing the hospital stay and postoperative complications (Silver et al., 2013). The financial impact that prehabilitation programs have in the care of cancer patients lies in their ability to improve patient's functional reserve. Moreover, cancer prehabilitation promotes strategies to reduce anxiety and psychological stress. A combination of functional and psychological optimization prior to surgery results in decreased length of stay and readmissions and therefore reductions in costs (Silver et al., 2013).

Acute Hospitalization/Rehabilitation Consultation

Since the majority of cancer survivors are hospitalized at some point after their diagnosis, utilizing hospital-based systems to detect and treat disability can work well as a basic care model. However, hospital-based teams are usually focused on acute injuries with new major

Table 10.1 Cancer rehab delivery care models

Care model	Timing	Challenges/barriers
Prehabilitation	Prior to the start of oncologic treatment	Patient adherence Scheduling with oncologic treatment
Acute hospitalization/ rehabilitation consultation	During hospitalization (after surgery or medical complications)	Patient ability to tolerate therapy Ongoing oncologic treatment
Acute inpatient rehabilitation	After acute hospitalization	Timing in relationship with oncologic treatment Patient tolerance Insurance approval
Subacute rehabilitation	After acute hospitalization or acute inpatient rehabilitation	Timing in relationship with oncologic treatment
Home healthcare	At any point during or after oncologic treatment	Lack of standardization
Outpatient therapy rehabilitation	At any point before, during or after oncologic treatment	Patient access to outpatient services Tolerance to treatment Medical appointment burden
Home exercise programs	At any point before, during or after oncologic treatment	Adherence to the program Patient tolerance Patient ability to learn an exercise program
Palliative rehabilitation	At any point during or after the oncologic treatment	Delay in referrals Polypharmacy Pain Changes in level of consciousness

Barawid, Covarrubias, Tribuzio, and Liao (2015), Berger et al. (2010), Brady, Roe, O'Brien, Boaz, and Shaw (2017), Buffart et al. (2015), Cheville, Kornblith, and Basford (2011)

physical impairments, while cancer patients often exhibit insidious disability and accumulate mild to moderate physical impairments over time that eventually overwhelm their reserves and ability to compensate (Cheville et al., 2011). Appropriate screening of patients to identify functional impairments in the acute care hospital should prompt physical and occupational therapy referrals to minimize functional decline. In addition, using psychiatric consultation services can help guide the patients' rehabilitation planning.

Acute Inpatient Rehabilitation

Older patients who undergo cancer treatment are at high risk for developing functional impairments, especially those that undergo surgery. Functional impairments after hospitalization can result in worsening quality of life, increased burden for caregivers, and higher risk of readmission/complications. Patients with moderate to severe functional impairments, good family support, and tolerance to participation in 3 h of therapy per day are potential good candidates for acute inpatient rehabilitation (AIR). Multiple studies have shown that cancer patients that undergo AIR have equivalent functional gains and length of stay (sometimes even shorter) than those that have similar non-cancer-induced disability (Fortin, Voth, Jaglal, & Craven, n.d.; Greenberg, Treger, & Ring, n.d.; Hunter & Baltisberger, n.d.). AIR has the potential of decreasing the financial burden for patients, families, and healthcare companies. By improving the patient's independence level, there is potential for decreasing or avoiding the need of 24/7 healthcare aide or caregiver assistance.

Subacute Rehabilitation

Subacute inpatient rehabilitation centers, also known as skilled nursing facilities (SNFs), are another alternative available to patients with moderate to severe deficits that can benefit from a rehabilitation program but that are too deconditioned to be able to tolerate the intensity of AIR programs or that may require longer inpatient rehabilitation time. Currently, there are no dedicated SNF cancer rehabilitation programs; however, this is an area of potential growth.

Home Healthcare

Home health-based rehabilitation programs are ideal for patients with limited access to transportation or who are too debilitated to attend outpatient rehabilitation sessions. Similar to the case of SNFs, currently there are no dedicated home health cancer rehabilitation programs, except for home-based hospice programs. Nevertheless, home health programs are a common rehabilitation model used for patients with a large variety of disabilities that has demonstrated improvement in patients' functional status. Approximately 39% of Medicare patients that were hospitalized required home health services upon discharge (Greysen, Stijacic Cenzer, Boscardin, & Covinsky, 2017). Comparable with other rehabilitation services, home health rehabilitation program costs are directly proportional to the patient impairment levels.

Outpatient Rehabilitation

Ambulatory services can be useful in the cancer population at any point. From diagnosis through survivorship, outpatient rehabilitation programs have historically been the most common form of delivery of cancer rehabilitation services. Ambulatory services include physical, occupational, and speech therapy; psychology; exercise physiology; and supportive services (massage therapy, recreational therapy, etc.). Rehabilitation physicians are specifically trained to identify patients' needs, prescribe appropriate therapy, and oversee their progress (Fried et al., 2001). Some examples of ambulatory rehabilitation interventions include treatment of shoulder pain and lymphedema in breast cancer patients, speech and swallowing therapy in the head and neck of cancer patients following radiation, hand therapy for patients with chemotherapy-induced peripheral neuropathy, and cognitive therapy for patients with brain tumors (Cnossen et al., 2017; Khan, Amatya, Pallant, Rajapaksa, & Brand, 2012).

Home Exercise Programs

Home exercise programs (HEP) can be used at any stage of rehabilitation treatment. They could be part of the prehabilitation program or used to target specific impairments during and after the oncologic treatment phase, including maintenance programs during surveillance. They are likely the most cost-effective programs as patients only require a few sessions of therapy to ensure understanding and correct performance of these exercises. Home exercise programs rely deeply on the patient's capacity to retain new knowledge, perform the instructed exercises correctly, and be compliant and motivated. Therefore, patients with moderate to severe cognitive impairments and poor motivation are not ideal candidates for this type of rehabilitation program (Baima, Omer, Varlotto, & Yunus, 2017). In a recent Cochrane systematic review, multidimensional home-based survivorship programs were found to improve patients' quality of life while reducing the anxiety, fatigue, and insomnia in breast cancer survivors. The programs included psychological and physical exercises with good adherence and clinically significant outcomes. Some of the exercise programs included muscle stretching, core exercises, and aquatic exercises (Cheng, Lim, Koh, & Tam, 2017).

Interdisciplinary Team Roles

Given the relatively new concept of cancer rehabilitation, the role of interdisciplinary care team members can be ambiguous and is still being established. Physiatrists are poised to play a vital leadership role given their capabilities in diagnostic, educational, prescriptive, and advocacy roles (Cheville, 2017). In addition, physical, occupational, speech therapists, exercise physiologists, psychologists, nurses, and athletic trainers may play a role in the care of cancer patients and survivors. The specific delivery systems are currently institution-specific. Ideally, a comprehensive functional assessment is performed prior to initiating any cancer-directed intervention, in order to improve performance outcomes during and after treatment (Swartz et al., 2017).

Stages of Cancer Rehabilitation

Setting goals within cancer rehabilitation is a challenging, dynamic process that requires consideration of many factors. Such factors include patient age, comorbidities, type and stage of cancer, baseline physical function, and socioeconomic background. During a cancer survivors' entirety of experience, distinct stages can be identified as times that should trigger an updated evaluation of possible or anticipated deficits and functional goals. Four stages of cancer rehabilitation have been proposed by Dietz which include preventative, restorative, supportive, and palliative (see Table 10.2) (Gerber et al., 2017).

Overview of Disabilities Related to Cancer

Cancer-Related Fatigue

The National Comprehensive Cancer Network defines cancer-related fatigue (CRF) as "a distressing persistent, subjective sense of physical, emotional, and/or cognitive tiredness or exhaustion related to cancer or cancer treatment that is not proportional to recent activity and interferes with usual functioning" (Berger et al., 2010, p. 912). CRF is the most common symptom reported by cancer patients and survivors, which significantly impacts all aspects of quality of life and causes alterations in daily routine (Rao & Cohen, 2008). It is estimated that 70% of elderly cancer patients experience fatigue, which is associated with decreased adherence to cancer treatment (Rao & Cohen, 2008). One-third of patients still report clinically significant fatigue, even 6 years after completing treatment. Aging and concomitant frailty may predispose to symptomatic fatigue, but only a few studies have specifically assessed the impact of fatigue in the geriatric population (Rao & Cohen, 2008). Symptom burden, comorbidities, and depression are associated with the prevalence of CRF (Giacalone et al., 2013). Early recognition and thorough evaluation of fatigue and evaluation of other causes such as anemia, sleep disturbance, and mood disorders are important initial steps in management. Many pharmacologic agents to improve CRF have been studied. Methylphenidate has shown improvement on fatigue scales but may cause restlessness and insomnia. Donepezil has been studied in non-anemic patients with CRF and showed an insignificant improvement in fatigue intensity compared to placebo (Jones et al., 2016). Exercise programs are still the most widely studied and prescribed nonpharmacologic intervention for cancer-related fatigue (Jones et al., 2016). In a 2012 Cochrane review of 56 randomized controlled trials, exercise interventions were statistically more effective than control groups for CRF (Cramp & Byron-Daniel, 2012). According to American Society of Clinical Oncology CRF guidelines, cancer survivors were suggested to participate in 150 min of moderate aerobic exercise and two to three strength training sessions every week. Walking programs are the most common exercise intervention recommended for cancer survivors (Berger et al., 2010). Improving sleep disturbances, psychosocial interventions, and energy conservation education are an important part of treatment plans as well.

Table 10.2 Stages of cancer rehabilitation

Stage	Definition/goals	Example(s)
Preventative	Start soon after diagnosis, prior to beginning treatments Prevent impairments, return to baseline function if possible	Identify baseline function and impairments Prehabilitation Education/anticipatory guidance regarding cancer-related fatigue, chemotherapy-induced neurotoxicity, etc.
Restorative	Maximize functional recovery in patients with identified impairments in function and abilities	Shoulder physical therapy after mastectomy Aerobic exercise program after bone marrow transplantation
Supportive	Maximize function after patients sustain permanent impairments from cancer or its treatment Increase mobility and self-care abilities	Acute inpatient rehabilitation for hemiplegia after brain tumor surgery Cognitive rehabilitation after brain tumor resection or whole brain radiation Range of motion exercises, home exercise programs for maintenance Complete decompressive therapy for lymphedema
Palliative	Optimize quality of life in patients with terminal disease, reduce dependence in mobility and self-care, preserve dignity	Modalities including positioning, heat/cryotherapy, prescribing assistive devices and durable medical equipment, caregiver education, training, and support

Broadwell (1987), Cheville et al. (2011), Debes, Aissou, and Beaussier (2014), Silver and Baima (2013)

Pain Management in Elderly Patients

Effective pain management in geriatric populations can be challenging. Elderly patients and their caregivers may expect pain to be part of the aging process and therefore not report pain to healthcare professionals. Other barriers to reporting may be cognitive impairment, slowness to respond, concern about loss of independent living, caregiver burden, and language barriers (Delgado-Guay & Bruera, 2008). Pain in older cancer patients may be undertreated given concerns about polypharmacy, toxicities, and atypical manifestations of pain. A multidisciplinary team using both pharmacologic and nonpharmacologic approaches to pain management is often the most effective approach (Delgado-Guay & Bruera, 2008). An initial detailed assessment of pain, including history and physical exam, is instrumental to an effective treatment plan. Understanding the etiology of pain, extent of cancer, and specific treatment plans, as well as goals of care regarding pain management, is essential (American Pain Society, 2008). A multitude of specific cancer pain syndromes have been identified (see Table 10.3).

The "WHO analgesic ladder" approach, published in the 1980s, provides a basic framework of pain management for patients with active cancer and includes acetaminophen, nonsteroidal anti-inflammatories for mild pain, and advancing to opioids for moderate to severe pain (WHO, n.d.). Adjuvant analgesics, as well as interventional, rehabilitation, psychological, and integrative approaches to pain control are now included in guidelines. Opioids are often under prescribed to older adults with malignant pain (AGS Panel on Persistent Pain in Older Persons, 2002). In a recent cross-sectional study of 244 patients with advanced cancer, older age was associated with a lower likelihood of receiving an opioid prescription, more comorbidities, and poorer functional status (Gauthier et al., 2017). In older patients, urinary retention and fecal impaction may be more problematic side effects (AGS Panel on Persistent Pain in Older Persons, 2002). The American Geriatrics Society recommends beginning with 30–50% of the recommended starting dose for younger adults when prescribing opioids to elderly adults (AGS Panel on Persistent Pain in Older Persons, 2002). For patients with neuropathic pain components, agents such as gabapentin, pregabalin, and topical lidocaine can also be considered. Physical modalities including heat, cryotherapy, laser, manual therapy, and electrotherapeutic modalities can be used as adjunctive therapies to decrease pain. Indications, precautions, and

Table 10.3 Cancer pain syndromes

Pain syndrome	Description	Possible treatments
Pathologic fracture	Fracture within preexisting lesion (metastasis) or primary tumor	Surgical stabilization (long bone), vertebroplasty/kyphoplasty, radiation treatment
Obstruction/perforation of viscus	Obstruction of bile duct, ureter, or bowel lumen by intra-abdominal or pelvic cancer	Percutaneous decompression, stenting, surgery
Neoplastic spinal cord compression	Acute to subacute onset of back pain and/or weakness, bowel/bladder changes	Corticosteroids, surgical decompression, adjuvant radiation therapy
Radiation plexopathy	Pain, paresthesias, weakness in affected distribution (brachial or lumbosacral)	Physical therapy, modalities, neuropathic pain agents
Bone metastases	Metastatic spread of variety of primary tumors, direct nociceptor activation	External beam radiation therapy (effective 80–90% cases), NSAIDs, bisphosphonates
Hepatic distention syndrome	Stretching of capsule by primary tumor or metastases causing dull, subcostal pain that may radiate to the right shoulder	Pharmacologic pain agents, systemic cancer therapy
Leptomeningeal metastases	Can present as headache, nonspecific pain, variety of neurologic complications (motor, sensory, cognitive)	Intrathecal therapy, adjuvant pharmacologic pain agents
Radiculopathies	Malignant process that compresses, distorts, and inflames nerve roots causing pain, paresthesias, weakness in radicular distribution	Neuropathic pain agents, physical therapy
Painful peripheral mononeuropathies	Could cause malignant intercostal neuropathy from chest wall tumor	Neuropathic pain agents, therapy
Painful gynecomastia	Develops in men with prostate cancer receiving antiandrogens alone	Prophylactic radiation therapy
Postmastectomy pain syndrome	Persistent pain after any breast surgery; multiple possible etiologies. Dull, burning, and aching pain experienced over the axilla, anterior chest wall, and medial upper arm, associated with sensory loss	Rehab, neuropathic pain agents, interventional pain procedures
Phantom limb pain	Following amputation	Desensitization therapy, mirror therapy, neuropathic pain agents
Post-thoracotomy pain syndrome	Neuropathic pain localized to the region of the thoracotomy scar, experienced months post-surgery	Assess for tumor recurrence, therapies, desensitization, neuropathic pain agents

Halbert, Crotty, and Cameron (n.d.), Mercadante (1997), Paice et al. (2016), Taillibert et al. (2005)

contraindications for various modalities are important considerations (see Table 10.4) (Maltser, Cristian, Silver, Morris, & Stout, 2017). In a study of 274 cancer survivors with cancer-related pain, improvement in pain severity over time was predictive of less disability in 12 months. Thus, effective pain management strategies may decrease chronic disability among cancer survivors (Wang et al., 2011). Overall, treatment of pain in elderly cancer patients can be challenging, and a multidisciplinary approach with the goal to decrease the suffering of the patient and improve quality of life should be key treatment goals.

Chemotherapy-Induced Neurotoxicity

Chemotherapy-induced peripheral neuropathy (CIPN) is a well-known complication of taxane- and platinum-based chemotherapy agents. Sensory abnormalities typically begin in lower extremities, progress to a stocking-glove pattern, and may worsen with subsequent cycles of chemotherapy. Motor involvement leading to weakness can be seen as well. Long-term impacts on proprioception and sensation negatively impact gait, balance, and mobility years after completing treatment (Maltser et al., 2017). Changes in sen-

Table 10.4 Modalities, indications, precautions, contraindications

Modality	Indications	Precautions	Contraindications
Heat	Pain relief, muscle relaxation, tissue extensibility	Impaired lymphatic function, scar tissue	Unmanaged tumor/active disease, peripheral vascular disease, severely impaired sensation, irradiated tissue
Ultrasound	Tissue extensibility, inflammation, pain relief	Impaired sensation, open wounds or skin fragility	Active cancer or history of cancer
Cryotherapy	Acute management of inflammation, pain relief, hair loss management	Impaired sensation, open wounds or skin fragility	Ischemic tissue, peripheral vascular disease, Raynaud syndrome
Transcutaneous electrical nerve stimulation	Sensory pain management, scar desensitization	Insensate tissue	Unmanaged tumor/active disease, over pacemaker, open wounds
Manual therapy	Pain relief, joint mobility, tissue extensibility, soft tissue and radiation fibrosis management, lymphatic stimulation	Impaired sensation, open wounds or skin fragility, dysvascular tissue	Acute radiation dermatitis, unmanaged tumor/active disease, bone fragility due to metastasis or osteoporosis
Spinal manipulation	Spinal mobility and alignment, pain relief	Open wounds or skin fragility	Bone fragility due to metastasis or osteoporosis, radiculopathy, spinal stenosis, myelopathy, spinal cord compromise from tumor or lesion

Maltser et al. (2017)

sation and proprioception can be particularly significant in elderly patients with prior history of diabetic or other genetic or acquired neuropathies. The incidence of diabetes increases with age, with the highest rate in people over 65 years old. Hershman et al. (2016) studied the risks and comorbidities of chemotherapy-induced peripheral neuropathy (CIPN), finding that age and history of diabetes were independent predictors of the development of CIPN. Elderly patients are already at an increased risk of falls, and fall risk is two to three times greater in those with a history of receiving neurotoxic chemotherapy agents (Winters-Stone et al., 2017). Interval assessments for the development of CIPN by oncology teams are critical. Rehabilitation interventions may include PT for strengthening, balance, and gait training and occupational hand therapy and activities of daily living (ADL) modifications. Bracing devices can maintain safety and skin integrity and should be considered by rehabilitation providers. Management of associated neuropathic pain with agents such as gabapentin, pregabalin, and duloxetine may also be indicated (Winters-Stone et al., 2017).

Frailty

Frailty is a clinical syndrome found in people over the age of 65, with a loss of physiologic reserve due to decreased physiological capacity, weakness, weight loss, slow walking speed, self-reported exhaustion, and low physical activity (Fried et al., 2001; Winters-Stone, Bennett, & Mick, 2015). This syndrome occurs disproportionately in patients older than 70 years of age diagnosed with cancer, affecting over half of the population (Winters-Stone et al., 2015). Comprehensive geriatric assessments may be useful to stratify patients into low- versus high-risk categories to help predict their tolerance to anticancer treatment and risk of side effects from chemotherapy (Freiberger, Kemmler, Siegrist, & Sieber, 2016). The Karnofsky Performance Scale (KPS) is a measure of functional capacity. It has consistently been found to predict survival in cancer patients, and is often used as a scale to assess appropriateness for further anticancer therapy or clinical trials (see Table 10.5) (Amano et al., 2015; Raj, Silver, Pugh, & Fu, 2017). Geriatric tools such as the Modified Geriatric

Table 10.5 Karnofsky Performance Scale (KPS)

100	Normal; no complaints; no evidence of disease
90	Able to carry on normal activity; minor signs or symptoms of disease
80	Normal activity with effort; some signs or symptoms of disease
70	Cares for self; unable to carry on normal activity or to do active work
60	Requires occasional assistance but is able to care for most personal needs
50	Requires considerable assistance and frequent medical care
40	Disabled; requires special care and assistance
30	Severely disabled; hospitalization is indicated, although death not imminent
20	Very sick; hospitalization necessary; active support treatment is necessary
10	Moribund; fatal processes
0	Dead

Raj et al. (2017)

Assessment (MGA) identified more elderly cancer patients with frailty than oncologists' assessment using the onc-frail method (Kirkhus et al., 2017). Exercise interventions including functional and balance training have been shown to be effective in improving functional performance, ADLs, and quality of life in frail, institutionalized adults (Weening-Dijksterhuis, de Greef, Scherder, Slaets, & van der Schans, 2011).

A systematic review by Weening-Dijksterhuis et al. (2011) found a positive impact of a training program that includes progressive resistance, balance, and functional training for the prevention and treatment of frailty in elderly cancer patients. Progressive resistance training (PRT) has been found to be one of the most effective exercise programs to increase muscle strength while improving cardiovascular disease risk factors in the elderly population (Sousa, Mendes, Monteiro, & Abrantes, 2014).

Advanced Cancer Burden

In 2016, nearly 1.7 million new cancer cases were diagnosed, and an estimated 20–50% will experience a metastatic recurrence, and 596,000 will die from their disease (Amano et al., 2015). Patients with advanced cancer often have significant functional impairments, leading to psychological distress, disability, and increased reliance on caregivers (Pergolotti, Deal, Lavery, Reeve, & Muss, 2015). Cachexia and sarcopenia are common in advanced cancer and have implications for exercise tolerance and prescription. Exercise may cause further functional decline in patients with cachexia without appropriate protein and energy balance (Hopkinson, 2015). Neurologic structures can be affected by primary and metastatic disease or treatment, and new changes may be the presenting signs of metastatic disease. Changes in cognition, speech, memory, personality, sensorimotor, and autonomic dysfunction should all be investigated (Raj et al., 2017). Home modifications, appropriate adaptive equipment evaluations, and prescriptions should be an important part of the rehabilitation plan for elderly patients with advanced cancer, to reduce fall risk and improve home and community safety. Collaboration with palliative care teams to address the physical and psychological symptoms as well as spiritual and existential needs is paramount to high-quality supportive cancer care (Raj et al., 2017).

Neurologic Compromise in Cancer Patients

Brain Tumors

Brain tumors can produce long-term disability due to the tumor itself, the effects of

surgical treatments, as well as the neurotoxic effects of radiation therapy and chemotherapy (Vargo, 2011). The incidence of all primary central nervous system tumors is 20.6 cases per 100,000 individuals, with the greatest incidence among patients aged 75 and older (Flowers, n.d.). The most common diagnosis of brain cancer is metastatic; this is a result of the increase in overall primary cancer survival and advanced techniques for early detection (Khuntia, 2015). The most common primary malignancies to metastasize to the brain are the breast, lung, and melanoma (Posner, 1992). Signs and symptoms of brain tumors depend on the location of the tumor, with the majority of tumors in the elderly developing in the cerebral hemispheres. Advanced age and poor functional status at diagnosis are associated with a poorer prognosis (Buckner, 2003). Common rehabilitation impairments include gait dysfunction, hemiparesis, cognitive and behavioral deficits, dysphagia, and aphasia. There is evidence for the utilization of inpatient rehabilitation services for patients with brain tumors, with functional outcomes comparable to patients with stroke and traumatic brain injury. There are several factors that differentiate brain tumor patients from those with stroke, multiple sclerosis, and traumatic brain injury, including disease progression, as well as effects of chemotherapy and radiation therapy (Greenberg et al., n.d.).

Dysphagia

Dysphagia is an often less thought of complication in elderly cancer patients that impacts quality of life and function. Many types of dysphagia are amenable to speech and language pathology evaluation and treatment interventions. The incidence of dysphagia has found to be similar in brain tumor and stroke patients. Those with infratentorial lesions had a higher prevalence of dysphagia compared to those with supratentorial lesions, but no significant differences were found between benign and malignant brain tumor patients (Park, Chun, Lee, & Song, 2013).

Dysphagia is also common in advanced lung cancer due to nerve compression or direct tumor invasion. Dysphagia in advanced lung cancer patients was found to have a prevalence of nearly 20% in one recent study. Dysphagia resulted in increased fatigue, duration of meal times, decreased desire to eat, and reduced quality of life (Brady et al., 2017).

Cognitive Dysfunction

Chemotherapy-related cognitive impairment is becoming more recognized as a complication that can persist for months to years after treatment completion (Vega, Dumas, & Newhouse, 2017). This is particularly relevant for older cancer survivors. Patient reports suggest that the cognitive effects of cancer treatments are not routinely discussed, and interval cognitive assessments are not typically part of the evaluation and management of older patients with cancer (Vega et al., 2017). Other contributing factors and consideration for clinicians include age-associated cognitive decline with normal aging, co-development of dementia, targeted therapy, and endocrine therapy. Preliminary research suggests the importance of routinely asking older cancer patients about their cognitive functioning and performing assessment at regular intervals. Nonpharmacological and pharmacologic strategies for management of chemotherapy-related cognitive impairment require further research and implementation (Vega et al., 2017).

Spinal Cord Injury

Epidural spinal cord compression (ESCC) is one of the most serious complications of advanced cancer and occurs in up to 5% of cancer patients (L'Esperance et al., 2012). These patients tend to be older and female as opposed to traumatic spinal cord injury patients (McKinley, Seel, & Hardman, 1999). Challenges affecting geriatric patients such as polymorbidity, polypharmacy, and previous declining functional status make this population of spinal cord patients challenging. Impaired memory or depression may interfere with carry-over during the rehabilitation process (Helweg-Larsen & Sørensen, 1994). ESCC most commonly presents with pain and is usually progressive and can include weakness, numbness, and bowel/bladder dysfunction. Acute back pain in cancer patients warrants an urgent evaluation (Graber & Nolan, 2010). Unlike degenerative joint disease, pain from spinal metastases is most commonly found in the thoracic spine (Patchell et al., 2005). Evaluation of ESCC includes magnetic resonance imaging (MRI) of the entire spine with gadolinium. Treatment includes corticosteroids, surgical intervention, and radiation therapy (Chaichana et al., 2008). There is evidence that decompression improves ambulation, continence, and survival (McKinley, Huang, & Brunsvold, 1999; Patchell et al., 2005). Inpatient rehabilitation will likely be required for survivors of ESCC, with patients achieving comparable Functional Independence Measure (FIM) scores and discharge to home rates as well as shorter lengths of stay than traumatic spinal cord injury patients (McKinley, Conti-Wyneken, Vokac, & Cifu, 1996; McKinley and Huang et al., 1999).

Psychosocial Aspects of Aging with Cancer

Some research suggests that the psychological impact of cancer is less negative among elderly patients compared with younger patients, though specific themes regarding coping mechanisms in elderly patients have not been well-defined (Alon, 2011). A meta-analysis noted the paucity of clinical trials regarding psychosocial distress in adult cancer patients (Preyde & Synnott, 2009). Even less research on the prevalence of depression has been done in older adult cancer patients, and diagnosing depression in this population can be challenging. Negative self-perception of aging and cancer at baseline has been associated with negative evolution patterns of elderly patients' physical and mental health (Schroyen et al., 2017). These could be used as markers of physical and psychological vulnerability in older patients with cancer. In a study by Drageset, Eide, and Hauge (2016), more than half of the nursing home residents with cancer reported symptoms of depression. A recent study found that depression and low social support have been linked to more falls (Zhang et al., 2017). Better understanding of barriers to mental health treatment could help facilitate referrals and improve access to mental healthcare in selected patients (Preyde & Synnott, 2009). Support groups appear to improve morale and quality of life in cancer patients. Most studies reported that participants felt less isolated, better understood, or more hopeful about their disease (Chakkamparambil et al., 2015).

Precautions in Elderly Patients

Aging and Comorbidities

Patients' prior comorbidities and functional status often limit the oncologic treatment and the rehabilitation options (Fortin et al., n.d.; Presley, Gross, & Lilenbaum, 2016; Wu, Carolina, & Weng, 2015). With the aim to determine which patients are likely to tolerate more intensive treatments, multiple geriatric research groups created several validated screening tools, including the Comprehensive Geriatric Assessment and the Chemotherapy Risk Assessment Scale for High-Age Patients. These scales take into consideration functional and nutritional status, polypharmacy, and mental health among others (Kang et al., 2014). A comprehensive functional assessment performed by a cancer rehabilitation specialist could improve patients' functional status prior, during, and after treatment, especially those undergoing surgery (Carli et al., 2017; Maltser et al., 2017; Partridge, Harari, Martin, & Dhesi, 2014).

Surgical Precautions

Surgery represents one of the most important components in the treatment of cancer (Carli et al., 2017). The rehabilitation provider should take into consideration the general postsurgical precautions while promoting early mobilization as a way to reduce postoperative events (Wildes et al., 2015). Several studies have highlighted the importance of early mobilization and perioperative rehabilitation with the goal of improving postoperative outcomes and reducing the risk of complications such as deep venous thrombosis (Carli et al., 2017; Granacher, Gollhofer, Hortobágyi, Kressig, & Muehlbauer, 2013; Hershman et al., 2016; Skinner, 2017; Yang et al., 2016). However, even with the appropriate rehabilitation, surgery represents a major stressor in the elderly population. A direct negative effect of surgery on muscle mass, oxygenation, deconditioning, sleep, and mental disturbance has been described in elderly patients (Carli & Zavorsky, 2005).

These postoperative effects put the elderly population at a higher risk for complications and should play an important role when starting a rehabilitation program.

Specific postoperative precautions depend on the type of surgery, perioperative complications such as local or systemic infections, bleeding, hematoma or seroma formation, anemia, delirium, and cardiovascular complications. Specific precautions may include recommendations of weight-bearing status and joint range of motion following skin or muscle grafting for limb salvage surgery and shoulder range of motion following mastectomy (Zhao et al., 2015).

Cardiovascular and Respiratory Systems

Cardiovascular and respiratory complications have been largely associated with mortality in the older population. Evaluating these systems could help identify areas that require optimization prior to cancer surgery or any other oncologic treatment.

Advanced cancer often results in significant muscle wasting usually associated with worsening pulmonary function generally due to accessory muscle weakness as well as primary or metastatic disease in the lungs. Additionally, muscle loss in combination with side effects from radiation therapy and chemotherapy has the potential to develop cardiomyopathy (Maltser et al., 2017). Exposure to chest wall radiation and some chemotherapy agents such as anthracyclines may result in worsening cardiovascular function and heart failure (Maltser et al., 2017). Prior cardiac and pulmonary comorbidities as well as oncologic treatment play an important role when prescribing an exercise program. However, exercise has been associated with improvements in patients' cardiorespiratory function and biopsychological outcomes, decreasing the risk of side effects and complications. A systematic review concluded that an exercise prehabilitation program is beneficial in elderly patients undergoing abdominal or cardiac surgery (Carli & Zavorsky, 2005). Close monitoring of vital signs and cardiac function is highly recommended during initial stages of the rehabilitation process (Pierson et al., 2001). Moreover, observation of symptoms that could suggest cardiovascular and respiratory dysfunction is also recommended. Associated symptoms may include excessive fatigue, sweating, as well as severe shortness of breath during exercise (Maltser et al., 2017).

Falls and Fractures

A systematic review by found that falls in older adults with cancer are more common than in the general population, concluding that the risk of falls could be intrinsic to the disease itself. Sensory deficits associated with peripheral neuropathies from various causes contribute to impaired balance, gait, and mobility, contributing to higher incidence of falls in elderly patients. The rehabilitation team should work on preventive strategies to decrease the incidence of falls, including lower extremity strengthening, balance, and activities of daily living training. Fall prevention strategies are particularly important in patients with bone fragility. Low mineral bone density is associated with aging and has a negative impact on fragility and the risk of fractures. Cancer is a major risk factor for local and generalized bone loss, with bone loss substantially higher than in the general population. This is due to many factors, including direct effect of cancer cells, chemotherapeutic agents, corticosteroids, aromatase inhibitors, and androgen deprivation therapy (Reuss-Borst, Hartmann, Scheede, & Weiß, 2012). Other cancer-associated risk factors include bone metastasis, deconditioning, and nutritional factors. Weight-bearing exercises have a positive effect on bone mineralization. However, rehabilitation exercises should be modified to prevent falls and fractures. Progressive resistive exercises, excessive rotation, and manual muscle testing should be avoided in extremities that are at high risk of fracture (Roodman, 2004).

Bone metastases occur most often in breast, lung, and prostate cancer and can result in pain, fractures, hypercalcemia, and spinal cord compression, which impact quality of life and functional mobility (Costa, Badia, Chow, Lipton, & Wardley, 2008). Metastatic bone lesions of long bones and the spine have the greatest risk of progressing to pathologic fractures. Mirels scoring system to assess fracture risk may be helpful to providers when prescribing appropriate mobility interventions (Coleman, 2006; Mirels, 2003). Pain with use (functional pain) seems to be the single best predictor of an impending pathologic fracture (Mirels, 2003). Rehabilitation is still indicated in the presence of bone metastases to promote safety, maintain function, and prevent fractures with activities of daily living. Rehabilitation can reduce risk of fractures through axial loading, balance training, and spinal extension exercises (Cheville, 2005). Fall prevention strategies and education regarding lifting objects are very important for patients (Bunting & Shea, 2001). Rehabilitation interventions can be performed safely and have not been shown to increase the risk for fractures (Bunting & Shea, 2001; Cormie, Newton, Spry, Joseph, & Galvão, 2015; O'Toole GBP, 2009). In one study among 54 patients with metastatic bone disease participating in an inpatient rehabilitation program, only 1 fracture occurred during rehabilitation, which did not affect the clinical course of the patient (Bunting, Lamont-Havers, Schweon, & Kliman, n.d.).

Barriers to Rehabilitation

Gaps in the delivery of cancer rehabilitation services were first documented by Lehman et al. in 1978 (Paul & Buschbacher, 2011). At that time, a large need for rehabilitation services was observed. A general lack of identification of patients' disabilities and physicians being unfamiliar with the concept of rehabilitation were recognized as barriers in the delivery of rehabilitation services. Since then, other publications have addressed this topic with similar arguments (Angeles & Program, 1990).

Lack of Referrals and Limited Access

Lack of or delay in referrals is usually the result of providers' unfamiliarity with rehabilitation services and how they can benefit their patients. Screening tools built into the electronic medical record system have been proposed as a way to identify patients' symptoms and functional deficits and trigger referrals when needed, but further research is needed in this area (Silver et al., 2015).

Preconceived Notions About Exercise

Some barriers for the delivery of cancer rehabilitation services are intrinsic to individual patients' populations. Elderly patients have preconceived expectations about exercise programs. They often think that their age is an impediment to participate in certain activities, and their family will find their ideas about exercising dangerous and irrational. They also overestimate the effort that they need to put into a program. These concerns along with their fear of falling often limit their desire to participate in different programs. In addition, older patients are not well educated on the positive effects of exercise for their health and well-being (Freiberger et al., 2016).

Psychological and Cognitive Barriers

Patients' mood and cognition play an important role in their desire and willingness to participate in rehabilitation programs. Depression and cognitive impairments have been associated with decreased gains in rehabilitation programs. However, there is further evidence that patients with mild to moderate dementia should not be excluded from rehabilitation programs (Huusko, Karppi, Avikainen, Kautiainen, & Sulkava, 2000). Special efforts should be placed into identifying patients with depression or cognitive deficits with the aim of tailoring their rehabilitation programs while providing additional treatment for their comorbidities.

Comorbidities and Healthcare Burden

The prevalence of comorbidities is especially high in cancer patients. Older adults with cancer have a higher number of comorbidities when compared to an age-matched control group and may interfere with cancer treatment (Williams et al., 2016). The effect of comorbidities in older adults not only contributes to a higher rate of complications and mortality but also plays an important role in the approach and delivery of rehabilitation services. Comorbidities may cause an increase in the burden of appointments and visits to clinics and hospitals, leaving less time and resources, including transportation, for participation in cancer support services and rehabilitation activities (Wu et al., 2015).

Financial Burden

Rehabilitation services are heavily influenced by financial and insurance support. Cancer is one of the costliest medical conditions that a patient can encounter. The Agency for Healthcare Research and Quality estimated that the total cost of cancer in the United States in 2014 was $87.8 billion (American Cancer Society, n.d.). Even with insurance or Medicare responsible for covering most of the cost of cancer treatments, it is believed that a patient spends, on average, about $35,000 out of pocket (Rodriguez-Bigas, Chang, & Skibber, 2007). Due to the large financial burden that results from cancer treatment, very little room is left for rehabilitation expenses. A combination of multiple hospital visits along with high co-payments or lack of insurance coverage makes it very difficult for cancer patients to access rehabilitation services.

Cancer Rehabilitation in Palliative Care Patients

Cancer rehabilitation and palliative care are very similar in many aspects. Both specialties focus on improving cancer-related symptoms and cancer treatment-related side effects, with the main goal of improving patients' quality of life (Silver et al., 2015). However, rehabilitation providers focus more on patients' functional status and the issues that can affect such, while palliative care has more emphasis on symptom burden and difficulties related to end of life. The goal of these specialties is not to cure the cancer but improve patients' health-related quality of life.

Palliative care and cancer rehabilitation are critical components of the care offered to patients with oncological conditions. Nevertheless, the delivery of these services has been limited by patients' access to them. The goal of these specialties is often not well-known which results in low or delayed referrals. Palliative care is frequently associated with end of life or pain-related issues, while the value that it provides to improving other symptoms and caregiver burden is often overlooked (Raj et al., 2017; Silver & Gilchrist, 2011).

Patients with metastatic non-small cell lung cancer who were introduced to palliative care soon after diagnosis reported higher quality of life, less depression, less aggressive end-of-life care, and longer median survival compared to those who received the usual oncologic care (Temel et al., 2010). Palliative care is considered one of the categories of cancer rehabilitation (preventive, restorative, supportive, and palliative). The rehabilitation goals for palliative patients are to help relieve symptoms while respecting patients' wishes, promote mobility and changes in position to prevent contractures and decubitus ulcers, provide assistance with breathing/relaxation techniques, and low frequency therapy. Other goals include family education regarding mobility and assistive devices, nonpharmacological treatment of pain and other symptoms, and maintenance of independence and quality of life (Barawid et al., 2015).

A combination of supportive services, medication, and physical activity are potential tools that can be used to counteract the symptoms generated by the disease or the oncologic treatment. Some of the most common symptoms include pain and gastric irregularity (Barawid et al., 2015). Pain is the most common symptom at the end of life and affects more than 70% of cancer patients at some point. Malignant invasion is generally the source of pain; however, non-cancer musculoskeletal pain is another source of symptoms in these patients. A combination of medical treatment usually prescribed by the palliative care team, physical therapy, exercise modalities, and injections (joint injections, peripheral blocks) provided by a cancer rehabilitation physician have the potential to improve patients' symptoms (Barawid et al., 2015).

Chemotherapy-induced nausea is one of the most common problems that cancer patients encounter. Prophylactic medications prescribed by oncologists and palliative care medical support often provide relief of the symptoms. However, some of the medications used, specifically for pain management, can result in other gastrointestinal (GI) complications such as constipation. Dehydration, electrolyte abnormalities, immobility, and medications are some of the contributory factors causing slowing of the GI system and hard stools. Cancer rehabilitation can play an important role in helping these symptoms by promoting mobilization and positioning while improving pain through exercise, musculoskeletal strengthening, and relaxation techniques, which has the potential to decrease opioid use. Rehabilitation providers are trained to diagnose and treat issues related to neurogenic bowel and bladder which can also have a significant negative impact on patients' quality of life (Barawid et al., 2015).

Cancer rehabilitation and palliative care synergistic work have the potential to play a positive role in patients' quality of life, symptoms, and caregiver burden. They are critical components of the oncologic care and necessary tools to promote patients' wellness. Underutilization of these services needs to be addressed by generating new strategies that will improve patients' access to the benefits that palliative care and cancer rehabilitation providers can offer.

Exercise

Most studies supporting positive benefits of exercise for cancer survivors have been with younger patients; however, exercise has shown to have a positive impact on older cancer patients' bone health, function, strength, and quality of life. A decrease in strength, aerobic capacity, and the ability to generate rapid force is directly proportional to the patient age. Resistance, high velocity, and aerobic training have been found to improve patients' strength and aerobic capacity which has been associated with better functional abilities as well as fall risk reduction and decrease in age-related decline (Concannon, Grierson, & Harrast, 2012). Balance activity is recommended at least twice a week to decrease the risk of falls. While for resistance exercise, patient should be encouraged to perform 10–15 repetitions of 8–10 exercises at moderate to high intensity at least 2 times per week (Concannon et al., 2012). Resistance exercise training programs have been found particularly helpful in maintaining bone density of cancer patients. In a study performed with breast cancer patients older than 50 years old, 1 year of supervised resistance exercise in combination with a home exercise program has been shown to preserve bone mineral density in the spine and increase extremity strength (Dobek, Winters-Stone, Bennett, & Nail, 2014). Aerobic and resistance exercise have also shown to improve the quality of life of older adults diagnosed with prostate cancer and to decrease the risk of all-cause mortality by 33% in cancer survivors (Buffart et al., 2015; Hardee et al., 2014).

Frailty and overall patients' functional and medical status are some of the most common barriers that often limit exercise prescriptions and patients' participation in exercise programs. However, several studies have shown that physical activity is safe and has a positive impact for frail older patients despite having multiple comorbidities. A systematic review concluded that training programs can increase physical fitness, functional performance, and quality of life in frail older adults (Weening-Dijksterhuis et al., 2011). Although general precautions such as falls should be considered when prescribing an exercise program, exercise training has been shown to be safe in older patients, even those with bone metastasis (Cormie et al., 2013). Nevertheless, it is recommended that the training programs are tailored to patients' needs, comorbidities, and functional deficits.

Research to Practice Recommendations

Cancer rehabilitation is an interdisciplinary field aimed at diagnosing and treating physical, psychological, and cognitive impairments in cancer patients and survivors and improving quality of life and maximizing independence. With the increase in life expectancy, cancer incidence and prevalence are higher in individuals 65 years and older. This population presents several challenges that can affect outcomes and treatment options. Cancer rehabilitation can prepare patients to undergo potentially morbid treatments as well as improve functional impairments secondary to cancer treatments or the disease itself, from diagnosis through survivorship or end of life. The stages of cancer rehabilitation include preventative, restorative, supportive, and palliative; and its services can be delivered in different settings, including acute and subacute inpatient settings, outpatient clinics, and home-based programs.

A comprehensive geriatric evaluation and the use of a chemotherapy risk assessment scale are useful tools to identify patients' functional status as well as impairment risk factors. Frailty is a common geriatric syndrome that could limit oncologic treatments and increase patients' risk of developing functional deficits. Progressive resistance, balance, and functional training have a positive impact on preventing and treating frailty in elderly cancer patients. Furthermore, moderate aerobic exercise and two to three strength training sessions per week have been found to be beneficial for patients with cancer-related fatigue. In addition to fatigue, neurologic and musculoskeletal impairments, cancer-related pain is present in more than 70% of this patient population at some point and can be challenging for the elderly population. Such pain is best managed by a multidisciplinary team using both pharmacologic and non-pharmacologic techniques aimed at improving function. Functional pain is the best predictor of pathologic fracture in the setting of bone metastases, and rehabilitation can reduce fracture risk through axial loading, balance training, and spinal extension exercises. We can conclude that physical activity is safe overall and has positive impacts on functional performance and quality of life for frail older patients with multiple comorbidities.

Despite the advancements in cancer rehabilitation in the past several years, further research and education are needed. Existing practice gaps left to be addressed include identifying the most effective care delivery systems for specific populations and randomized controlled trials for various types, intensities, and duration of exercise programs. Studying the sustainability of benefits obtained from structured rehabilitation interventions and financial implications for healthcare systems are also needed. Further defining specific precautions during the rehabilitation of older adults would be helpful in prescribing treatments. Exploring and addressing common barriers for referral to rehabilitation providers and participation in programs also remain to be studied.

Future Research and Final Discussion

With the aging of the population, the increase of the incidence and prevalence of cancer, and the advancements in medicine that result in more survivors, the cancer population is growing. Symptoms and complications of the disease and/or the oncologic treatment are more prevalent requiring greater support from cancer rehabilitation physicians. Research and standardization of the efficiency and efficacy of cancer rehabilitation treatments need to be further developed (Gerber, 2001). Further research is also needed to determine the impact that exercise has on the inflammatory markers and chemotherapy uptake by the tumors (Gerber, 2001). Moreover, not much is known about cancer rehabilitation in different age groups (Johansen, 2007). Research is needed to determine the appropriate exercise outcome measurements for specific target populations, especially older adults as their multiple comorbidities and fragility can result in greater functional decline.

Education regarding the goals of cancer rehabilitation and the benefits that these programs can provide is necessary to increase awareness and increase the number of patients that could benefit from them. Education efforts should be directed to oncologists, surgeons, primary care providers, nurses, therapists, and the patients themselves. This will also allow a better integration of multiple oncological services as well as collaboration among the different oncologic specialists.

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11 Aging with Brain Injuries

Asha Vas and Marsha Neville

Overview

Adults over the age of 65, referred to as older adults, are the fastest-growing segment of the US population. Aging in older adults causes changes in multiple body systems, including the brain. An insult or injury to the brain combined with changes associated with aging results in significant functional, social, and economic implications. Advances in brain sciences within the last two decades have significantly enhanced our understanding of the aging brain. Especially, neuroimaging technologies (e.g., magnetic resonance imaging) help establish convergence between brain structures, cognition (thinking abilities), and daily functional performance. More so, these advances are just beginning to guide assessments and treatments of adults with brain injuries. Brain injuries result from a wide range of disease processes including neurological and psychiatric illnesses. The current chapter's focus is on two major causes of brain injury in older adults, traumatic brain injury (TBI) and stroke. Therefore, the term "brain injury" in this chapter refers to TBI and/or stroke. In addition to TBI and stroke, this chapter discusses emerging associations between brain injuries and dementia. The chapter begins with an introduction to brain injury. Following the introduction, the impact of brain injury is examined on domains of (a) neural systems, (b) cognition, and (c) daily functionality. To establish context of the impact of brain injury on the three domains, aging-related changes in healthy adults in these three domains are foregrounded first, followed by a discussion of these changes in older adults with brain injury.

Brain Injury

Brain injury is a public health problem. Older adults are disproportionately at higher risk for a brain injury. In the USA, every 21 s someone suffers a TBI, and every 45 s someone suffers a stroke. Over 5 million people are disabled following a TBI (Center for Disease Control and Prevention (CDC), 2016), and nearly 5 million people are disabled secondary to stroke (American Heart Association (AHA), 2017). Thus, 10 million people are disabled secondary to these two types of brain injuries. Falls are the leading cause of TBI in older adults followed by motor vehicle collisions (CDC). Causes of stroke are multifactorial but include modifiable risk factors such as blood pressure, obesity, smoking, high cholesterol, diabetes, and low physical

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activity. Other factors related to stroke include age, gender (women at greater risk), family history, race (African-American and Hispanics at greater risk than Caucasians), and socioeconomic status (American Heart Association (AHA), 2017).

Brain injuries result in varying degrees of motor (e.g., physical movements), sensory (e.g., vision, hearing, speech), cognitive (e.g., memory, critical thinking), and psychological (e.g., depression) impairments. These impairments often result in difficulties in thinking abilities, dependency on daily routine tasks, reduced social participation, and psychological difficulties. Depending on the severity and location of the injury, long-term outcome of a brain injury varies from gaining pre-injury level of independence to maximum dependency on basic activities of daily living (de la Plata et al., 2008). The added impact of aging on brain injury poses significantly more challenges. Therefore, this chapter reviews the impact of "normal/healthy aging" on the brain systems and brain health, followed by the compounded impact of brain injury on the aging process. Three important domains relevant to understanding aging and brain injury are (a) neural, (b) cognitive, and (c) daily function.

- Neural (brain) structures: nerve cells in the brain are called neurons. The cell body of the neuron forms the gray matter of the brain. The electrical and chemical signals from the cell bodies are carried by the nerve fibers, referred to as white matter (paler tissue). The protective covering of the nerve fibers (referred to as myelin) helps convey messages between brain regions. The nerve cells and nerve fibers are nourished and protected by specialized cells called glial cells. Synapses are junctions between two nerve cells through which impulses pass by diffusion of a neurotransmitter (chemical) in the brain (Buonomano & Merzenich, 1998; Jessell & Kandel, 1993).
- Cognition (thinking) processes: most prominent thought processes of attention, memory, problem-solving, reasoning, judgment, language, and processing speed are referred to as cognition. These thought processes are active through the day (and night) when we engage in any activity, whether it is thinking of someone, watching a TV show, dreaming, or solving a complex problem (Albert, 2017; Barney & Perkinson, 2015).
- Functionality (daily life): our interest, initiation, engagement, and participation in home, work, school, and social activities form our identity. All of us desire to be in engaged in varying degrees of daily function (Albert, 2017).

These three domains share a symbiotic relation (Fig. 11.1). That is, strength and resilience of

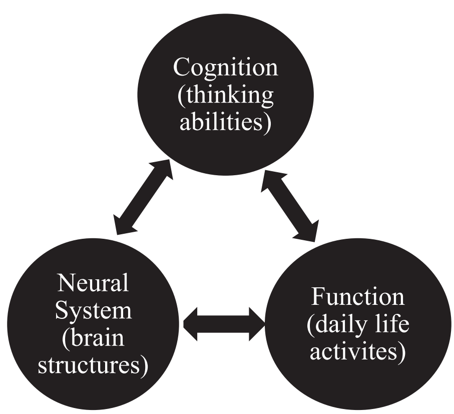

Fig. 11.1 Aging Systems Triad

one domain facilitates and strengthens another domain. Similarly, impairment of any one domain can negatively impact another domain.

Age-related changes in any of the three domains (either in isolation or in combination) vary across individuals. This variability demonstrates the complexity of the aging process that is dependent on myriad factors including overall health, education, coexisting medical conditions/diseases, trauma, lifestyles, genetic makeup, and social influences to name a few. Advances in medical technology have led to the survival of more than 125,000 individuals each year in the USA who will live with long-term consequences of brain injury (American Heart Association (AHA), 2017; Center for Disease Control and Prevention (CDC), 2016; Luchter & Walz, 1996). The long-term consequences depend on multiple factors including severity of brain injury, rehabilitation efforts, comorbid medical conditions, pre-existing cognitive reserves, and family and community support.

Aging and Neural Systems

Healthy Older Adults

Normal aging is accompanied by changes within the brain, as early as the fourth decade (in the 30s) of one's life. Brain weight and volume reduce by 5–10% between the ages of 30 and 90 (Guttman, 2001; Moretti et al., 2012). Brain volume loss is seen within gray matter of the frontal and temporal lobe (Bigler, Kerr, Victoroff, Tate, & Breitner, 2002). Changes in nerve fiber (i.e., white matter) integrity, especially wearing of the insulation of the fibers, are common. This change interrupts the smooth transmission of the electrical signals and consequently impedes the flow of information between brain cells and networks in the brain. Additionally, aging is associated with brain changes at a synaptic level. In older adults, increased synaptic pruning (loss of connections between neurons) and reduced plasticity of synaptic connections leads to reduction in the number of synapses. Some researchers reported as much as a 20% decrease in synaptic density in people over the age of 60 (Masliah, Crews, & Hansen, 2006). Although these neural changes show a linear decline, human brains adapt to these changes quite effectively.

According to the Scaffolding Theory of Cognitive Aging (STAC; (Goh & Park, 2009)), functional changes with aging are part of a life span process of compensatory cognitive scaffolding that is an attempt to alleviate the cognitive declines associated with aging, and the selective changes in the aging brain reflect neural decline as well as compensatory neural recruitment. While aging is associated with reductions in cortical thickness, white matter integrity, dopaminergic activity, and functional engagement in posterior brain regions such as the hippocampus and occipital areas, there are compensatory increases in frontal functional engagement that correlate with better behavioral performance in older adults. That is, these adaptations are ongoing across the life span, even without an injury or disease (Park & Reuter-Lorenz, 2009).

Older Adults with Brain Injury

Whereas normal aging is often considered as the progression along a temporal trajectory with slow gradual decline in the neural structure, a brain injury could result in a sharper decline. The decline is triggered by a sequence of neurobiological events that alter that trajectory, causing premature brain changes that manifest as an early onset of decline (Cole, Leech, & Sharp, 2015). The decline is more significant following a severe injury as compared to a mild one. Researchers reported brain volume reductions both globally and in specific brain regions including the gray matter (in frontal lobes) and hippocampus (in temporal lobes). The hippocampus plays a significant role in memory encoding and retrieval (Bigler et al., 2002). Structural damage to neuronal networks, whether from a TBI or a stroke, can affect both short and long nerve fibers, as well as tracts between the nerve fibers connecting the right and the left hemisphere of the brain (referred to as the corpus callosum). Moreover, the interaction between brain regions (referred to as functional connectivity) can be disrupted after a brain injury (Conlon, 2011).

The plastic nature of the brain, often referred to as "neuroplasticity," allows for brain cells and structures to connect with other cells and develop new connections, even after a brain injury. These connections can be facilitated by pharmacological agents, therapy (e.g., occupational therapy, speech therapy), and life experiences. Positive neuroplasticity refers to the brain's ability to show desirable change including rewiring of brain networks that facilitates and recovery of function after a brain injury (Nudo, 2006). On the other hand, negative plasticity, also known as "maladaptive plasticity," refers to brain changes that occur as a result of unhealthy and less efficient compensatory mechanisms (Nudo, 2006). For example, older adults with a brain injury who may have had difficulties with complex challenging tasks or engagement in social or home activities may avoid them altogether or resort to lesser desirable habits (e.g., avoid weekly trips to senior center). These maladaptive adaptations of avoidance and limited engagement may appear to have short-term success (with no failure at regular tasks). However, decreased cognitive enrichment and limited participation in daily life tasks are not optimal to strengthen cognition and maintain brain health at the neural and functional levels and may even trigger a decline that often continues as a linear downward trajectory (Chapman et al., 2013). The next section will present the impact of aging on "cognition" in healthy older adults and older adults with brain injury.

Aging and Cognition

Healthy Older Adults

> A process of gradual, ongoing, yet highly variable changes in cognitive functions that occur, as people get older. Cognitive aging is a lifelong process. It is not a disease or a quantifiable level of function. ((Institute of Medicine, 2015), p. 20)

Cognition (thinking) is a complex phenomenon. Multiple factors including sensory and motor abilities, genetic makeup, societal support, and educational background play a significant role in cognitive aging. Although an overall decline is often considered inevitable, some cognitive processes are found to improve, as one gets older. Age-related cognitive changes vary considerably across cognitive functions and individuals (Park & Schwarz, 2000). This complexity presents with challenges and opportunities to exploit, understand, and facilitate adaptive mechanisms to restore and enhance cognition in older adults. For the purpose of this chapter, "cognition" is examined under four broad domains: (a) processing speed, (b) attention and memory, (c) executive function, and (d) language. These domains interact with each other, both in health and disease.

Processing speed is the pace/speed at which one takes in information to act on or respond (Salthouse, 1996). This speed-based ability varies widely across domains including auditory (hearing), visual (seeing), or motor (physical movement) speed. In lab-based tests, processing speed (or speed of processing) is quantified by the amount of time taken to do a task such as time to connect dots on a pattern, reading speed accuracy, vigilance in identifying specific pictures, and scanning pictures, shapes, and colors (Salthouse, 1996). That is, processing speed draws on fundamental skills of attention and memory to remember and follow commands. Older adults often show decline in processing speed as it is largely dependent on sensory perceptual skills including vision, hearing, and physical ability to move and monitor responses, all of which often decline in old age (Watson et al., 2010).

Simple *attention* such as watching a routine television program tends to be preserved in older age. Difficulties may be encountered, however, when divided attention is required such as trying to pay attention to the television and simultaneously talk on the telephone (i.e., multitasking). This does not mean that the activities cannot be performed but rather that they take longer! This difficulty in multitasking forces an individual to focus on one task at a time, which could perhaps work in favor of cognitive changes/decline. Increasingly, researchers are demonstrating the harmful effects of multitasking and its toll on productivity (Adler & Benbunan-Fich, 2012). "Speed is the modern, natural high," says psychiatrist Edward Hallowell, MD, director of the

Hallowell Centers for Cognitive and Emotional Health in Sudbury, MA. But he insists that true multitasking is a myth. One may feel that he/she is doing two or more things at a time, but that assumption is likely an illusion. Our brains are adapting to quickly switch back and forth between tasks *at a cost*. The cost is the "quality and efficiency." Multitasking in this chapter refers to doing two or more activities at the same time that require complex attention (e.g., talking to a friend in person and sending instant messages on your phone) versus simple rote attention (e.g., watching TV and eating ice cream).

Aging effects on *memory* are similar to that of attention. Long-term memories and recall of past events that have been stored over many years remain relatively preserved in old age. Recent or short-term recall of word lists, phone numbers, or details of a text or story (e.g., character in a story, actor that played the role in a movie) is often affected as one gets older (Moscovitch & Winocur, 1992; Park & Schwarz, 2000).

Executive functions serve as a command center of our thinking abilities and often guide and monitor complex activities. Examples of executive function include, but are not limited to, problem-solving, reasoning, judgment, planning, organization, goal implementation, and monitoring. Some executive functions remain relatively intact even as one advances in age (Albert, 2017). Traditional ways of approaching solutions and reasoning based on wisdom and life experiences are maintained in older adults or may even show improvement. However, problem-solving and reasoning of novel situations or information that have not been encountered in the past may take extra time to solve. For example, new information related to changes in technology may be difficult and often frustrating. Similarly, adapting to current money management practices may appear daunting and often leave older adults to succumb to frauds (de la Plata et al., 2008).

Language abilities, including linguistic and communication functions, remain stable during aging process in many healthy adults. Linguistic skills of vocabulary, grammar, and basic writing skills remain stable or may even enhance with age. Knowledge and life experiences certainly contribute to enriched linguistic abilities. Difficulties with word retrieval finding are often reported in older adults (Nussbaum, Pecchioni, Robinson, & Thompson, 2000). Older adults adapt to these lapses in word retrieval and word finding by compensating with contextual cues, substituting with alternate phrases or ideas. However, language and communication problems can be exacerbated by medical conditions, lack of sleep, fatigue, and loss of stimulating environments (Durmer & Dinges, 2005).

Older Adults with Brain Injury

Brain injury, especially those with moderate to severe severity, often presents with a lasting impact on cognitive abilities (Ashman et al., 2008). Exacerbated cognitive decline results from a cumulative effect of brain injury and normal aging effects. Decline is often noticed in all four domains discussed in the above paragraphs, including processing speed, attention and memory, executive functions, and language (Kalaria, Akinyemi, & Ihara, 2016; Sun, Tan, & Yu, 2014). The severity of impact on cognition depends on "risk" and "reserve" factors. Some of the risk factors that exaggerate the negative impact of a brain injury in older adults include (a) severity of injuries, (b) multiple brain injuries, (c) period of loss of consciousness, (d) associated medical conditions, and (e) limited support (e.g., rehabilitation, environmental enrichment, family, and community). Some of the pre-injury reserve factors that could offer protection from steeper decline include (a) higher education, (b) good overall health, and (c) social and family support. Cognitive reserves are akin to financial assets that offer protection during crisis.

In the majority of older adults with moderate to severe brain injuries, cognitive functioning is likely to be more negatively affected than healthy aging adults (Kalaria et al., 2016; Sun et al., 2014). That is, cognitive changes associated with aging are exaggerated, and reductions are noted on the four broad domains on cognition (processing speed, attention and memory, executive functions, language) (Corkin, Rosen, Sullivan, & Clegg, 1989; Victoroff, 2002). Long-term impact of a brain injury (combined with aging) on cognition varies between TBI and stroke, both qualitatively and quantitatively.

Attention problems following TBI vary widely depending on the severity of the injury. Decreased ability to focus and sustain attention for extended periods of time, as compared to pre-injury levels, is a common observation by healthcare providers and family members (Coronado, Thomas, Sattin, & Johnson, 2005). The individual may not even notice that the concentration level is different and may even come across as someone with no interest or motivation to engage in a task. Some of the attentional impairments presented (also reported by family members) include distractibility, feeling overwhelmed even with simple tasks, fatigue, information overload, and difficulty processing more than one to two steps on a task (or slower processing of information).

Attentional problems following a stroke: In majority of stroke survivors following a right brain stroke of moderate to severe severity (that often results in left side body weakness or paralysis), attentional deficits are presented in the form of a "neglect" (Corbetta & Shulman, 2011). An individual with "neglect" does not pay attention to the left side of his/her body and people and objects on his/her left side. Ignoring food on the left side of the plate and missing numbers on the left side of the clock – all of which are "neglect" symptoms – are commonly reported by family members and caregivers of stroke survivors.

Memory impairments following TBI: Recall difficulties are often reported more for short term (events that took place in the last half hour to an hour) as compared to long term (events that took place years ago). Often short-term recall difficulties significantly affect critical daily functions including medication management, placement of objects, bill payments, and so on. Therefore, therapists and family members make strong recommendations for memory notebooks (e.g., calendars) and organizational devices. The regular use of these compensatory devices has yielded reasonable positive findings (Cicerone, Levin, Malec, Stuss, & Whyte, 2006). Long-term memory of past significant events (e.g., wedding dates, graduations) is often not affected following a mild or moderate TBI. However, specific details of these memories (e.g., food served at the event) may be affected.

Working memory, ability to maintain and manipulate information, is often affected even following a mild TBI. Examples of working memory tests in a lab often include remembering a string of random numbers and rearranging them in an ascending order. Real-life examples include taking notes during a lecture or watching a TV segment and discussing the details with a friend. In both examples (remembering numbers or taking notes during lecture), the individual manipulates the information (reorganizes or paraphrases) and "keeps things in mind for a short period." Therefore, "working memory" can be used interchangeably as "short-term memory." Working memory is a complex phenomenon that is mediated by frontal lobes and is often considered an executive function versus a simple memory function (Park et al., 2003).

Memory impairments following Stroke: The localized pathology (right versus left stroke) of a stroke presents with unique memory challenges. Following a right brain stroke, majority of the stroke survivors present with difficulties remembering the global picture or gist of information. They may still remember the details of the information, but may miss the order or sequence of the details. Missing the gist may present as difficulty understanding inferred meaning of a joke, remembering key points of a conversation with a healthcare provider, or missing the moral of a parable in the scriptures. Short-term memory problems are common following a left brain stroke. Most commonly, memory for details is most affected. Memory for gist and long-term memory are relatively spared in comparison to an individual with right stroke. Individuals with left brain stroke often require repetition of instructions and frequent reminders.

These memory distinctions and challenges between right and left brain stroke offer therapists and family members unique set of remediation and compensatory strategies. The use of memory aids such as calendars is useful for all (including healthy adults) but certainly is critical for adults with left brain stroke. Similarly, guiding and training right brain stroke survivors in understanding humor, body language, and overall goal of a task (or event) is paramount for adults with right brain stroke. Awareness of these distinctions can help family members plan their schedules and family events and guide their loved ones with daily independence.

Executive functions are mediated by the frontal lobes with coordination and feedback from the rest of the brain. Therefore, executive dysfunctions are reported following both a TBI and a stroke. Traditionally, literature has reported significantly more executive dysfunctions following a TBI, given the vulnerability of the frontal lobes following a motor vehicle accident or falls. However, increasingly researchers are recognizing that executive dysfunctions play a significant role in majority of the cognitive impairments following a stroke, right or left. As discussed earlier, executive function is an umbrella term that includes complex behavior such as planning and execution of goals, learning, innovation, and appropriate social behavior – all of which draw on coordinated effort by the frontal lobe networks (Cicerone et al., 2006). Family members and caregivers often report executive dysfunctions as an individual's lack of interest and ability to solve complex problems, impulsivity, and disorganization. Executive dysfunctions result in missing daily appointments, delayed bill payments, difficulty in keeping a job and/or relationships, emotional lability, and anger issues. Additionally "neglect" problems following stroke also result in decreased awareness and limited engagement in surroundings.

Language difficulties differ between TBI and stroke, both qualitatively and quantitatively. Following a mild to moderate TBI, language comprehension (at a surface level) and production are relatively intact. Individuals are able to comprehend and conduct daily conversations and routine tasks. Language fluency, with regard to word recall and fluid expression with appropriate vocabulary, is relatively spared (Ferstl, 2001; Holliday, Hamilton, Luthra, Oddy, & Weekes, 2005). Even if these problems are evident in acute stages post-TBI, there is often significant recovery of language functions including vocabulary, syntax, and grammar (Coelho, 2007). That is, the majority of individuals with TBI may not manifest classic aphasic disturbances (often seen following stroke), especially in chronic stages of recovery. However, adults with TBI demonstrate difficulties in complex language functions that involve synthesis and application of information for novel tasks, new learning, and social functioning that draw upon proficient language function (Cannizzaro & Coelho, 2002; Galski, Tompkins, & Johnston, 1998; Vas, Spence, & Chapman, 2015). These complex language functions rely heavily on higher-order executive functions; hence, the language difficulties are often termed as cognitive-linguistic impairments.

After a stroke, it is common to have language and communication problems. In majority of stroke survivors with left brain stroke, "aphasia" is common sequelae (Cannizzaro & Coelho, 2002; Wade, Hewer, David, & Enderby, 1986). Aphasia is the loss of ability to comprehend and/or express verbal, auditory, reading, and written language. Aphasia varies widely depending on the severity and location of the stroke in the brain (Wade et al., 1986). Thus, different forms of aphasia lead to varying degrees of impairments. An individual with fluent aphasia (often referred to as Wernicke's aphasia) has difficulty comprehending language, but may have no difficulty speaking. Since comprehension is impaired, the produced speech, although fluent, often has limited relevance to the context of the information (e.g., conversations, written material). Friends and family members find it frustrating (and helpless) to see their loved one with fluent aphasia not make "sense" despite fluent speech. The individual with this form of aphasia may often fail to realize they are saying the wrong words and/or a string of words that are made up (Wade et al., 1986).

The other common form of aphasia is called "nonfluent" aphasia. In this case, an individual with stroke understands (i.e., comprehends) the information (e.g., conversations, written material) but has difficulty with speech production. The individual tries to get few meaningful words out, although has difficulty forming complete sentences, and may omit prepositions or articles in the sentence structure (Wade et al., 1986). Another form of aphasia, called "global aphasia," is the combination of both fluent and nonfluent aphasia. That is, an individual may experience difficulty with both language (information) comprehension and speech production. Individuals with global aphasia usually have severe language and communication difficulties. In addition to aphasia, left hemisphere stroke survivors often present with difficulty encoding language details. Therefore, these individuals rely more on contextual cues and general world knowledge (Ferstl, 2001; Ferstl & Kintsch, 1999) versus explicit details of information to communicate. Communication is marked by simple generalized phrases and often does not include important details to enrich an idea or a thought.

Adults with right hemisphere stroke have the opposite presentation. Language and communication difficulties following right hemisphere stroke are beyond the word and sentence level, as opposed to adults with aphasia (Beeman, 1993). Memory for details (i.e., words and sentences) of the information is relatively intact, but the ability to draw inferences, global meanings, and generalized ideas may be significantly impaired (McDonald, 2000; Ulatowska, Chapman, Highley, & Prince, 1998). The attentional deficits, discussed in previous paragraphs, also contribute to distractibility and difficulty "reading" people and their body language and context of the situation. These difficulties often result in inappropriate comments and behavior. As one can imagine, these behaviors can be equally frustrating for family members and friends to see their loved ones experiencing these difficulties.

Aging and Functionality

Healthy Older Adults

Daily function is expected to change as adults age. Although the frailty in neural and cognitive functions is inevitable, it is increasingly clear that an aging brain is adapting to the changes by continuously reorganizing its thought processing, task management, and environments (Park & Reuter-Lorenz, 2009). Older adults' "adaptive brain" responds to internal and external environmental changes (Sugiura, 2016). Adaptations are continually made to compensate for the decline and to perhaps reverse some aspects of the decline. External aids and home adaptations are common forms of compensation. Examples are hearing aids, eyeglasses, calendars, organizers, safety railings in the house, and so on. The effective and continual use of compensations become challenging especially with associated medical conditions such as arthritis and heart and lung diseases. Loss of muscle strength, vision changes, changes in balance, and sensory changes put older adults at greater risks for falls which could result in a TBI. Despite compensation and adaptations, functional changes are common in older adults.

Aging body and brain including changes in overall health, family support, and financial security directly affect psychological health. Loss of a spouse, job, partner, friend, and pets significantly affects the mental well-being of older adults. Healthy psychological state is often attributed to positive optimistic attitude in older adults (Barney & Perkinson, 2015).

Older Adults with Brain Injury

Functional changes in older adults with brain injury reflect the cumulative effect of neural and cognitive changes over an extended period of time. The adaptations to aging process require volitional and intentional effort to continually reevaluate the changes to adapt accordingly (Flanagan, Hibbard, Riordan, & Gordon, 2006; Haring et al., 2015; Mak et al., 2012; Moretti et al., 2012). Neural and cognitive declines as a result of a brain injury may impair this volitional ability. Consequently, older adults with brain injuries may demonstrate limited success in optimal adaptations and thereby present with limited engagement and participation in daily life tasks

(Sendroy-Terrill, Whiteneck, & Brooks, 2010; Stocchetti & Zanier, 2016; Testa, Malec, Moessner, & Brown, 2005). Additionally, cognitive and psychological changes during aging combined with a brain injury may alter lifestyles including diet, exercise, and engagement in risky behavior, all of which negatively influence quality of life.

Table 11.1 Risk of dementia post brain injury

Minimal risk	Increased risk
Mild TBI with no loss of consciousness	Severe TBI with loss of consciousness
Single TBI	Multiple TBIs
Mild stroke	Severe stroke
No genetic ApoE4 genotype	Presence of genetic ApoE4 genotype

Brain Injury: Dementia

Older adults with a brain injury are concerned about developing dementia. Although there appears to be an association between a history of a brain injury, especially TBI, and onset of dementia, there is limited evidence to suggest that a brain injury directly causes dementia (Vincent, Roebuck-Spencer, & Cernich, 2014). Epidemiological research over the past 30 years has focused on the link between brain injury (especially TBI) and dementia. Findings indicate that individuals with a previous history of brain injury have a higher risk of developing dementia later in life compared with those with no such history. It is also important to note that not all individuals with a dementia have a history of brain injury nor do individuals who have survived a brain injury invariably develop dementia later in life. In fact, studies suggest that the overall rate of Alzheimer's dementia (AD) in people with TBI is similar to that of the general population. For example, Guskiewicz and colleagues' (Guskiewicz et al., 2005) study of 2552 National Football League retirees found the rate of AD among older retirees (but not younger) who had experienced football-related TBI was similar to the general population. On the other hand, higher rates of AD in adults with TBI were found in younger NFL retirees with more severe or repeated injuries. These findings demonstrate that a higher risk for AD after TBI is not a uniform phenomenon and that specific risk factors play a role.

A strong association is established between a specific gene and dementia. A gene called apolipoprotein E or APOE4 allele is often associated with dementia (Victoroff, 2002). This gene has been identified as a substantial risk factor in Alzheimer's. The level of risk for Alzheimer's depends upon how many copies of the APOE4 allele one carries. It is believed that individuals who inherit two or more copies of the APOE4 are at a significantly higher risk of developing AD (Mayeux et al., 1995). Some researchers also believe that a history of brain injury alone does not increase the risk of Alzheimer's, but a combination of the APOE4 allele and brain trauma results in significantly greater risk of developing dementia. Thus, a previous history of brain injury increases the risk of AD only if one was already predisposed to the genes (Mayeux et al., 1995).

In sum, a brain injury may not cause dementia, but certain factors associated with a brain injury may make an individual "more at risk" for developing dementia (Thompson, McCormick, & Kagan, 2006; Vincent et al., 2014) (Table 11.1). These factors that enhance the risk are (a) severe forms of brain injuries, (b) repetitive injuries (even if each injury is of milder severity), and (c) the presence of APOE protein (Bigler et al., 2002).

Research to Practice

A lesson from aging-related research in TBI is that more can be done to improve long-term outcomes of TBI. Knowledge from research over the last decade has the potential of advancing and strengthening existing *practices* through the application and translation of emerging evidence into therapies to reduce the impact of aging-related decline in adults with TBI and dementia.

I. *Practice recommendations.* This section provides some general overviews of translating research into practice. Refer to Chapter 21 for a detailed account of rehabilitation approaches. Emerging research proposes that healthcare providers, including therapists and family members, include *protection*, *detection*, and *prevention* approaches to reduce the impact of a brain injury in older adults.

- *Protection*: The aging process is confounded by a brain injury. However, we are increasingly aware of protective mechanisms that have proven to lessen the burden of aging-related decline in TBI populations. Some of these approaches are, but not limited to, the following:
  - *Building cognitive reserves*: Cognitive reserves refer to the cognitive/brain capital that an individual builds over a lifetime. Cognitive reserve can be measured by level of education, socioeconomics, occupation, leisure activities, and physical activity across a life span. Enhanced cognitive reserve can help minimize effects of age-related cognitive declines, avert stressful situations, and help compensate for TBI-related cognitive impairments (Baltes & Baltes, 1990; Barulli & Stern, 2013). Brain imaging research suggests that building cognitive reserves strengthens frontal brain regions and large brain networks that mediate higher-level thinking. Engagement in cognitively stimulating environments and activities is one way to build cognitive reserves. In older adults with TBI, creative and innovative activities could be done both at home and outside. Examples of such activities in their daily life are engaging in a new hobby; novel (and functional) ways to reorganize pantry, closets, and drawers; recognizing distractors on the desk and around the house; identifying less important items on the to-do lists versus the most critical tasks; creative ways to write Christmas cards and thank-you notes; innovative uses of a same kitchen tool; and deeper level synthesis of news, information, movies, and conversations (Carvalho, Rea, Parimon, & Cusack, 2014; Schneider et al., 2014).
  - *Maintaining healthy lifestyles:* Physical fitness is increasingly identified as a cognitive enhancer. When comparing physically active to more sedentary older adults, Erickson and Kramer (Erickson & Kramer, 2009) found an increase in memory networks in the brain and an increase in gray matter in the prefrontal, parietal, and temporal regions. Engaging in physical exercise may be done through a variety of activities. The American Heart Association recommends 150 minutes per week of moderate exercise or about 30 minutes 5 days a week. Moderate exercise can be determined by your heart rate, your breathing, and your own feeling of exertion. We frequently teach clients to use a scale of 1–10 when exercising. If you begin at a level one, moderate exercise would be a feeling of about five out of ten. A person can still talk but will find themselves needing to take more frequent breaths. Before beginning this level of exercise, talk with your physician. Many YMCAs and community centers offer specific classes for older adults. Classes may include yoga, tai chi, chair exercises, and dance. Other activities can include walking, playing with children, and completing activities around the house (vacuuming, dusting, folding clothes, and gardening). Recreational activities can also provide the needed physical activity. Bowling, golf, bocce ball, shuffleboard, and ping-pong are some examples of activities for physical exercise. Additionally, physical fitness can be augmented by balanced diet that helps maintain bone and muscle health.
  - *Social interactions:* All humans are social beings. Interaction (in person, face to face) with others stimulates brain regions that are associated with reasoning, critical thinking, memory, and emotional regulation (Krueger, Barbey, & Grafman, 2009). Research has shown that these social interactions, even via social media, cause biochemical changes in the brain that have a positive impact on overall well-being.
- *Detection:* The practice of TBI-related screening procedures is limited in pri-

mary, secondary, and tertiary care centers including rehabilitation hospitals. A TBI is a not an isolated event, and its long-term sequelae are well documented even decades post-TBI (Masel & DeWitt, 2010). Therefore, routine physical exam should take into consideration TBI-related sequelae including cognitive changes (above and beyond healthy aging), psychological health, and daily life functionality. Early detection can lead to appropriate therapeutic strategies and stave off decline for years or even decades.

- *Prevention:* The epidemiologic data shows that falls are the most common cause of TBI in the elderly. Therefore, one of the primary prevention measures should be geared toward preventing falls. Examples of preventative measures are:
  - Environmental modifications: Tripping has been shown to occur at a fairly high frequency prior to a fall. Therefore, elimination of environmental hazards (both indoor and outdoor) may have promise in reducing the rate of fall-induced TBI. Antiskid footwear and grab bars in bathrooms and other areas of the house may help reduce the burden of indoor falls (Clemson, Mackenzie, Ballinger, Close, & Cumming, 2008). Modification of flooring to a more impact-absorbing or antiskid function may help reduce the consequences of a fall or may prevent the fall from happening. Further, elimination of outdoor environmental hazards could include repairing uneven surfaces and painting sidewalks and curbs, improving/installing outside lighting, and slip-resistant outdoor surfacing.
- Physical exercises: Participating in fitness programs such as tai chi, yoga, weight training, aerobics, swimming, and regular exercise in the gym could build the physical reserve that could help prevent/limit damage from a fall (Taylor-Piliae et al., 2014). Furthermore, improved physical strength and balance help maintain engagement in home and community activities that fosters independence and promotes overall health.

II. *Future directions in practice and research*: Although the last decade has shown significant promise in the brain science, the contribution of TBI to the aging brain and vice versa has many unanswered questions. An integrative approach could further help understand this bidirectional impact. Cross talk between research experts in imaging, neurobiology, and biostatistics, therapists (e.g., occupational, physical, and speech), behavioral analysts, and family members can help establish markers of impairments and function in aging with brain injury. Additionally, this integrative approach guide develops therapeutic interventions to minimize the impact of one on the other (i.e., aging and TBI). With regard to TBI and dementia, more research is warranted to understand the mechanisms underlying genetic and medical comorbidity factors that increase risk of dementia among TBI survivors (Jellinger, 2004).

Clinicians should continue to focus on evidence-based therapies to maximize fall prevention including medication review, patient education, environmental assessment, and institution of strength and balance exercises. Another area of research that could strengthen practice protocols is to examine and establish precise dosage and frequency therapeutics to optimize rehabilitation short-term and long-term outcomes.

Conclusion

Aging is inevitable, and aging with associated medical conditions (e.g., TBI, AD) can be a significant burden to the individual, families, and society. Although there is much to learn about aging in TBI populations, recent advances have significantly improved our knowledge of factors that contribute positively to the aging process. Protective and preventative facts such as physical fitness, cognitive (thinking) exercises, and social engagement can facilitate repair and slow the overall brain injury-related declines during aging. Healthcare providers, including therapists, have an opportunity and responsibility to integrate therapies for individuals and families to best deal with aging and TBI. Additionally, detecting dementia symptoms in aging adults with TBI should be a routine practice both in primary and secondary medical health facilities. The complex relationship between TBI and AD highlights potential opportunities for research, intervention, prevention, and improved clinical management of older adults living with a history of TBI.

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Mental Health Disorders in Older Adult Populations

12

Ben Lippe and Brittany Hall

Overview

As the "baby boomer" era culminates in a striking increase in the geriatric population in the United States, it will be important to explore and understand the role of mental health for this age group. Many mental health problems within the geriatric population are experienced at a higher rate than adult normative samples, including neurocognitive disorders. Additionally, according to Blazer (2003), one of the most highly prevalent psychiatric disorders experienced in older age is depression. For example, prevalence rates for depression in the elderly have been estimated at up to 16% of the elderly population (Almeida & Almeida, 1999). Also, as mental health can affect a range of different spheres, including social relationships and medical outcomes, careful evaluation and treatment of psychiatric concerns and behavioral issues can help optimize factors and potentially improve quality of life. Recognition of the historical context of mental health concerns in the elderly is important in setting the stage for improved understanding of current mental health concerns in this population. This chapter will provide a brief history of mental health, explore some common mental health concerns experienced within elderly populations, and provide an overview of depression in the elderly, along with treatment options and future directions for clinical research.

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Definition Issues

There are a range of terms used to describe aging adult populations. "Elderly," "geriatric," and "mature" are a few examples. How are these terms defined and who makes that decision? In the United States, Medicare becomes available at the age of 65 for most, and this age represents a common benchmark for defining the low-point threshold for older adult populations (APA, 2014). The research behind our understanding of older adult populations, rather unfortunately, is often poorly described and lacks consistent uniformity with respect to defining specific age ranges. According to a publication associated with the American Psychological Association (2014), most gerontologists and researchers consider over 65 years old to identify this group. However, others set the mark at various other age ranges, including as low as 50 years old (Cole & Dendukuri, 2003). For the current chapter, the present material and descriptions are primarily aimed to describe individuals over the age of 65, although inclusion of some literature with lower age-range cutoffs has also been included.

Similar to the importance of how "elderly" is defined, and the way in which "mental health" is

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defined, will guide subsequent discussion regarding the relative significance and applicability of mental health concerns within the geriatric population. Does the term "mental health" simply reflect the presence or absence of a psychiatric disorder? Surely, the term does encompass the presence or absence of symptoms and clinical presentations associated with discrete disorders, although the term is actually more broad-ranging in nature. Mental health also reflects a psychological state of general well-being, as well as a vast array of behavioral expressions of underlying mental strata. Mental health affects practically every aspect of day-to-day emotional states, behaviors, and even physiological responses. When applying this term to mental health problems, and needs within the geriatric population, some special considerations are indicated that will be discussed in the present chapter.

Not surprisingly, mental health concerns and needs can vary across the lifespan. Some psychiatric conditions only occur in childhood as they are developmental in nature, while others can originate at any point across the continuum of the lifespan. Thus, the trajectory of mental health concerns over the course of the lifespan must include a dynamic and malleable conceptualization of relevant factors contributing to the development and prevention of psychiatric disorders. For the purposes of the current chapter, the focus will be on disorders most likely to originate in, or prominently affect, older adulthood. Although some disorders of childhood may continue throughout the lifespan into older adulthood, the relative proportion of these disorders is substantially less when compared with other mental health disorders that originate after childhood.

Brief Historical Summary

Recognition of mental health problems in elderly populations has historically been associated with significant stigma. Senility and loss of cognitive capacity have not been well understood over the course of history, so it is not surprising that treatment and management of care for these individuals was also poorly implemented. For additional historical context, consider a few examples to help build a bridge for understanding current conceptualizations of mental health in older adulthood. For example, in ancient times, it was thought that disease and behavioral disturbances were due to evil spirits physically located in the head. Accordingly, one treatment to help address the disease was called trephination. In trephination, holes were actually bored into the skull to allow a physical avenue for the evil spirits to be released from the afflicted individual. An unfortunate side effect was death due to cranial trauma and blood loss. Clearly, advances were needed.

The ancient Greeks, most notably Hippocrates, developed a *Humoral Theory of Illness*. The basic premise was that imbalance among the "humors," that is, certain body fluids (e.g., blood), was associated with physical, emotional, and behavioral disturbances. This theory has since been discredited. During portions of the Middle Ages, the primary theory to understanding and treating illness rested in religious explanations, including punishment from God for sins committed. In some cases, the punishment for sins as provided by certain religious authorities included hangings or other torturous means in an effort to help reconcile the individual into a righted relationship with God or else exterminate their lives (Koenig, King, & Carson, 2012).

During the Renaissance, new thoughts on the relationship between spiritual forces and health emerged, and the focus on etiology of physical or emotional distress shifted to the emerging role of medicine. Eventually, discovery of microorganisms and recognition of their role in acquisition and development of disease during the eighteenth and nineteenth century prompted exploration into new angles on understanding health and illness. As classically portrayed in Hollywood movies about early attempts toward mental health treatment, sending elderly patients to an "insane asylum" was not an uncommon practice, although the specific rationale and understanding of effective treatment with this approach was limited, at best (Grob, 2014). Often, these psychiatric facilities were considered the equivalent of "holding tanks" for individuals that members of society either felt unsafe, disruptive, or otherwise uncertain how to manage the cognitive and behavioral conditions which can occur in late-age patients. The negative stigma associated with psychiatric facilities has slowly been shifting as more modern evaluation, diagnosis, and treatment have become available. The state of psychiatric facilities in the United States now includes improved recognition of the underlying etiology behind behavioral problems and neurocognitive disorders, as well as drastically-improved facility conditions that are often patient-centric and focused on safety and comfort (Sharpe, 2014).

By the time of the twentieth century, formal practice of psychotherapy and psychiatric intervention was established, having built on the historical knowledge-base of medicine that preceded it. However, it became increasingly clear that understanding of the basic biological elements that influence acquisition and development of disease was insufficient to explain the wide range of factors that can influence physical and mental health. From the information gap inherent in this too-narrow biological reductionist perspective, the *Biopsychosocial Model* emerged.

The Biopsychosocial Model and Mental Health Conditions

The Biopsychosocial Model (Engel, 1989) theorizes that bio-physiological, psychological, and social/cultural aspects of disease are all interrelated and contribute to a more comprehensive understanding of the mechanisms involved in the prevention, acquisition, development, or maintenance of disease. Biological notions are still relevant in this Model and can include physical development, injury, or deterioration. For example, *synaptogenesis* and *pruning* are relevant to the developing brain in infancy and childhood, although they become less pertinent once the brain has passed a certain developmental threshold. More relevant for older adult populations would be preventative maintenance to help limit brain-based deterioration or impairment, which may be observed in such conditions as Alzheimer's dementia. Psychological components of the *Biopsychosocial Model* include psychiatric illness, emotional coping abilities, and cognitive elements such as the ability to understand and apply information. Additionally, social factors are used to collectively describe environmental factors associated with enhancement or management of disease. For example, access to healthcare, cultural differences in the expression of illness, or financial considerations all fall within the realm of "social" relevance. The intercorrelated nature of the bio-physiological, psychological, and social/cultural domains described by the *Biopsychosocial Model* is applicable to all age ranges throughout the lifespan. Recognition of the mental health needs and concerns within the geriatric population has been increasing recently, as there has been growing identification of the particular difficulties encountered by this age group. Along with the increase in research and the overall knowledge-base regarding mental health issues affecting adults, there has been growing interest in addressing the specific needs of elderly individuals suffering from psychiatric and neuropsychological disorders. For example, Eyre and colleagues (2015) suggest robust predictions of increased age-related cognitive problems and geriatric depression as the world's population collectively ages. Costs associated with healthcare have steadily increased over time, and costs associated with managing psychiatric conditions are no exception. As a representative example, the annual costs for dementia-related healthcare in the marketplace have been estimated between \$109 and \$172 billion (Hurd, Martorell, Delavande, Mullen, & Langa, 2013).

Similarly, spending on evaluation and treatment of psychiatric conditions has increased. Reasons for this increase include the growing overall volume of elderly individuals, as well as a proportionate increase in the availability of assessment and treatment services aimed at assisting these individuals. Additionally, stigma regarding mental healthcare in the general population has trended downward, with attitudes regarding seeking professional help for mental health problems improving over time. Older age (as well as female gender) has also been found to be associated with more positive attitudes toward mental health treatments (Parcesepe & Cabassa, 2013). Collectively, understanding of the mental health issues and needs of older adults has shifted over the course of history, and current efforts toward these aims have provided improvements in care. Still, challenges still remain in diagnosis, treatment, and full recognition of the wide range of biopsychosocial factors unique to older adults.

Psychosocial Aspects of Aging

As noted, mental health disorders across the lifespan can include significant distress and impairment for older adults. The psychosocial stressors often involved with aging are diverse and prevent challenges unique to older adults. When medical problems exist, including psychiatric or neurocognitive problems, the effects of these psychosocial stressors are compounded. For example, the financial costs associated with increased healthcare utilization, potentially including in-home healthcare services or residential treatment facilities, can be all but unaffordable for some. A recent survey suggested that the average cost of retirement is well over 700,000 dollars ("Finances in Retirement," 2017). As healthcare costs have continued to rise, these numbers will likely increase, particularly for those elderly individuals with chronic or progressive illnesses.

Stress on families and caregivers can be another burden associated with psychiatric disorders in the elderly. Caregiver burden is an important consideration that has received increasing recognition in the literature as a factor affecting various health outcomes (Adelman, Tmanova, Delgado, Dion, & Lachs, 2014). Assistance with activities of daily living (e.g., when the patient has functional limitations associated with mental health concerns) can be challenging for caregivers to consistently provide. As patients may receive feedback regarding this caregiver burden, feelings of resentment or guilt may arise which, unfortunately, may further exacerbate stress and contribute to interpersonal tensions within close relationships (Cousineau, McDowell, Hotz, & Hébert, 2003). Proper and adequate self-care for caregivers is essential in helping to limit caregiver burden and manage associated emotions more adaptively. The saying "it's difficult to pour from an empty cup" certainly applies here. Caregiver support groups and other psychosocial interventions have utility in providing a shared sense of community and to help support practical problem-solving for caregivers.

Given the focus on physical and cognitive decline in older adulthood, the notion of successful aging can easily be forgotten or dismissed. Although variably defined in the literature, common elements of successful aging include absence of disease and disability. More specific models to help explain successful aging paradigms indicate that "success" in aging can be more nuanced than simply absence of disease and disability. Factors associated with successful aging in the literature include aspects such as increased physical activity, not smoking, lower systolic blood pressure, and global cognitive functioning. A meta-analysis by Depp and Jeste (2006) found that the mean proportion of successful agers across the included studies was only 35.8% of older adults.

Ethical considerations come into play when discussing, for example, access to healthcare for older adults. Socioeconomically, older adults after retirement tend to receive less overall annual income than during peak periods of employment. This can lead to changes in the ability of patients to select ideal insurance plans. It also influences the likelihood of needing out-of-network healthcare services which frequently occurs in the realm of outpatient psychiatric and psychotherapeutic private practice. Additive psychosocial barriers include affordability of transportation to clinic visits, mobility concerns when experiencing frailty or comorbid medical issues, and variability of available resources across urban versus rural areas (i.e., clinics and hospitals tend to be built in population hubs, leaving those in rural environments with fewer options and further distances to travel for treatment). Furthermore, clinicians encounter ethical issues in the direct provision of care for the elderly. O'Connell, Sommer, and Dunn (2017) outline a range of ethical considerations often involving a "state of unease" between ethical principles and offer several examples of ethical dilemmas encountered by providers working with elderly patients. One such example suggests that elderly patients may have capacity for certain activities or decisions, while concurrently not having capacity for other activities or decisions.

Common Mental Health Concerns

The specific criteria for mental health disorders may be found in various sources, including the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10) (World Health Organization, 1992). However, the most frequently utilized source for diagnostic criteria among mental health professionals in the United States is the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013), and this diagnostic criteria set will be utilized throughout this chapter when describing the mental health disorders commonly encountered within the older adult population.

In the DSM-5, primary diagnostic categories vary from disorders of infancy and childhood to those originating during, or affecting the continuum of, the lifespan. For the purposes of the current chapter, the focus will be on disorders most likely to originate during or prominently affect older adult populations. Diagnostic categories in the DSM-5 include, among others, depressive disorders, anxiety disorders, substance-related and addictive disorders, personality disorders, trauma- and stressor-related disorders, bipolar and related disorders, and schizophrenia spectrum disorders.

In the context of aging adults, the category of neurocognitive disorders is of notable importance. Mild and major neurocognitive disorders refer to neuropsychological conditions in which the primary deficit is cognitive in nature and is reflective of acquired deficits rather than impairment that is developmental in nature. The cognitive deficits may be due to underlying medical conditions, medication or substance-induced conditions, or to Alzheimer's disease, vascular issues, Lewy bodies, Parkinson's disease, frontotemporal issues, traumatic brain injury, HIV infection, Huntington's disease, prion disease, or other underlying medical conditions (DSM-V, 2013). Typically, these disorders develop later in life, although no specific age requirement is necessary for diagnosis. Cognitive deficits associated with frontotemporal damage or deterioration can also lead to dysfunction in executive functioning. In a practical sense, these individuals may have difficulty with organization, planning, or difficulties with impulse control.

Sometimes, diagnostic opportunities are missed because mild neurocognitive disorders can be mistakenly attributed to normal age-related declines. Such statements as "My memory is slipping, but that's normal at my age" may in fact be true but, alternatively, may indicate the presence of a progressive neuropsychiatric condition. Thorough evaluation by mental health providers, sometimes including neuropsychological testing and diagnostic imaging, can help shed diagnostic light to distinguish between differential diagnoses. The importance of accurate evaluation, diagnosis, and treatment is underscored by psycho-ethical concerns inherent in determining capacity, competency, and addressing boundary concerns (Moye, Marson, & Edelstein, 2013). Comorbid psychiatric illnesses can also complicate diagnostic veracity. Overlap between symptoms of delirium, dementia, and depression can lead to misdiagnosis without careful consideration and thorough evaluation of each respective illness (Downing, Caprio, & Lyness, 2013). The respective symptoms can occur either independently or simultaneously and may vary across time points as seen in the progressive nature of dementia, or the waxing and waning course typical of delirium.

Individuals with chronic pain often suffer beyond the physical difficulties of an aging body. Chronic pain has been associated with increased risk of depression and anxiety, as the impact of chronic pain can be felt through various psychosocial stressors including functional disability (e.g., impairment in work and social functioning) and financial difficulties associated with high healthcare costs of managing pain (Gatchel &

Okifuji, 2006). Given the higher prevalence of chronic pain conditions in later adulthood, awareness of the emotional impact of pain is key. Somatic symptom disorders, which can include distress associated with physical complaints including pain, are often found in populations with predominant chronic illness and chronic pain concerns. In somatic symptom disorder, excessive thoughts, feelings, or behaviors associated with one or more somatic complaints lead to clinically significant distress. There is limited research regarding age-related differences in prevalence rates with somatoform-type symptom presentations, with some research suggesting that prevalence rates actually decease after the age of 65, although the reason for this decline remains unclear (Hilderink, Collard, Rosmalen, & Voshaar, 2013). As a result of chronic pain, another developing area of interest in the literature surrounds the growing opioid epidemic, with some research suggesting an inverse correlation between age and likelihood of opioid misuse (Papaleontiou et al., 2010). It appears that advanced age is associated with decreased likelihood of misuse behaviors, and prevalence rates of opioid abuse are lower in adults over 60 versus younger persons.

A growing area of interest, not without controversy reflective of the national debate regarding legalization of cannabis, involves the role of substance abuse in geriatric populations. Wu and Blazer (2013) offer that age-related changes may enhance adverse effects of substance use and, additionally, that there is an increased potential to self-medicate with substances (both prescribed and illicit) in light of increasing health problems. Prevalence rates tend to be lower for individuals over 65 as compared with younger individuals, with marijuana and alcohol being the most highly utilized substances, respectively. Individuals with substance use disorders are at higher relative risk of having comorbid psychiatric illness, including opiate use disorder (Kester, Strauss, Greenlee, Suzuki, & Huang, 2017). One-month prevalence rate estimates for older adults were approximately 1.0%.

Similar to substance use disorders, onset of symptoms for other psychiatric disorders can occur at various times across the lifespan. Although the mean age of onset for a manic, hypomanic, or depressive episode in bipolar I disorder is 18 years old, first onset can occur over the age of 65 (APA, 2013). Bipolar I symptoms, particularly when primary concerns involve disinhibitive symptoms (e.g., sexual indiscretions, social inhibition), should always be evaluated with respect to the possibility of other medical factors to prevent misdiagnosis. For example, these symptoms could potentially be the result of neurocognitive (e.g., frontotemporal dementia) or substance-induced problems. Schizophrenia is considered a chronic illness, with typical onset in the 20s, although symptoms may persist throughout the lifespan. Of note, psychotic symptoms actually tend to decrease in later adulthood, thought to possibly be related to naturally reduced dopaminergic activity (APA, 2013). According to Tamminga, Buchanan, and Gold (1998), as compared with positive symptoms (e.g., delusions or hallucinations), negative symptoms of schizophrenia tend to be the most persistent and are associated with poor overall outcome. Given the increased risk for adverse effects, including cardiac and metabolic issues, Gareri et al. (2014) offer recommendations for ethical use of antipsychotic medications for geriatric patients, including exclusive use of atypical antipsychotics (vs. first-generation antipsychotics) with lower risk of extrapyramidal side effects.

Although the literature has been mixed regarding the precise relationship between age and obsessive compulsive behaviors, the implications of having an obsessive compulsive or related disorder may be exacerbated for elderly individuals. For example, hoarding disorder can contribute to increased risk for falls, fire hazards, or interference with nutrition (Ayers et al., 2014). Obsessive compulsive disorder (OCD) tends to begin earlier in life, with elderly individuals having suffered, at times, for decades. In geriatric populations, the content of perseverative cognitions may differ from those of younger individuals with OCD. Obsessive cognitions regarding toileting and medication schedules are more frequent in older individuals with OCD versus non-elderly individuals (Dell'Osso et al., 2017).

Some mental health concerns stem from difficulties with emotional adjustment to life stressors, potentially including new medical diagnoses or end-of-life considerations. Problems with anxiety, including generalized anxiety disorder, specific phobias, panic disorder, and anxiety disorders due to medical conditions, remain challenging in older adulthood. Significantly higher rates of anxiety have been identified in medically ill geriatric patients (Tolin, Robison, Gaztambide, & Blank, 2005). Of note, anxiety disorders due to medical conditions have historically been misapplied as suggesting that the anxiety is "about" a medical condition, rather than a direct pathophysiological consequence of a medical condition. Examples of medical conditions with causal relationships to anxiety include vitamin B12 deficiency, encephalitis, and hyperthyroidism. Applied in the context of geriatric psychiatry, accurate diagnosis of anxiety symptoms and associated disorders allows providers to more efficiently and precisely address these symptoms through empirically supported treatments.

As one approach for managing anxiety symptoms includes psychotropic medications such as benzodiazepines, it is important for providers to consider risks and benefits of pharmacologic intervention specifically for elderly individuals. As benzodiazepines have been associated with increased risk of falls and various cognitive impairments (e.g., confusion) in geriatric populations, careful consideration of benefits versus risks is required. Ayers, Sorrell, Thorp, and Wetherell (2007) describe the role of anxiety in older adults, as well as insight into efforts toward effective evidence-based psychotherapeutic treatments. They found that relaxation training, cognitive-behavioral therapy, and also supportive therapy and cognitive therapy have demonstrated effectiveness in the literature, although they caution the need for additional studies given the relatively small geriatric sample sizes in the research.

Taken collectively, there is clearly a broad range of psychological and psychiatric elements that may contribute to distress and functional impairment within the geriatric population. Of these symptoms and disorders, Blazer (2003) suggests that depression is likely the most frequent cause of emotional distress in older adulthood. Accordingly, a closer inspection into the role and impact of depression within geriatric populations is warranted.

An Overview of Depression

In common vernacular, the term "depression" is often used in reference to the more formally titled Major Depressive Disorder. Although there are other depressive disorders, including persistent depressive disorder and depressive disorder due to another medical condition, for the purposes of this chapter, the term "depression" will reflect the literature regarding major depressive disorder (unless otherwise stated). According to the DSM-5 (APA, 2013), the symptoms of depression must include either depressed mood state or loss of interest or pleasure. Additional symptoms of depression include significant changes in appetite or weight, sleep-related disturbances, psychomotor retardation or agitation, fatigue, feelings of worthlessness or excessive guilt, difficulty with thinking, concentration, or decision-making, and recurrent thoughts of death or suicidal ideation. Duration of mood symptoms must last for at least 2 weeks, although the depressive episode may last significantly longer. Depression causes marked distress to the individual sufferer and also has societal implications given the tremendous financial resources, both directly (costs of treatment for depression) and indirectly (lost work time; functional impairment).

There is a qualitative difference between the more common human experience of "having the blues" or experiencing negative mood states in relation to challenging life events versus depression. According to the aforementioned meta-analysis by Depp and Jeste (2006), although variably defined, "successful" aging has been linked to minimal disability and the absence of depression. Once an individual has had a major depressive episode, the risk of experiencing future episodes of depression increases. Other risk factors for recurrence of depression include severity, comorbid psychiatric illnesses, female gender, and, relevant to the current chapter, older age (Hoertel et al., 2017). Although the criteria set for diagnosis is well-established, there remain some challenges inherent in accurately conceptualizing depression given the range of symptom clusters, duration, and severity (Snowdon & Almeida, 2013).

The Unique Presentation of Depression in Aging Populations

A wealth of research has demonstrated that the age of onset of depression greatly impacts the trajectory of future mental health. Furthermore, the age of onset of depression may be an indicator of the topography of the depressive episode. In a previous study by Charlton and colleagues (2013), age of onset of depression was separated into early onset (first episode prior to age 30), midlife onset (first episode between ages 30 and 49), and late onset (first episode after age 50). The late-onset group demonstrated greater weight loss and gastrointestinal symptoms. Additionally, early- and late-onset depression groups showed significantly more suicidal thoughts and early sleep insomnia (as opposed to midnight insomnia).

Research has repeatedly demonstrated that depression in elderly adults is characterized by more cognitive symptoms rather than emotional symptoms, which is opposite of younger counterparts (Blazer, 2002). Increased severity of depression is also associated with increased cognitive deficits, and these deficits may be especially severe among individuals with later-onset depression (Naismith et al., 2003; Salloway et al., 1996). The presentation of cognitive symptoms in older adults with depression may be misattributed solely to a medical condition or natural aging. Depression symptoms may go undetected or unnoticed because the primary impairments are cognitive in nature, rather than emotional; thus, highlighting the importance of sensitive screening that considers how depression presents differently across the lifespan in order to effectively identify and treat symptoms. Common symptoms, such as fatigue, limited appetite, or sleep disruptions, can be caused by medical conditions or medications rather than overt depression. Elderly patients are more likely to present with these somatic or insomnia symptom complaints to primary care physicians than any other provider type (Downing et al., 2013).

Etiology of Depression in Older Adults

Bereavement

There are several reasons why aging adults face disproportionately higher rates of depression. Due to the natural aging process, many older adults will begin to see a pruning of their social support as a result of death. For those who are healthy enough to live into later adulthood, they become familiar with the loss of spouses, siblings, and friends. Older adults face bereavement at disproportionately higher rates and have fewer resources (i.e., social support, finances, etc.) to assist them through this process. Previously, bereavement was considered a “rule-out” for a major depressive disorder if the symptoms lasted less than 2 months following the death of the loved one (American Psychiatric Association, 2000). However, updates in the diagnostic manual now recognize the severity of bereavement symptoms and do not distinguish between a major depressive episode and bereavement if symptoms requirements for the diagnosis are met. Additionally, a major depressive disorder with onset due to bereavement will respond similarly to psychosocial and psychiatric medication treatments as other non-bereavement-based depressive episodes (APA, 2013).

While the death of a loved one is sufficient to trigger depression, for many older adults, bereavement is often the catalyst for one’s own existential crisis. The death of others, particularly those similar in age, prompts one to think about personal finitude. The concept of an existential crisis is demonstrated in Erik Erickson’s stages of psychosocial development (1970); the inability to fulfill the major role obligations in a phase of development results in an existential identity crisis. The later life existential crisis is characterized by the desire to improve one's life before the onset of illness and death, and the primary domains of concern revolve around mortality, legacy, and achievement (Andrews, 2016). Those who do not resolve these concerns are likely to experience depression.

Decrease in Available Resources

Another risk factor for depression is psychosocial stress. Older adults experience financial strain and an overall decrease in available resources at disproportionately higher rates. They face natural physical maturation, along with higher rates of medical illness that impede their ability to maintain lucrative employment. As previously mentioned in this chapter, the cost of retirement alone places excess stress on older adults. According to the National Council on Aging, over 25 million Americans over the age of 60 are considered economically insecure, as they live at or below 25% of the federal poverty level.

Aging adults also experience a loss of independence and autonomy while simultaneously facing a loss in social support and financial resources. For many older adults, this creates a lack of access to positive reinforcement in the environment and feelings of helplessness that lead to depression. For example, when an older adult loses the ability to drive, this may mean losing his or her primary means to access social interaction and other rewarding pleasurable experiences. Financial strain, physical limitations, and decreased social support impede access to other forms of transportation at higher rates than younger age groups. When taken together, these psychosocial strains that affect older adults at disproportionately high rates are a pathway to the development or onset of depression.

Comorbid Medical Conditions

A third etiology for depression in older adults is the higher rate of medical conditions. Research demonstrates an overall increased risk for the development of depression in the presence of medical illness (Dew, 1998), and this relationship appears to be bidirectional in nature. Furthermore, older adults with depression have been shown to produce higher healthcare costs compared to non-depressed controls (Katon, Lin, Russo, & Unutzer, 2003), suggesting they access and require more intense and/or more frequent medical care.

Medical conditions that are typical of the aging adult may actually cause depressive symptoms due to changes in brain functioning, which could contribute to the presentation of increased cognitive impairment in depression exhibited by older adults. For example, vascular depression, a subtype of depression first proposed in 1995 (Hickie et al.), is based on the theory that vascular insufficiency in the brain leads to changes in the basal ganglia and frontal lobe structures. Vascular depression is defined by vascular disease, cognitive impairment, and late-onset all within the context of depression (Shear et al. 2005). This form of depression occurs exclusively in late life and is a prime example of depression associated with stroke.

According to the *National Stroke Association*, at least one-third of stroke survivors experience depression, and poststroke depression is underdiagnosed. The risk for stroke and depression is bidirectional, as chronic depression is a risk factor for stroke and the vascular insufficiency that occurs during a stroke may also cause depressive symptoms. Research in the medical field is also more closely identifying markers for poststroke depression, and some risk factors for mental health problems following stroke include aphasia and dominant hemispheric lesions (Mitchell et al., 2017).

Alzheimer's disease is another medical disease that contributes to vascular depression. Depression is common among individuals with Alzheimer's disease; however, it is often undetected as many of the symptoms overlap and are attributed solely to the medical condition. Shared symptoms between depression and Alzheimer's disease may include anhedonia or a loss of pleasure of interest in once enjoyable activities, difficulties with concentration, and impairments in sleep (hypersomnia or insomnia). Self-report of depression among individuals experiencing these diagnoses may be impacted by difficulties with memory and barriers in communicating or expressing one's experiences. Furthermore, due to the impairing nature of Alzheimer's disease, medical providers are often most concerned with managing the "primary disease" and not necessarily assessing for impairment related to mental health problems that may exacerbate the clinical picture.

Treatment for Depression: The Biopsychosocial Approach

A literature review of 74 studies concluded that older adults with depression endorsed a poorer quality of life. This finding appears to be stable with the passing of time, and individuals who endorsed poor quality of life when initially assessed were less likely to demonstrate improvements in depressive symptoms in follow-up care (Sivertsen, Bjoklof, Engedal, Selbaek, & Helvik, 2015). Therefore, improving quality of life may be a primary goal when attempting to address depressive symptoms.

Depression treatment is more successful when patients with depression are treated based on their personal preferences (Chilvers et al., 2001; Kwan, Dimidjian, & Rizvi, 2010). Furthermore, recent research demonstrated that depression influences which treatment options patients prefer, and the severity of symptoms contributes to indecision about treatment options (Luck-Sikorski et al., 2017). In a recent study conducted by Luck-Sikorski et al. (2017), elderly adults (patients 75 years and older) identified medication, psychotherapy, or a combination of the two as preferred treatments; however, overall preferences for engaging in treatment were found to decline with higher-depression symptom ratings. Logically, one might expect individuals experiencing higher levels of impairment to present to treatment. However, depression is amotivational in nature. Thus, the finding that older adults are less likely to engage in treatment with increased symptomology is likely a function of the disorder. Other studies also indicate that psychotherapy-use among older adults has recently decreased (Marcus & Olfson, 2010). Taken together, the implications of these findings are significant in highlighting the importance of early identification of, and dissemination of, various treatment options for depression. Older adults with more severe symptoms are not likely to experience a natural rebound in mood given the nature and complications of the aging process (i.e., increased isolation with time, declining physical health, decreased independence); therefore, there may be a limited "window of time" in which to engage this population in effective treatment if the individual is experiencing a rapid decline in mood functioning. Depression intervention in primary care (use of antidepressant medication as mainline treatment, and psychotherapy as alternative treatment) for older adults has demonstrated success, particularly for patients with more significant depressive symptoms (Bruce et al., 2004).

Effectiveness of Psychiatric Medications

Antidepressants are the most researched and the most utilized treatment for depression in older adults. Research has demonstrated that one-third of older adults who were treated with antidepressants achieved symptom remission (Kok, Nolen, & Heeren, 2012). While previous studies indicate that antidepressants are more effective than placebo for older adults, a meta-analysis that examined 34 randomized clinical trials, with individuals 60 years and older, indicated that, with increasing age, the effectiveness of antidepressants decreases (Calati et al., 2013). Another potential contributing factor limiting the success of antidepressants may be due to errors or oversight on the part of the prescribing physician for the older demographic. In a previous study of outpatient older adults with depression, 10.9% utilized antidepressants, and the majority of those individuals (59.6%) were prescribed a sub-therapeutic dose (Wilson, Copeland, Taylor, Donoghue, & McCracken, 1999). Recent research using the *National*

Ambulatory Medical Care Survey estimated that antidepressant prescriptions almost doubled between 2002 and 2012 (from 5.2% to 10.1%) among older adults seeking treatment in outpatient visits. Findings also suggested older adults were exposed to potentially preventable adverse side effects in one out of every ten antidepressant-related visits (Rhee, Schommer, Capistrant, Hadsell, & Uden, 2017).

Older patients often present with a more complex medical picture than their younger counterparts, and this greatly impacts how psychiatric medications are prescribed. For example, the use of pharmacotherapy for patients with dementia is contraindicated. Depressive symptoms may also be mistaken as anxiety among older adults due to difficulties with insomnia, and the use of benzodiazepines can interfere with optimal cognitive functioning. Research findings about the intricate nature of treating depression with pharmacotherapy among older adults suggest the need for more targeted training in geriatric psychiatry among providers, particularly as the average age of the population begins to rise. Results from the aforementioned studies indicate the need for separate and adjunctive treatment to reach the majority of older adults with depression who are inappropriate for, or non-responsive to, psychiatric medications.

Behavioral Interventions

A meta-analysis conducted by Pinquart and colleagues (2006) found that older adults with milder forms of depression, including persistent depressive disorder, may benefit more from psychotherapy than psychiatric medications. When conducting therapy with older adults, there are multiple barriers to treatment engagement, including cognitive functioning, medical status, conflicting medical appointments, cost of treatment, transportation, and availability of services. Taking these obstacles into consideration, the most effective behavioral interventions may be those that engage older adults of varying cognitive abilities and are accessible in multiple settings. When traditional individual or group psychotherapy options are appropriate and accessible, these are encouraged as primary interventions or as adjuncts to antidepressant medication. When behavioral therapies for depressed older adults were compared, cognitive-behavioral therapy and reminiscence/life review (a review of the past to find meaning in the present) demonstrated the largest effects, compared to interpersonal psychotherapy, brief psychodynamic therapy, psychoeducation, supportive interventions, and physical exercise, which demonstrated medium to small effects (Pinquart, Duberstein, & Lyness, 2007).

One form of cognitive-behavioral therapy that is widely administered within psychological and medical environments is *behavioral activation*. The theory of the intervention aligns well with the life of older adults, as Lewinsohn (1974) theorized that depression is caused by a diminished access to, or engagement in, positive reinforcement in the environment. Behavioral activation attempts to increase engagement in adaptive activities, decrease engagement in activities that maintain depression or create a risk for depression, and solve problems that limit access to positive reinforcement. *Behavioral activation*, as demonstrated by engagement in meaningful and rewarding activities, has been shown to be an effective intervention for depressive symptoms (Alexopoulos et al., 2016); however, older adults may have limited resources or access to promote behavioral activation, and the motivation to seek out these opportunities is likely to lessen with increases in depressive symptomology. Research conducted with older US Veterans receiving behavioral activation intervention through the Department of Veterans Affairs demonstrated no significant differences in cost between services delivered in-person versus telehealth (Egede et al., 2017). Furthermore, behavioral activation has been found to be equivalent in decreasing depressive symptoms, whether implemented with telemedicine versus in-person delivery (Egede et al., 2015). Currently, research is being conducted to examine if behavioral activation provided in the context of primary care for depressed older adults is effective if delivered by mental health nurses (Janssen et al., 2017). Results from this study may contribute to how mental healthcare is delivered in primary care settings by medical providers.

A literature review examining the effects of exercise alone on depression symptoms demonstrated that older adults who engaged in exercise demonstrated significant reductions in depressive symptoms (Catalan-Matamoros, Gomez-Conesa, Stubss, & Vancampfort, 2016). Furthermore, another study examined the effectiveness of exercise intervention among patients, aged 53 years and older, who were not responding to antidepressant therapy after at least 6 weeks of treatment through primary care, psychiatric services, or other mental health services (Mather et al., 2002). Results yielded a 30% reduction in self-reported depressive symptoms. Exercise intervention benefits not only mental health among older adults but also physical health. Broadening the treatment options for this demographic is important to engage individuals who may be more resistant of typical psychological intervention and may not be able to afford traditional psychotherapy. Dissemination of behavioral health treatments beyond the psychologist or the traditional mental health provider is imperative to reach the growing population of older adults. Creativity is key to be able to provide treatment to older adults suffering from depression in the environments that they frequently occupy.

Cognitive Impairment Interventions

Given that depression co-occurs with neuropsychological deficits, particularly among older adults, cognitive training tasks may be one way to improve overall cognitive functioning and depression simultaneously (Naismith & Mowszowski, 2016). Cognitive training works to teach new approaches to achieving goals by bypassing impaired cognitive processes and using new internal and external techniques. Research has demonstrated improved cognitive functioning and concomitant improvements in depressive symptoms (Diamond et al., 2015; Wolinksy et al., 2009). Furthermore, cognitive training may pose a new treatment option for older adults that may be preferred, particularly by those who are resistant to more traditional psychological intervention. It is important to note that, when considering treatment, the relationship between vascular depression and later life cognitive impairment due to stroke or Alzheimer's disease is bidirectional in nature. Therefore, cognitive functioning may rebound with improvement in depressive symptoms (McDermott & Ebmeier, 2009).

Availability of Treatment

It is crucial to address the availability of treatment options given the living conditions and limited access to resources among older adults struggling with depression. Increased rates of late-life depression are found among patients in hospitals and in nursing homes (Helvik, Skancke, & Selbaek, 2010; Luppa et al., 2012; Seitz, Purandare, & Conn, 2010). Additionally, previous research has found that treatment seeking was greater among those with accessibility to services (Nurit, Dana, & Yuval, 2016). In-house intervention within the nursing home and during prolonged hospitalizations allow for ease of access and may be most cost-effective as these are the environments where higher rates of depression are found. Furthermore, many of the treatment options may be delivered by staff trained in the intervention; thus allowing for reduced cost in delivery of services. Intervention may also be feasible for these patients when included in outpatient medical visits to make more efficient use of transportation.

Additional Considerations

Risk of Suicide

According to Volkert and colleagues (2013), suicide risk in the elderly is relatively high given the broader rates of depressive disorders. Recent estimates suggest that the rates of suicide for the elderly are 15.01 per 100,000, with 1 elderly suicide occurring every 96 min (American

Association of Suicidology, 2014). There are various reasons for this finding. Older adults tend to face increases in health-related challenges, decreased financial resources, and grief all in the context of less frequent opportunities for social contact and geographical distance from family members. Research has demonstrated that a lack of positive social connectedness is associated with suicide in older adulthood (Fassberg et al., 2012). All of these factors increase suicide risk for elderly individuals; however, these symptoms are often unassessed and may go ignored. Older adults frequent medical care settings, and this may prove a primary place for suicide prevention through routine assessment or screening. For example, research has shown that an increased number of illnesses are directly related to increased risk of suicide, and elderly adults who died by suicide were about two times as likely to have visited a medical physician within the week of death. Most individuals who died by suicide met with a physician within the month prior to death (Juurlink, Herrmann, Szalai, Kopp, & Redelmeier, 2004). Perhaps most concerning is that suicidal behavior among older adults is particularly lethal (Conwell, van Orden, & Caine, 2011) and, in the United States, older adults are less likely to endorse suicidal ideation to others (Duberstein et al., 1999).

Special Considerations

The combination of numerous risk factors with a lack of communication about suicidal thoughts, and particularly lethal attempts, suggests the need for widespread and regular assessment of suicidal ideation, intent, and planning among older adults. The first example of universal suicide screening in the United States was implemented at Parkland Health and Hospital System, an 862-bed county hospital in Dallas, Texas (Roaten, Johnson, Genzel, Khan, & North, 2018). Each patient who receives services at the hospital is administered a brief suicide screen by a staff member. Those who screen positive for risk of suicide are triaged for further assessment and, ultimately, higher levels of care as needed. Similar assessment could be more easily adopted by smaller medical facilities, particularly those that serve higher numbers of older adults. Therefore, training staff in suicide risk assessment and providing routine and universal suicide screening in medical practice is an important step in reducing death by suicide among older adults.

Role of Family and Caregivers in Symptom Management

Older adults face increased difficulties to treatment adherence, and family-member involvement may increase treatment adherence and improvements in depression symptoms (Unützer & Park, 2012). Family members and caregivers play an important role in providing collateral information to medical and mental health providers. When a family member or caregiver notices changes in the demeanor, activity level, and/or mood of an older adult, they can report this information to providers as the older adult may be less inclined to share these symptoms or may not be aware how to advocate for treatment. Family members and caregivers can educate themselves on the prevalence of depression in later life and be careful not to dismiss or automatically attribute depressive symptoms to another medical condition or aging. Furthermore, family and friends of older adults do not need to be experts in mental health to help reduce depressive symptoms. For example, increased positive social support is a protective factor against suicidal behavior; therefore, simply engaging in positive and routine contact with an older adult may decrease suicidal and depressive symptoms.

Cultural Considerations

It is always important to consider the role of culture when evaluating for psychiatric illness and psychosocial stressors. In many cultures, elderly individuals are revered for their wisdom, and older adults command respect for their wisdom. They tend to be more engaged in family and social functioning and can hold important places of leadership within family and cultural systems. In some Western societies, however, aging is viewed as more of an adverse situation of decline, loss, and indifference. In such cultures, older adults may be more at risk of being neglected and less involved in personally meaningful family or social relationships. Given that a notable risk factor for development of depression is social isolation, the cultural background and current standing of each individual must be properly placed into context to help conceptualize depressive symptoms.

Further highlighting the importance of culture, female gender, as well as minority racial and ethnic status, has been associated with higher risk of unemployment (National Council on Aging). Research examining potential discrepancies in depression treatment response between black and white older adults (older than age 60) found that treatment with psychiatric medication (venlafaxine) and supportive care demonstrated no significant differences in remission rates between groups, regardless of between-group differences in overall health functioning and previous treatment engagement (Hall et al., 2015). Cultural considerations also include spirituality, which appears to serve as a protective factor for depression and suicidal thoughts. More specifically, organizational religious activity and intrinsic religiosity may indirectly influence depression and suicidal ideation, but additional research is needed to demonstrate the strength of this relationship (Jung, Roh, Moon, & Kim, 2017).

Evaluating Depression

Given the information presented in this chapter about the risk for depression in older adults, is enough being done to identify depression among this age demographic? Detecting depression among older adults is confounded by high rates of medical comorbidity, resistance to psychiatric evaluation, poor self-report, and/or use of medications. However, as increasing rates of adults are entering into later stages of life due to aging of the baby boomer generation, depression detection becomes increasingly important. Sensitive screening measures, along with collateral information, may help to reduce the barriers to detection. Similar to suicide screening within this population, implementing routine depression assessment procedures in nursing homes, hospitals, and outpatient medical facilities will likely produce significant identification, as these are the settings with larger numbers of depressed older adults. Obtaining collateral information on a consistent basis from friends, family, and caregivers about an older adult's daily functioning will help place assessment results into context and add an additional layer of detection. This approach is particularly useful among older adults who are reticent to report depressive symptoms, or who may have difficulty providing accurate self-report due to other medical or cognitive difficulties.

As a representative sample of efforts to screen for depression in elderly adults, the *Geriatric Depression Scale* (Yesavage et al., 1983) is perhaps the most widely utilized self-rating assessment measure of depression among older adults. The scale has well-established reliability and validity and was normed on individuals over age 55. The 30-item "Yes/No" scale was designed to assess symptoms of both physically healthy and physically ill individuals, as well as those with mild to moderate cognitive impairments. A 15-item short form (*Geriatric Depression Scale-Short Form*) was also developed and demonstrated to have a strong correlation with the original form (Geriatric Depression Scale-Long Form; Sheik & Yesavage, 1986).

Key Research to Practice Message

Practice Recommendations

There are various ways to help bolster ethical treatment and decision-making when working with elderly individuals. For example, providers should carefully consider and aim for gold-standard professional ethics, including review of suggested best-practice guidelines from reputable professional organizations as well as consultation from colleagues or advisory boards when appropriate. In the APA's (2014) guidelines for working with elderly individuals, the authors' suggestions include working within an appropriate scope of competence, making effort to understand the aging process and associated psychosocial factors, and continuing education regarding the current state of knowledge about health and cognitive issues. Exploration and awareness of personal prejudices and biases against persons based on age-related factors can also facilitate meaningful change and help limit the likelihood of engaging in prejudicial practices.

Awareness of the unique presentation of depression in older adults can also help to guide appropriate assessment and intervention. For example, providers are encouraged to recognize the extended importance of cognitive symptoms in depression, as research supports the more cognitive expression of depression symptoms in elderly adults (versus emotional symptoms). Careful consideration and selection of psychotropic medications are also indicated given metabolic and other physiological differences between younger populations and elderly populations. The guiding theme of the aforementioned practice recommendations is that of appropriate acknowledgment of age-related factors when seeking to understand, evaluate, and provide ethical treatment services to older adult populations.

Future Directions in Practice and Research

There is a dearth of research examining depression, specifically with older adults; however, a spotlight has recently been shed on the health of older adults due to the "aging baby boomer generation." It is anticipated that this growing awareness of physical and psychiatric conditions will promote continued progress toward understanding and treating these issues. Given the complexities and seemingly ever-changing nature of the healthcare landscape, it will be critical to build upon the existing research-base, along with efforts to improve clinical care for elderly individuals suffering from mental health conditions. Efforts toward these goals continue and include recommendations for priority research areas. Hoeft and colleagues (2016) offer three domains targeted to help improve services for late-life depression. Chiefly, they suggest promotion of patient-centric and culturally sensitive care, inclusion of caregivers from outside of what has historically been considered the clinical-care team (e.g., family members, community-based programs), and inclusion of care in alternate settings other than primary care (e.g., nursing homes, community settings).

Future directions for clinical care may potentially include dissemination of depression treatments by nonmental health providers to help bolster access to care at the points of medical contact that are most commonly utilized by elderly individuals (e.g., integrated primary care). The aim of this approach would be to enhance access to care, potentially providing services for patients that otherwise may not have been identified or reached through current avenues. Moving forward, the feasibility of implementing routine screening procedures to identify depression and suicidal ideation should also be a primary focus of clinical attention.

Conclusion

Whether in regard to depression or any other of a range of psychiatric conditions, recognition of the factors associated with aging and unique to elderly adults is crucial in providing optimal treatment and care. Bearing in mind the historical context of attempts toward understanding mental health in older adult populations, it is with renewed vigor that present attempts seek to alleviate emotional distress and promote improved quality of life in this age group. As the so-called silver tidal wave of the aging baby boomer generation approaches, continued efforts toward recognizing the unique biopsychosocial needs of the elderly, including the important role of mental health in this population, and continued development of empirically based psychiatric and psychotherapeutic treatments will be key in bolstering support for this group.

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13 The Mismanagement of Multiple Medications in the Older Adult Population

Namirah Jamshed

Overview

Prescribing medications is an integral part of taking care of older adults. Medications are used to treat symptoms, cure or manage a disease, improve function and quality of life, and possibly improve survival. However, they are also the most frequently misused form of therapy for medical problems in the aged. This chapter will focus on how medications are mismanaged in the older population and its consequences. Indeed, mismanagement of medications in older people is associated with an increased risk of adverse drug reactions (ADRs), healthcare utilization, and mortality (Cahir, Bennett, Teljeur, & Fahey, 2014; Hamilton, Gallagher, Ryan, Byrne, & O'Mahony, 2011; Laroche, Charmes, Nouaille, Picard, & Merle, 2007; Lau, Kasper, Potter, Lyles, & Bennett, 2005; Passarelli, Jacob, & Figueras, 2005). In older people, age-related changes in pharmacokinetics, multiple chronic conditions (MCC), malnutrition, and polypharmacy make them vulnerable to ADRs (Mangoni & Jackson, 2004; Spinewine et al., 2007). Heterogeneity in older patients also makes prescription management complex. Changes in drug metabolism that occur with aging are based on complex interactions among genetics, physiology of aging, disease, and environment. To avoid mismanagement of medications in the elderly, we have to be aware of the impact of multiple medicines while interacting with these factors. With the rapidly growing older population and the number of MCC, it is imperative that we continuously monitor older people for potentially inappropriate prescribing (PIP) and potential prescription omission. The Centers for Medicare & Medicaid Services (CMS) monitors the use of high-risk medications in the elderly using Medicare Part D data. Medications are defined as high risk based upon the *Pharmacy Quality Alliance* drug list used for CMS Part D Star and include prescriptions recommended by the American Geriatrics Society (AGS). National data from 2014 shows that high-risk medication prescribing is 0.86 claims per elderly beneficiary. Southern parts of the United States have the highest rate of prescribing high-risk medications. Unfortunately, despite accepted consensus on high-risk medications and the availability of instruments to detect PIP, they continue to be prescribed (Fick et al., 2003).

PIP is a result of mismanagement of drugs. It includes medications given when the risk outweighs the benefit and omission of drugs when medically indicated (Spinewine et al., 2007). The prevalence of PIP in primary care is significant. In a study done in a primary care setting, one-third of patients aged over 65 were given

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medications that were potentially inappropriate. At the same time, drugs that may have been of benefit were absent in 84.8% of the people (Bruin-Huisman, Abu-Hanna, van HCPM, & Beers, 2017). The use of prescription medications is increasing in the United States. The National Health and Nutrition Examination Survey (NHANES) data estimated the prevalence of prescription drug use from 1999 to 2000 and 2011 to 2012. Thirty-nine percent of people over the age of 65 reported polypharmacy with an increase from 24% to 39% in 2011–2012. Drug classes that had a significant increase in use included antihypertensive, antihyperlipidemic agents, and antidepressants (Kantor, Rehm, Haas, Chan, & Giovannucci, 2015). The high prevalence of chronic conditions in the elderly makes them vulnerable to potentially harmful consequences due to ADRs, leading to increased hospitalization, exacerbation of illness, nursing home (NH) placement, and falls and fractures, in addition to nonadherence. In a study that evaluated the prevalence of PIP in community-dwelling older adults, 40% of them were using inappropriate medications as defined by the Beers criteria from 2003 (Fick, Mion, Beers, & Waller, 2008). The study also found an increase in healthcare utilization and cost related to drug problems when compared to patients not taking inappropriate medications. PIP is also associated with increased risk of hospitalization and death among NH residents (Lau, Kasper, Potter, & Lyles, 2004). The epidemiology of drug use in the older population is an essential factor in determining mismanagement of multiple medications.

Epidemiology of Medication Use in Older Adults

Seniors account for 13% of all the population but are responsible for 35% of all healthcare expenditure, 34% of all prescriptions dispensed, and 42% of prescription drug expenditure (Fan, Sharpe, & Hong, 2003; Rubin, Koelln, & Speas, 1995). In the United States, 88% of community-dwelling older people use one or more medications. Additionally, compared to other countries, the United States has a higher number of average medication use when compared to other countries. Medications used more often are cardiovascular, gastrointestinal, central nervous system, analgesics, and vitamins. In general, women take more medications than men (Giron et al., 1999; Hanlon et al., 1992; Hsu, Lin, Chou, & Lin, 1997; Nobili et al., 1997; Nolan & O'Malley, 1988). African American and Hispanic Americans tend to use fewer medications than whites (Espino et al., 1998; Hanlon et al., 1992). Hospital discharge is associated with a slightly higher number of medications when compared to that of community-dwelling older people (Beers, Dang, Hasegawa, & Tamai, 1989; Gonski, Stathers, Freiman, & Smith, 1993; Vankraaij, Haagsma, Go, & Gribnau, 1994). In long-term care facilities (LTCFs), the average number of routinely scheduled medications averages six to seven. The use of a psychotropic is a particular issue in the LTC setting. Dementia or mental illness has been associated with increased use of these medications in the LTC setting. In 1987, federal legislation mandated clearly defined medical indications for all medications prescribed in LTC. The Omnibus Budget Reconciliation Act (OBRA) of 1987 resulted in a significant reduction in the use of psychotropic drugs (Beardsley, Burns, Thompson, Larson, & Kamerow, 1989; Hughes, Lapane, & Mor, 2000). How a drug or drug-drug interaction harms or benefits an older person is dependent upon how each person handles that drug (*pharmacokinetics*) and how that drug affects the body (*pharmacodynamics*).

General Principles of Pharmacokinetics and Aging

Physiological changes occur with aging that may impair organ function. This change results in a reduction in physiologic reserve from homeostenosis, which reduces the ability to cope with stressors. Figure 13.1 shows the effect of homeostenosis as we age. The main changes occur in a reduction in renal and hepatic clearance. Elimination half-life is prolonged due to an

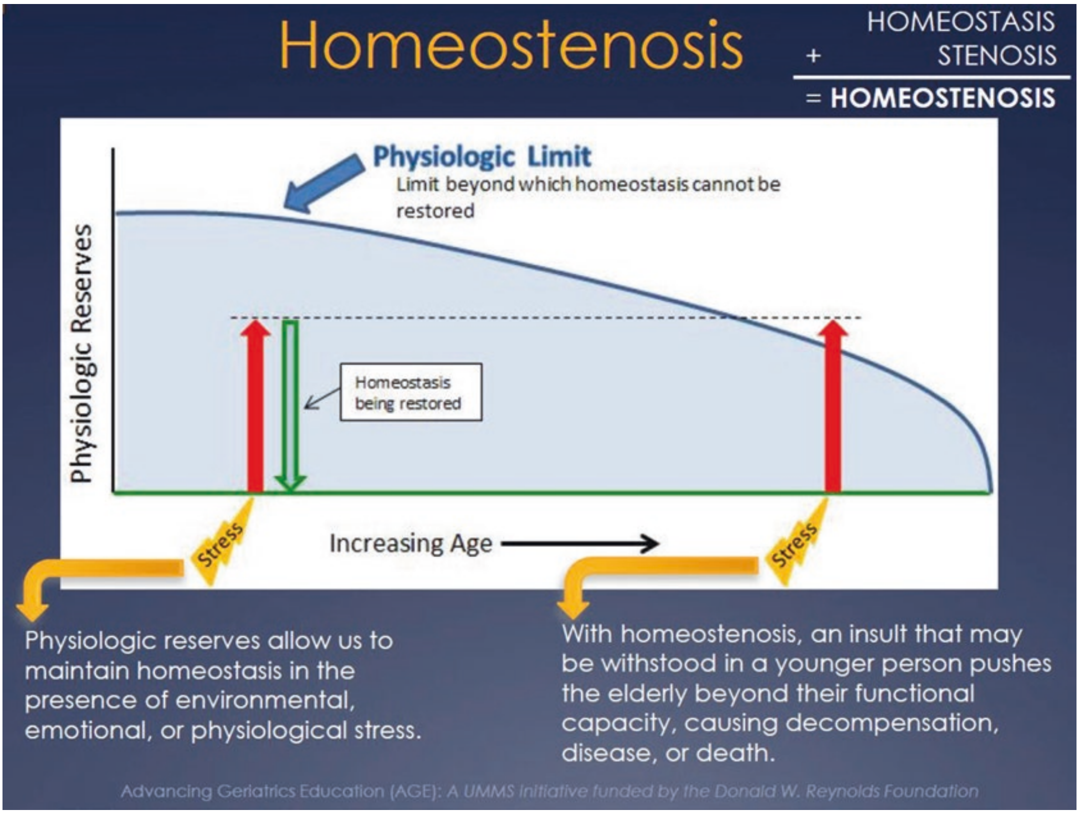

Fig. 13.1 Homeostatis in the older adult

increase in the volume of distribution of lipid-soluble drugs. There is also increased sensitivity to drug classes such as anticoagulants and psychotropic drugs (Mangoni & Jackson, 2004). Absorption, distribution, protein binding, metabolism, and elimination of drugs are affected, albeit heterogeneously among older people. Combined effects at both the physiological and organ levels thus have clinical consequences in older people. Table 13.1 summarizes the pharmacokinetics in the older adults.

Drug Absorption

Intestinal epithelium surface, gut motility, splanchnic blood flow, and likely gastric acid secretion decrease with age. Drugs such as tricyclic antidepressants (TCA) and opioids that reduce gut motility may further slow intestinal absorption. However, studies on the effect of aging on drug absorption are not consistent. Significant changes in absorption rates for different drugs have not been confirmed. There is some evidence that absorption is impaired for vitamin B12, iron, and calcium and increased for levodopa (Blechman & Gelb, 1999; Mangoni & Jackson, 2004). Tissue blood perfusion is reduced in older people. Reduction in perfusion could lead to a reduction in the rate of transdermal absorption. The same is true for absorption from the subcutaneous and muscular tissue. Because absorption is unpredictable in the older adults, intramuscular (IM) injections should be avoided. IM injections also increase the risk of sterile infiltrates (Trautinger, 2001).

Table 13.1 Pharmacokinetic changes in the older adult

Absorption	
Gastric pH Gastric emptying delayed A decrease in intestinal blood flow Passive diffusion minimally changed A reduction in first-pass hepatic extraction	Development of atrophic gastritis Use of acid-suppressive medications 30–40% decrease from age 20 to 70 Actively absorption drugs such as calcium may be reduced Increase bioavailability of drugs such as oral propranolol and morphine
Distribution	
A decrease in the volume of distribution of water-soluble (hydrophilic drugs) An increase in the volume of distribution of fat-soluble (lipophilic drugs) A reduction in serum albumin	Alteration of the relationship of unbound and total plasma drug concentration making drug concentration interpretation more difficult Measurement of free plasma drug concentration is preferable
Metabolism	
A decrease in phase I metabolism Sparing of phase II reactions Age-associated reduction in hepatic blood flow	Decrease in clearance Reduction in clearance of high hepatic extraction ratio drugs
Clearance	
Reduction in renal mass, number, and size of nephrons A decrease in glomerular filtration rate	Reduction in total body clearance of drugs primarily excreted by the kidneys[a] Risk of ADR for drugs with narrow therapeutic margin[b]

[a]Angiotensin-converting enzymes inhibitors, acetazolamide, amantadine, aminoglycosides, chlorpropamide, cimetidine, digoxin, furosemide, lithium, metformin, procainamide, ranitidine, vancomycin
[b]Digoxin, aminoglycosides, chemotherapeutics

Distribution

Drug plasma concentrations are inversely proportionate to the volume of distribution. The distribution volume is dependent on the size of hydrophilic and lipophilic spaces it the body. Aging results in a progressive reduction in total body water and lean body mass, while the relative body fat increases. Water-soluble drugs, therefore, have smaller volumes of distribution, which results in higher serum levels when compared to younger adults for equal doses. Examples include gentamicin, digoxin, ethanol, theophylline, and cimetidine (Redolfi, Borgogelli, & Lodola, 1979).

There are no age-related changes in concentrations of albumin or alpha acid glycoprotein. The volume for lipid-soluble drug, however, increases resulting in prolonged half-life. Examples of such medications include amiodarone, diazepam, and verapamil (Turnheim, 1998). The risk of overmedication increases in frailty. The proportion of fat decreases with aging which leads to a reduction in the volume of distribution for lipophilic drugs and, thus, increases their serum concentrations. Therefore, patients with lower body weight who are older are at risk of PIP (Campion, Avorn, Reder, & Olins, 1987; Turnheim, 2003). The clinical relevance of these changes is likely limited (Mangoni & Jackson, 2004). However, in older patients who have severe malnutrition with very low albumin, the increase in free-drug concentration can lead to significant drug toxicity (Turnheim, 2003).

First-Pass Metabolism and Bioavailability

The first-pass metabolism reduces with aging, likely due to a reduction in liver mass and blood flow. Thus, concentrations are significantly increased in drugs undergoing extensive first-pass metabolism but decreased for prodrugs that need activation in the liver. Labetalol and propranolol are examples of drugs that have increased concentration due to impaired first-pass metabolism (Castleden & George, 1979). ACE inhibitors are prodrugs and, thus, may be reduced with increasing age (Davies, Gomez, Irvin, & Walker, 1984). Besides, some drugs that are metabolized by the liver have a narrow therapeutic window, such as warfarin, and require careful monitoring.

Clearance

Glomerular filtration rate (GFR) declines with age. The reduction is due to declining GFR and tubular function. This reduction in GFR could result in decrease excretion of water-soluble drugs. The increased incidence of adverse drug reactions (ADRs) could be a result of a reduction in renal function. Clearance of drugs correlates with creatinine clearance (CrCl). Measurement of CrCl helps in renal dosing medications that are excreted by the kidney. However, as creatinine clearance declines, lower muscle mass can falsely lead to a normal creatinine level on laboratory results. The average decline in CrCl is 50% from age 25 to 85 years. Renal dosing is recommended based on the Cockcroft and Gault formula to calculate CrCl. It is important not to overlook the renal dosing of medications in older adults (Papaioannou, Clarke, Campbell, & Bédard, 2000). There is a concern that this formula may not be accurate when applied to frail older patients. Impaired renal clearance leads to prolongation of half-lives of renally excreted drugs and an increase in serum levels. Thus, drugs with a narrow therapeutic index, such as digoxin, lithium, or aminoglycosides, are likely to have serious adverse effects if they accumulate even marginally (Anathhanam, Powis, Cracknell, & Robson, 2012; Beyth & Shorr, 2002).

Clinical Implication of Pharmacokinetic Changes with Aging

Pharmacokinetic changes with aging are expressed clinically as an unpredictable response to drug therapy when compared to younger adults. Clinicians should consider these changes when prescribing medications, because they may lead to ADRs. Both the frequency and severity of ADR increase in older patients. The two organ systems most commonly affected are the cardiovascular and central nervous systems (Hammerlein, Derendorf, & Lowenthal, 1998). The former shows a decline in responsiveness of the myocardium to catecholamine and norepinephrine, not only at rest but also with exercise. Beta receptor-mediated systemic cardiac and vascular responses decrease in older people. Significant structural, electrophysiological, and biochemical changes with aging are evident in the central nervous system, involving neurotransmitters. Use caution when using psychotropic agents due to the high frequency of delirium that could lead to hospitalizations. There is also a concern that a reduction in endogenous neurotransmitters causes an increased sensitivity. It is hard to extrapolate data from clinical trials that do not include older patients, to this population (Hammerlein et al., 1998). Clinicians need to transcend gaps in evidence-based medicine. Prescribing the right medication in the right dose for the right individual is extremely important for older people but is not without challenges.

Changes in Pharmacodynamics

The data on the differences in pharmacodynamics with aging are lacking. Pharmacodynamics can affect a person either by changing the sensitivity due to changes in number or quality of receptors. Alternatively, homeostenosis can affect pharmacodynamics. There are some data to show that some older people respond to certain drugs with increased or decreased sensitivity. Table 13.2 summarizes these medications.

Older people are less responsive to both beta-blockers and beta-agonists (Turner, Mier, Spina, Schechtman, & Ehsani, 1999; Vestal, Wood, & Shand, 1979). Also, there is a diminished maximum response to furosemide (Feely & Coakley, 1990). Of particular interest is the sensitivity to benzodiazepines. Psychomotor testing has shown that older people are more sensitive to the effects of benzodiazepines, such as nitrazepam, temazepam, midazolam, and diazepam. They also show increased sensitivity for opioids, metoclopramide, dopamine agonists, levodopa, and traditional neuroleptics (Feely & Coakley, 1990; Klotz, 1998).

Table 13.2 Drugs affected by changes in pharmacodynamics

Increased sensitivity	Decreased sensitivity
Benzodiazepines	Beta-blocker
Calcium antagonists	Beta-agonists
Dopaminergic agents	Calcium antagonists
H1-antihistamines	Furosemide
Metoclopramide	Vaccines
Neuroleptics	
Opioids	
Warfarin	

Additionally, autonomic dysfunction, impaired thermoregulation, decreased nutritional intake, lower cognitive reserve, glucose intolerance, and immunosenescence may affect response to a drug. Lower reserve, defined as homeostenosis, puts the older person at risk of adverse reactions to multiple medications such as orthostatic/falls with antihypertensive, TCA, and neuroleptics, urinary retention and constipation from anticholinergic drugs, and delirium and falls from any medications that have sedating properties (Agostini, Han, & Tinetti, 2004; Collins, Exton-Smith, James, & Oliver, 1980; Johnson, Smith, Spalding, & Wollner, 1965; Sheldon, 1963; Souchet, Lapeyre-Mestre, & Montastruc, 2005; Swift, 1984). Changes in both pharmacokinetics and pharmacodynamics can result in drug-drug interactions with polypharmacy.

Polypharmacy

Polypharmacy can be defined both as the concurrent use of multiple drugs or the administration of more medications than are clinically indicated. The change in aging demographics, advances in chronic disease treatment, and medication use for secondary prevention are some reasons for polypharmacy. Almost one-half (46%) of the hospitalized older patient take seven or more medications. These patients are frequently discharged on at least one additional medicine from the hospital. Americans in the community take an average of 2.7–4.2 prescription and nonprescription drugs (Hanlon, Schmader, Ruby, & Weinberger, 2001). The trend is similar in the United Kingdom (UK) where 45% of the medicines are given to people over the age of 65 (Wynne & Blagburn, 2010). It is not infrequent that older people are prescribed medications that have no clear indication or are ineffective. As people live longer, polypharmacy will be a significant challenge. Multiple comorbid conditions (MCC) pose the most significant risk for polypharmacy. The high prevalence of conditions MCC in older adults can lead to an increasing number of prescription and nonprescription drugs. In the United States, 80% of those over the age of 65 have two or more chronic conditions. Consequences include drug-drug interaction, drug-disease interaction, reduction in functional capacity, medication nonadherence, increase in geriatric syndromes, and increased mortality. Geriatric syndromes could consist of delirium, falls, hip fractures, and urinary incontinence. It is estimated that drugs alone account for about 12–39% of cases of delirium, the most common medications associated with this to include opiates, benzodiazepines, and anticholinergics (Alagiakrishnan & Wiens, 2004). A scoring tool, such as the anticholinergic cognitive burden scale (Indianapolis University Center for Aging Research, 2012), can be used to assess the risk of cognitive impairment with these medications. Controlled analysis has also shown an association between the number of prescription medication with declining functional status and intermediate activities of daily living in older community-dwelling women (Lau, Mercaldo, Shega, Rademaker, & Weintraub, 2011). Risk factors other than age include white race, poorer health, and the number of healthcare visits.

Changes in the pharmacokinetics with aging increase the risk of ADRs in the elderly. These are strongly correlated with a growing number of drugs taken. About 28% of hospital admissions in the United States for older adults are a result of a drug-related problem. Type A ADRs are natural reactions, related to the mechanism of action of the drug, and thus predictable side effects. Typically, they are dose-related toxicities and are related to the pharmacologic effect of the drug. These can also occur in the setting of renal or hepatic impairment. They are associated with high morbidity and low mortality. Examples include orthostatic hypotension from the use of anti-hypertensive medication. Type B reactions are personal and new responses that cannot be predicted from the known pharmacology of a drug. They are independent of dose and are rare. They are associated with low morbidity and high mortality. Hypersensitivity reactions are an example of type B ADRs. Approximately, 80% of ADRs related to hospitalization are type A (Schatz & Weber, 2015). Since they are predictable, they are potentially avoidable as well. Table 13.3 gives a detailed classification of adverse drug reactions (Edwards & Aronson, 2000). The risk of ADRs increases with the number of medications. Taking two medications increases the risk to 15%, 58% with five, and 82% with over seven medications (Prybys, Melville, Hanna, Gee, & Chyka, 2002). The most common drug groups associated with preventable hospitalization due to ADRs include antiplatelets (16%), diuretics (15.95%), NSAIDs (11%), and anticoagulants (8.3%) (Howard et al., 2007). Thus, polypharmacy is associated with increased healthcare costs, due to an increase in healthcare utilization and cost to the patient. The annual cost of drug-related morbidity and mortality in outpatient clinics is as high as 76.6 billion dollars (Ernst & Grizzle, 2001). Many treatment recommendations are based on studies conducted with young adults and exclude older adults with MCC. Treating the disease and not the patient, based on such guidelines, could lead to risks and benefits in this population that are unclear. Prescription cascades, such as those that drive medication to treat a side effect of another prescription, are common. Thus, managing ADRs in the older population remains challenging but an integral part of practicing medicine. Guiding principles and tools to assist with PIP in older people can close these knowledge and practice gap.

Guiding Principles of Prescribing for Older Patients

Appropriateness of Drug Therapy

How appropriate a prescription is refers to whether a medication is clinically effective. The benefits of the drug should outweigh the risks. Drugs should be safe without any drug-drug or disease-drug interactions. Based on aging physiology, drugs need to be correctly dosed and monitored if required. Finally, patients should be able to adhere to the medication schedule. Prescribing medications in older patients is a complicated process. Goals of care must be considered to optimize drug treatment to meet patient needs. Medication appropriateness can be evaluated by using a team-based approach to perform medication reconciliation. By doing so, we can eliminate unnecessary medications that are not clinically indicated and useful. Validated tools can be used to treat conditions that would be appropriate to treat. However, risk and benefit of these medications should be individualized. The highest risk of inappropriate medication use is during transitions of care across settings. Initially, these efforts can be overwhelming; however, such an approach will benefit the patient and avoid ADRs (Zullo, Gray, Holmes, & Marcum, 2017).

Starting Medications

Potentially beneficial medications are often omitted from being prescribed in hospitalized older adults. START (*Screening Tool to Alert doctors to the Right Treatment*) is a set of 22 validated criteria that was designed to address this. It was developed by a consensus process that involved experts in geriatric pharmacotherapy. Initially established in 2008, it was intended to assess prescribing in older adults in Europe. In 2015, it was updated to include drugs altered by renal function, thus needing renal dosing (O'Mahony et al., 2015). Therapies that may frequently be omitted among others in older patients, despite benefit, include a statin, antico-

Table 13.3 Types of adverse drug reactions

Type of reaction	Mnemonic	Features	Examples	Management
A: Dose-related	Augmented	Common Related to a pharmacological action of the drug Predictable Low mortality	Toxic effects: Digoxin toxicity; serotonin syndrome with SSRIs Side effects: Anticholinergic effects of tricyclic antidepressants	Reduce dose or withhold Consider effects of concomitant therapy
B: Non-dose-related	Bizarre	Uncommon Not related to a pharmacological action of the drug Unpredictable High mortality	Immunological reactions: Penicillin hypersensitivity Idiosyncratic reactions: Acute porphyria Malignant hyperthermia Pseudoallergy (e.g., ampicillin rash)	Withhold and avoid in future
C: Dose-related and time-related	Chronic	Uncommon Related to the cumulative dose	Hypothalamic-pituitary-adrenal axis suppression by corticosteroids	Reduce dose or withhold; withdrawal may have to be prolonged
D: Time-related	Delayed	Uncommon Usually dose-related Occurs or becomes apparent some time after the use of the drug	Teratogenesis (e.g., vaginal adenocarcinoma with diethylstilbestrol) Carcinogenesis Tardive dyskinesia	Often intractable
E: Withdrawal	End of use	Uncommon Occurs soon after withdrawal of the drug	Opiate withdrawal syndrome Myocardial ischemia (β-blocker withdrawal)	Reintroduce and withdraw slowly
F: Unexpected failure of therapy	Failure	Common Dose-related Often caused by drug interactions	Inadequate dosage of an oral contraceptive, particularly when used with specific enzyme inducers	Increase dosage Consider effects of concomitant therapy

agulation, ACE inhibitor, aspirin, metformin, antidepressants, antihypertensive therapy, L-dopa, and home oxygen for respiratory failure. Unfortunately, the detection of "under-prescribed" medications is based on disease-oriented guidelines, but not considering that most geriatric patients have multiple chronic conditions. Evidence suggests that patients with coronary artery disease, diabetes, and hyperlipidemia would benefit from a beta-blocker, ACEI, aspirin, statin, and drug to control DM. Following disease-oriented guidelines could result in a patient taking six or more medications. Some clinicians may thus "under-prescribe" to improve adherence and lower pill burden. Additionally, this kind or under-prescribing could reduce the risk of drug-drug interactions. However, such an approach requires patient-centered care that prioritizes and focuses on patient goals. Underutilization among clinicians may result from lack of knowledge of the benefit of that drug for the older population as well as its affordability and dose availability. Among the acutely ill newly hospitalized elderly patients, 57.9% had at least one appropriate medication missing from their list of regular prescription medications (Barry, Gallagher, Ryan, & O'Mahony, 2007). The probability of not prescribing appropriate medication increases in those over the age of 85 and female patients. Failure to not prescribe at a therapeutic level or under-prescribe could adversely affect outcomes. A typical example of under-prescribing is not starting anticoagulation for chronic atrial fibrillation in the elderly, despite the absence of definitive contraindications (Brophy et al., 2004). The consequence of this would result in a high rate of stroke or death (Hylek, Evans-Molina, Shea, Henault, & Regan, 2007). A prospective observational registry confirmed the risk of stroke prevention outweighed the risk of significant bleeding. However, the pattern of prescribing is changing in this vulnerable group with a greater willingness to treat elderly patients with atrial fibrillation for stroke prevention (Patti et al., 2017). The optimization of medication management in the older population is significant due to its clinical and economic implications.

Potentially Inappropriate Prescribing

Inappropriate prescribing of medication in older people includes the use of drugs that should be avoided in the elderly, pose more harm than benefit, are poorly tolerated by most older people, or are likely to exacerbate a clinical problem in older adults. It also includes underuse of appropriate medicines as has been discussed earlier. Inappropriate prescription increases morbidity and mortality in older adults. Between 25% and 40% of hospital admissions in elderly patients may be linked to drug-related problems. Also, 14–27% of community-dwelling older people in the United States use medications that should be avoided in older adults. PIP is associated with adverse outcomes, such as hospitalization and death in the nursing home setting (Fialova et al., 2005).

Multiple criteria have been published to address potentially inappropriate prescribing (PIP). These include the *Beers* criteria that were developed in the United States, first published in 1991, and subsequently modified in 1997, 2003, and latest in 2012 by an expert panel from the American Geriatrics Society (Laroche et al., 2007). Modified Beers criteria consist of two lists of drugs to be avoided in elderly patients: independent of diagnosis and considering diagnosis. Megestrol (Megace), glyburide, and sliding-scale insulin have been added to the list of medications that should be avoided in older adults (Gonski et al., 1993). In patients with syncope and risk of bradycardia, avoid use of acetylcholinesterase inhibitors (Gonski et al., 1993). Similarly, clinicians should avoid glitazones in patients with heart failure and selective serotonin reuptake inhibitors in patients with history of falls (Gonski et al., 1993; Vankraaij et al., 1994). The Beers criteria can be accessed on the American Geriatrics Society website at http://www.americangeriatrics.org. The site also allows printing it as a pocket card or downloading it as a smartphone app for the detection of potential errors of prescribing commission and omission.

Screening Tools of Older Persons' Prescriptions (STOPP) and *Screening Tool to Alert doctors to Right Treatment* (START) are unique in that they recognize both aspects of PIP. START outlines 22 evidence-based prescribing indicators of common prescribing omissions, based on commonly encountered diseases in older persons. STOPP comprises 65 indicators that pertain primarily to important drug-drug and drug-disease interactions potentially leading to side effects, such as cognitive decline and falls and therapeutic duplication. Medications in the STOPP criteria have been associated with ADRs (Hamilton et al., 2011). STOPP/START as a tool for older patients hospitalized with an acute illness improves the appropriateness of medication that is persistent up to 6 months after discharge. Additionally, if used within 72 h of admission, it reduces ADRs significantly with an absolute risk reduction of 9.3%. The routine application of the STOPP, START, and Beers criteria to show a meaningful clinical response and a significant reduction in ADR still needs to be investigated (O'Mahony et al., 2015). None of these criteria for PIP are meant to replace clinical judgment. The goal of these criteria is to reduce the occurrence of adverse drug events (ADE) and improve management of older patients. We cannot completely avoid potentially inappropriate medications. There are times when clinicians and patients agree that the benefits of the medication outweigh the risks. Therefore, prescribing decisions should always be individualized, based on functional status, cognitive status, psychosocial assessment, quality of life, and goals of care. Prognostication plays an important role in this shared decision-making (Pretorius, Gataric, Swedlund, & Miller, 2013).

A common PIP is the use of proton-pump inhibitor (PPI) for hospitalized patients for stress ulcer prophylaxis. The use of PPI has increased up to 456% in the 1990s since its introduction in the 1980s (Guda, Noonan, Kreiner, Partington, & Vakil, 2004). Overuse of PPI is associated with risk of *Clostridium difficile* infection (Cunningham, Dale, Undy, & Gaunt, 2003). Many of these patients are started on PPI for non-ICU settings during hospitalization and then not discontinued upon discharge despite lack of justification for a continued prescription. Other examples of PIP include increased risk of opioid use in patients with a history of falls and fractures and the use of antipsychotics for patients with dementia and behavioral or psychosocial disturbances (BPSD), (The American Geriatrics Society Beers Criteria Update Expert Panel, 2015). The Beers criteria for inappropriate medications in older adults have been developed to guide clinicians on prescribing in older adults (The American Geriatrics Society Beers Criteria Update Expert Panel, 2015). The criteria apply to all older adults, except those in palliative and hospice care. The 2015 updated version includes guidance on drugs that require renal dosing and have drug-drug interactions. Both Beers criteria and START/STOPP are limited in that older patients are underrepresented in most trials. The approach based on evidence could underestimate problems. The principle of "start low and go slow" continues to be taught in geriatric medicine. This principle applies to medications with a narrow therapeutic index or those with increased pharmacodynamics effect in older age, such as atenolol, oxybutynin, and lisinopril. Medication that may increase the risk of bleeding, geriatric syndromes, or change in mental status should be avoided in older patients as much as possible. For these patients, non-pharmacological therapies should be used. Clinicians are faced with significant challenges when prescribing for older adults. Overall management of an older patient, including prescribing, should be based on the patient's goals of care and a discussion of risks and benefits of medications.

Adherence

Medication adherence is important in the management of multiple chronic conditions in the elderly. The term medication adherence is defined as the extent to which a person's behavior coincides with the agreed medication regimen from a healthcare provider. Polypharmacy could lead to a higher chance of medication nonadherence. Nonadherence could lead to subtherapeutic doses and exacerbations of chronic diseases, leading to increased morbidity and healthcare utilization. Multiple factors are responsible for medication nonadherence. These include patient factors, medication factors, socioeconomic factors, and healthcare system and healthcare provider factors. Multiple patient factors, including behavior and attitudes, beliefs, and mental health, can affect adherence. Examples of medication factors include the cost of medication, complicated dosing schedule, and adverse drug effects. Provider factors are geared toward lack of communication and trust, whereas the healthcare system is unable to provide adequate follow-up and education leading to this phenomenon. Lack of a caregiver, or caregiver burden, is mainly responsible for the socioeconomic factor. Adherence can be improved with patient and caregiver education, communicating the desired benefit and possible adverse effects. Simple directions for how to take the medication and simplified regimen to once a day when possible would be beneficial. Patients should be given the formulation that best suits their needs, such as liquid or sprinkles when indicated. Pill boxes, or blister packs, may improve adherence for medication for chronic illnesses. For patients to receive a therapeutic benefit, it is important that their medication adherence be optimal. However, adherence to medications has always been an issue, especially among the elderly. It is important to keep the patient, medication, healthcare providers, healthcare system, and socioeconomic factors in mind to be able to come up with suitable and individualized solutions to overcome these issues. There is a need to ensure adherence to the medications prescribed so that the patient would be able to receive maximum therapeutic benefits (Yap, Thirumoorthy, & Kwan, 2016).

Cost-Effective Prescribing

Cost-effective prescribing is prescribing a medication that is both clinically and economically appropriate for a condition. Patients, prescribers, payers, and policymakers are all dealing with the increasing cost of prescription drugs in the United States. Approximately 12.5% of the population, over the age of 65 in the United States, consumes 32% of all prescription medications and 30% of the total healthcare expenditure. The United States (US) spends more on prescription medications than other countries. In 2013 the per capita spending for the United States on prescription drugs was $858 when compared to the average of 19 advanced nations at $400. Increasing drug cost contributes to healthcare spending and has significant clinical implications. Higher co-pays can be a driving force for lack of affordability, nonadherence, and negative clinical outcomes. Clinicians and patients need to become familiar with the cost of medications. These costs should be discussed with patients to come to an informed decision. Many clinicians and patients insist on brand-name drugs instead of generic. Using free samples of expensive drugs, left by pharmaceutical companies, results in the subsequent prescription of these brand names, thus increasing medication cost both to the healthcare system and the patient. Value-based prescribing should be an integral part of continuing medical education of all healthcare professionals who prescribe medications. Point-of-care reminders in electronic medical records can be used to improve prescribing knowledge, attitudes, and practices (Kesselheim, Avorn, & Sarpatwari, 2016). Some practical solutions to prescribing cost-effective medications include not prescribing a medication just because it is the latest on the market. Not all patients benefit from new and expensive drugs. Cost-effective prescribing improves the chance that drug costs would not burden the healthcare system or the patient. Patients and caregivers should be educated about generic medications. Many drugs now have generic equivalents that are affordable. These include fluoxetine (Prozac), lovastatin (Mevacor), lisinopril (Zestril), bupropion (Wellbutrin), metformin (Glucophage), loratadine (Claritin), and omeprazole (Prilosec). Most insurances have lower co-pays for generic versions of the brand-name drug. Lastly, providers can use evidence-based medicine to guide their treatment choice. Guidelines need to specify when a costly medication would benefit the patient. Oregon Health and Science University's Evidence-based Practice Center provides guidelines that provide an evidence-based approach to prescribing medications. Via their website http://www.ohppr.state.or.us/hrc/PMPD_hrc.htm#drugclass, they briefly summarize evidence-based approach on the advantages of one drug or class of drugs over another. They also include sample drug prices. Currently, the website includes information for many drug classes, including statins, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, proton-pump inhibitors, NSAIDs, and opioids (Tseng, 2004). Most recently, *the Screening Tool of Older Persons Prescriptions Frail* (STOPPFrail) identified 27 items that are potentially inappropriate. The criteria were developed to assist clinicians to deprescribe in frail older adults who have limited life expectancy. The tool assists clinicians with medication reviews and assessment of treatment goals in this context (Lavan, Gallagher, Parsons, & O'Mahony, 2017).

Drug-Induced Falls

Falls are related to the use of a higher number of medications. Drugs that have shown the most active association in studies include SSRI, TCA antidepressants, neuroleptic agents, BDZ, anticonvulsants, and class IA antiarrhythmic medications. One study showed the benefit of tapering and discontinuing psychotropic drugs by showing a 39% reduction in the rate of falling. A multifactorial approach to fall includes review and possible modification of medications. Because psychotropic medications have a strong association with falls, we should pay particular attention when prescribing them. There is also benefit shown by reducing the total number of medications to four or less for fall prevention.

Dementia and Medications

Approximately 47-million people around the world have dementia. Patients with dementia have higher comorbidity and polypharmacy than other patients when adjusted for age and gender (Clague, Mercer, McLean, Reynish, & Guthrie, 2017). Reasons cited are lack of guidelines, incomplete medical histories, lack of clinician time, diminished decision-making capacity, difficulty with comprehension and communication, and challenges in establishing goals of care (Reeve, Bell, & Hilmer, 2015). Many studies exclude elderly patients with comorbidities, thus providing little evidence for guidelines to optimize medication in this population. Evidence-based programs, incorporating patients' goals of care and clinical expertise, may assist in addressing polypharmacy in this population.

NSAIDS

Clinicians prescribe NSAIDs frequently for older patients. In patients with hypertension, NSAIDs may raise blood pressure. Blood pressure increases due to vasoconstriction and ECF volume expansion that may occur with these drugs. Such an effect, in turn, would lead to an increasing number of antihypertensive medications. The best approach would be to avoid using NSAIDs in older patients with hypertension and treat with alternative management. Clinicians should use the lowest dose if treatment is needed. Additionally, blood pressure should be monitored to detect any increase. Such an approach can avoid polypharmacy to treat elevated BP associated with NSAID use.

Thiazide Diuretics

Thiazide diuretics are one of the antihypertensives frequently used for blood pressure control. Both the European Society of Hypertension and Cardiology and the Eighth Joint National Committee guidelines recommend these for older patients with systolic hypertension (James et al., 2014; Mancia et al., 2014). In a systematic review, author found that thiazides reduced the risk of stroke and cardiovascular events (Sommerauer et al., 2017). The onset of action occurs in 2–3 h for most thiazides. The half-life ranges from 8 to 12 h which allows for once a day dosing. Chlorthalidone is twice as potent as hydrochlorothiazide with an elimination half-life of 50–60 h. Adverse effects include hypokalemia, hyperuricemia, hyperglycemia, hyponatremia, and hypomagnesemia (Practice, 2010). Not all hyperuricemia with this drug is associated with gout (Rochon & Gurwitz, 1997). The risk of hypokalemia can be reduced by combination treatment with an angiotensin-converting enzyme (ACE) inhibitor or angiotensin II receptor blocker (ARB). In older adults, it would be wise to monitor electrolytes 1–2 weeks after starting these medications. As with all medicines in older people, start low and go slow principle would benefit them when beginning these medications for blood pressure control.

Metoclopramide

Metoclopramide is used for the treatment of gastroparesis, nausea, vomiting, and GERD. Its main adverse effect is related to extrapyramidal signs and symptoms. If the side effects are mistaken for Parkinsonism, patients could end up on treatment with levodopa. Such prescribing cascades can be avoided by using non-pharmacological therapy for managing older patients, using the lowest effective dose, and considering safer alternatives that are safer for older patients (Rochon & Gurwitz, 1997).

Acetaminophen

Acetaminophen is the first-line analgesic for non-malignant pain. Acetaminophen-induced liver damage, from an accidental overdose, accounts for up to 55% of cases in older adults. The damage is, however, dose-related. Risk factors for hepatotoxicity include malnutrition, chronic alcohol consumption, and concurrent use of CYP-inducing drugs. Dose reduction is necessary for frail older adults for these reasons (Mitchell, Kane, & Hilmer, 2011).

Conclusion

Medication prescribing in older adults is a complicated process. It demands an interdisciplinary approach. Clinicians taking care of older adults have to transcend gaps in evidence-based medicine due to lack of studies including patients with MCC. Inappropriate prescribing can increase the risk of ADRs and thus adversely affects the patient and increases healthcare utilization and costs. We need studies that focus on processes that can guide medication use and strategies to reduce PIP.

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Part III

Clinical, Occupational and Functional Rehabilitation for the Aging Population

14 Employment Strategies for Older Adults

Susanne M. Bruyère, Sarah von Schrader, and Sara VanLooy

Importance of a Focus on Employment for Older Workers

People are choosing to delay retirement and continue working into their later years. Given the pressures older workers may face in the workplace, why do they stay? Working an additional 5 years may boost annual retirement income by more than 50% (Toder, Johnson, Mermin, & Lei, 2008). Continued earnings are a significant incentive to remain in the workforce, but nonfinancial rewards also play an important part in employee retention. People who feel that employment allows them continued personal growth, meaningful relationships, a sense of identity, and the opportunity to pass on knowledge and values are significantly more likely to remain in the workforce after they reach eligibility for retirement (Sass, 2016). There is also evidence that working longer contributes to physical and emotional well-being, connecting people to social networks and affording a sense of continuing contribution and meaning (Toder et al., 2008).

In addition, people are living longer lives and are healthier for a larger percentage of their lives, such that many people simply do not see themselves as "aging." While a person's chronological age may indicate they are close to retirement, their functional or psychosocial age may not motivate them to leave the workforce (Kooij, de Lange, Jansen, & Dikkers, 2008). Those who do feel the physical effects of age respond to it in a variety of ways, with some choosing to see the aging process as a collection of experience and skills that can be useful to their organization and to others (Ng & Law, 2014). Other older workers are retiring but going back to work part-time in new organizations or working as contractors.

Employers benefit from retaining seasoned employees who know their work and workplace well, have evolved with the organization, and can be available to mentor younger employees and welcome new talent joining the organization. Yet the natural aging process can include attendant health and disability issues that few workers or employers are prepared to handle proactively. The purpose of this chapter is to highlight the importance of retaining aging workers, describe challenges identified in doing so, and discuss workplace policies and practices that organizations can preemptively put in place to keep these workers productive and active longer into their working years.

We begin with statistics that document the demographics of the aging workforce and why workers are motivated to stay in the workforce longer and explore employer readiness for an aging workforce and documentation of workplace discrimination against employees. The remainder

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of the chapter focuses on strategies to increase older worker retention identified in the literature and our own research. While older worker discrimination in the application and hiring processes is worthy of further examination, this chapter keeps its focus on the employer's role in the retention and inclusion of older workers, as well as ways to support continued productivity and job satisfaction.

An Aging Workforce and Disability Prevalence

As the longevity of industrialized nations' populations increases, so does the average age of the workforce. Around the world, people are living longer and working longer (Toossi, 2009; Toossi & May, 2017). At the same time, the incidence of chronic health conditions is increasing; over 40% of US workers now have a chronic health condition, while 15–20% report health-related work limitations (Pransky et al., 2016).

Disability and chronic health conditions are not solely a function of age, but they become more common as a person ages. While medical advances and progress in public health have improved the health status of older adults, many conditions are more common with increasing age, such as hypertension, diabetes, heart disease, cancer, arthritis, and orthopedic disabilities. Sensory disabilities such as low vision or reduced hearing are also more likely (Kampfe, Wadsworth, Mamboleo, & Schonbrun, 2008; Pitt-Catsouphes, James, & Matz-Costa, 2015; Tishman, VanLooy, & Bruyère, 2012). Statistics from the American Community Survey (ACS) show that while 10.7% of working-age (21–64) people in the United States report some form of disability, over a quarter (25.4%) of those aged 65–74 report the same (Erickson, Lee, & von Schrader, 2016).

Nevertheless, older workers with and without disabilities are putting off retirement for reasons that range from financial need to personal fulfillment and identity. Economic conditions certainly are a major factor in the rising number of people delaying retirement (Tang, Choi, & Goode, 2013), but older workers are also highly engaged employees who continue to take pride in their work and would like the opportunity to use their talents, knowledge, and skills in contribution to their workplace and broader communities.

Why Retain Older Workers?

Retention of an aging workforce should be of interest to companies for business reasons; workers who are aging continue to be a valuable asset to organizations. Their experience and skills have been honed by decades of employment, and many have additional education and an expanded skill set gained during their career (Paullin, 2014). They hold a wealth of vital institutional knowledge, maintain important connections in employee networks, and are generally more engaged than their younger counterparts (Hursh, Lui, & Pransky, 2006; Pitt-Catsouphes & Matz-Costa, 2009; Toder et al., 2008). Interviews with national experts on this subject found that companies are struggling with the large numbers of older workers who are retiring and that the "brain drain" is a matter of concern to many. Departing older workers include many in senior staff and management positions, whose retirement represents a tremendous loss of institutional memory and knowledge of proprietary practices (Tishman et al., 2012).

In a survey of HR professionals conducted by the Society of Human Resource Management (SHRM), respondents indicated that the top five advantages of older workers were more work experience (i.e., more knowledge and/or skills), more mature/professional, stronger work ethic, able to serve as mentors to young workers, and more reliable. These respondents also identified the strongest applied skills of this cohort to be professionalism/work ethic, critical thinking/problem-solving, lifelong learning/self-direction, leadership, and ethics/social responsibility (SHRM, 2014).

Retention of an aging workforce also has implications for the aging population itself. A "productive aging" mind-set supports the idea that older adults have capacity that can be better developed in ways that allow them to contribute economi-

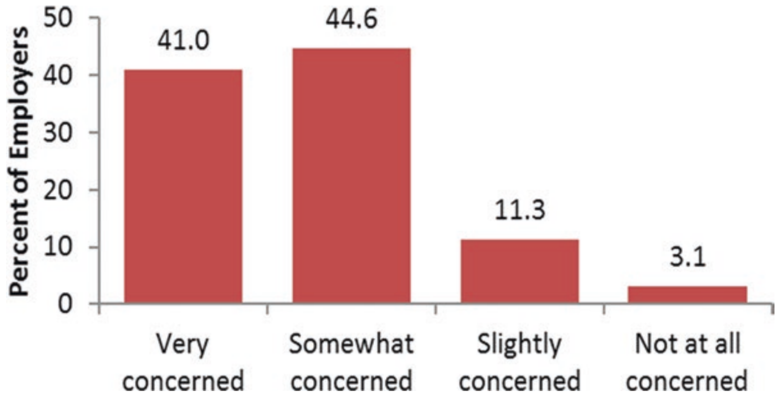

Fig. 14.1 Employer respondents: organizational concern about the impact of an aging workforce

cally to society, which can lead to multiple positives: offsetting physical strains, contributing to family and society well-being, and maintaining health and economic security (Gonzales, Matz-Costa, & Morrow-Howell, 2015).

Employer Readiness for an Aging Workforce

While the case can be readily made that employers should be making efforts to retain valuable older workers, evidence to date would suggest that they may not as yet be prepared to do so. In 2011, Cornell University partnered with the Disability Management Employer Coalition (DMEC), a national association of companies and suppliers focused on maximizing worker well-being and attachment to the workplace, both prior to and when disability or a serious health condition occurs.[1] The purpose of the collaboration was to conduct a short poll of disability management professionals in order to understand their concerns about the aging workforce and discover what organizations are doing or planning to do to retain older workers (von Schrader, Bruyère, Malzer, & Erickson, 2013). As shown in Fig. 14.1, among the 522 employer respondents, more than 85% indicated that their organization was concerned about the impact of an aging workforce. However, in only 36% of these organizations had this transferred into action, in terms of considering an aging workforce in their absence and disability management program design and implementation (see Fig. 14.2).

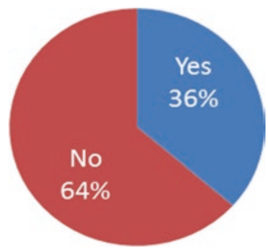

Fig. 14.2 Employers: has your organization considered the aging workforce in designing its absence and disability management program(s)? (N = 485 employers)

The level of concern varied across industries, with industries often associated with older workforces (e.g., transportation and utilities/oil/gas) indicating more concern than industries with a younger average workforce, such as technology and financial/banking/insurance (see Fig. 14.3). The level of concern roughly correlates to the age distribution across industries, that is, those industries with an older workforce are more concerned. For example, 45.4 was the median employee age for transportation and utilities industries in 2012,

[1]The Disability Management Employer Coalition (DMEC) is a membership organization of over 700 employer and supplier member organizations representing over 9500 absence and disability management professionals from across the United States and Canada. It is focused on education, knowledge, and networking for absence and disability professionals through national education programs focused on workplace strategies to minimize lost work time, improve workforce productivity, and maintain legally compliant absence and disability programs (see http://dmec.org/).

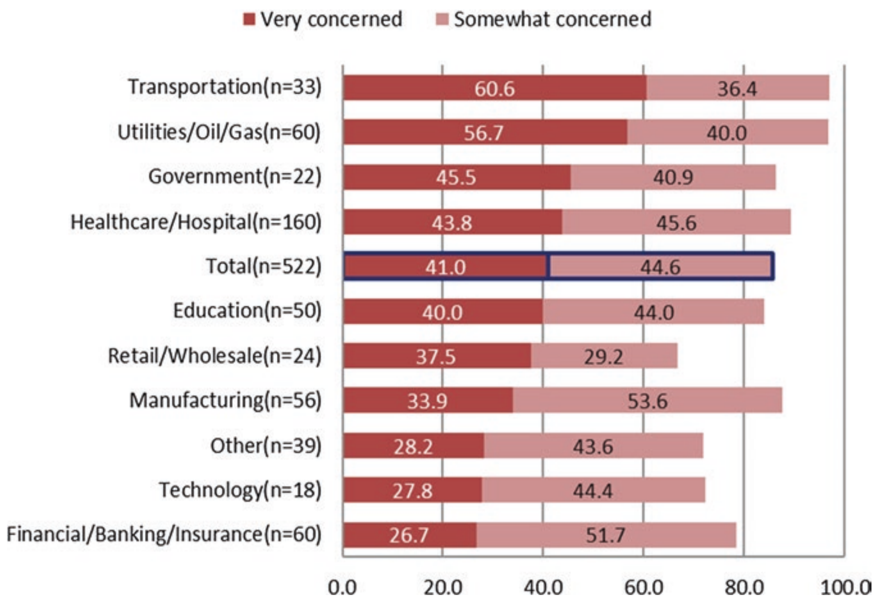

Fig. 14.3 Employer respondents: organizational concern about the impact of an aging workforce by industry

while in information the median age was 41.6, in finance the median age was 44.3, and in wholesale/retail the median age was 39.3 (Bureau of Labor Statistics, 2017).

Employment Discrimination and Older Workers

The lack of readiness of an employer to address the needs of older workers may result in perceived experiences of workplace discrimination. In a survey of their membership, AARP found that almost two-thirds of respondents had seen or experienced age discrimination, and more than 90% felt that age discrimination in the workplace today is somewhat or very common (AARP, 2014). While only a small fraction of instances of perceived discrimination lead to age discrimination charges, a review of charges which do get filed offers a chance to better understand where older applicants and employees are perceiving employment discrimination. Therefore, numerous researchers have examined the characteristics of disability and age discrimination charges filed with the US Equal Employment Opportunity Commission (EEOC) or state and local Fair Employment Practice Agencies (FEPAs). These charges offer a window into workplace behaviors.

In 2010, there were over 30,000 charges filed in the United States citing age discrimination under the Age Discrimination in Employment Act of 1967 (ADEA)[2] (von Schrader & Nazarov, 2015). Certain age groups file ADEA charges at higher rates – in particular, those at the pre-retirement age of 62–64 years old and those over 65 years file more charges (adjusted for the number of labor force participants in the age group) than those who are less than 62 years old (von Schrader & Nazarov, 2015). The most common issue named in age discrimination charges was discharge, cited on just over 50% of charges. Both of these patterns suggest that older workers are feeling pushed out of the workforce.

[2]The ADEA prohibits employment discrimination against persons 40 years of age or older (see www.eeoc.gov/laws/statutes/adea.cfm).

A large proportion of ADEA charges are filed jointly with other statutes such as the Americans with Disabilities Act or the Civil Rights Act. In fact, over half of ADEA charges were jointly filed in 2010, with 21% of ADEA charges also citing disability discrimination and filed under the Americans with Disabilities Act (ADA) (von Schrader & Nazarov, 2015). Age discrimination charges filed jointly with the ADA are more likely to cite issues with termination or employment relations than those filed with the ADEA alone. These charges can be informative to employers, who may be able to reduce their risk of being charged by proactively considering the needs of older workers in an effort to retain them. Attention to certain age-related health conditions may also support retention of valued older workers; Bjelland et al. (2010) looked at ADA charges that also cite age discrimination and found that age-related bases like heart conditions were more common among these charges, while mental health charges were less common.

Workplace Strategies to Maximize Retention

In the earlier pages of this chapter, we discussed why older individuals are choosing to stay in the workplace longer and the reasons why employers are also eager to see if they can retain them. We have also documented some challenges to this mutually desired outcome, such as employer preparedness to date, as well as perceived discrimination against older workers. We now focus on ways that employers can design policies and practices within their respective workplaces which will heighten the likelihood of keeping employees in the workforce, being able to do so productively, and with an experience of true inclusion and being valued. We will address issues and strategies around accommodation, workplace policies and practices, and workplace climate for inclusion.

Workplace Accommodation as a Retention Strategy

Workers who become disabled due to age or health conditions may need accommodation to continue to be productive on the job. However, employees often do not request needed accommodation, especially when they perceive such a request would be seen as "inappropriate" in the view of their supervisor, co-workers, or the organization due to cost, convenience, or perceived necessity. The likelihood of an employee believing that their request might be considered "inappropriate" increases with employee age, particularly when there are no other employees with known disabilities within the workplace (Baldridge & Swift, 2014).

A study of newly disabled workers using the Health and Retirement Study found that employer characteristics are less predictive of whether an individual is accommodated that the individual's characteristics of assertiveness and open communication (Hill, Maestas, & Mullen, 2016). The study further shows that if accommodation rates were to increase, it could delay labor force exit for older workers (Hill et al., 2016). McMullin and Shuey (2006) using Canadian data found that when older workers attribute their disability to aging, they are less likely to get needed accommodation. Organizations can proactively prepare for an aging workforce by putting in place a proactive accommodation policy and process including designating an organizational point person or office for accommodation issues. By understanding the common requests and needs of older workers, employers can be more prepared. If accommodation data is not routinely kept by individual departments or organizational central administration, survey data collected from supervisors and employees can be very helpful in understanding the general categories of requests made by older workers, with and without disabilities.

Understanding what accommodations are routinely requested, and why individual employees may chose not to request them (and may even be fearful of doing so), is an important first step in making needed changes to get older workers the supports they need to remain fully productive and engaged in the workforce. Identifying successful solutions will require teasing out more precisely the factors both within the individual and within workplace policies and practice that may impact the likelihood of an individual getting a needed accommodation. To do so, we can draw inferences from national survey data about the workplace experience, and we can examine feedback from employers themselves about good practices.

The Cornell/DMEC poll asked respondents to identify what they felt were leading practices for retaining older workers and whether/how they had considered the aging workforce in the design of their absence and disability management programs. In analyzing their responses, we identified a number of discrete practices as key to retaining older workers. These included accommodation, flexibility, updating of job descriptions, maintaining and enhancing benefits, wellness and safety programs, and effective disability management and return-to-work policies and practices (von Schrader et al., 2013).

While these practices were specific to the question about older workers, good practices for retaining older worker are usually good practices for all employees, regardless of age.

Of this list of practices, one stood out as critically important, setting a foundation for all others. *Accommodation* was the most commonly cited leading practice for retaining older workers. Respondents to the poll noted how important it is to "make a sincere effort to explore and offer reasonable accommodations" and communicate the desire to keep experienced workers by providing accommodation. Respondents also spoke generally about accommodations rather than describing specific accommodations made, although some noted common accommodations were implemented more broadly in the organization (e.g., "changed to 23-inch computer monitors, large text options, long term planning/budgeting for improved worksite access for those with mobility impairments…") (von Schrader et al., 2013).

Other accommodation-related ways to retain older workers included training managers about accommodation, building strategies and support systems for providing accommodations, reaching out to local resources for assistance in making accommodations, and ensuring that job descriptions are accurate and properly identify essential functions of a position. Respondents also mentioned creativity and flexibility in making accommodations as good practice for retaining older workers, e.g., "Making it part of the normal culture to offer various solutions to older workers" (von Schrader et al., 2013).

Information from national survey data can be an informative complement to these survey findings. In May 2012, a disability supplement was added to the annual Current Population Survey (CPS) conducted by the US Census Bureau. An item included on this survey asked the question: "Have you ever requested any change in your current workplace to help you do your job better? For example, changes in work policies, equipment, or schedules." The results of this survey help to frame an understanding of where accommodations are occurring and how employers are responding (von Schrader, Xu, & Bruyère, 2014).

Figure 14.4 shows the percentage of people with and without disabilities who requested accommodations, by age groups. In general, individuals with disabilities in all age groups except 65 years and older were more likely to have asked for accommodations than those without disabilities. This may reflect a concern among workers over 65 that disclosing a disability and requesting an accommodation may negatively impact their employment situation. This group may also be less aware of their rights under employment disability nondiscrimination legislation. However, employers interested in maximizing retention of older workers may want to create purposeful organizational messaging to encourage older employees to ask for the supports they need to be productive in the workplace.

As shown in Fig. 14.4 and Table 14.1, the prevalence of disability in the workforce consistently increases with age (the trend line), but the percentage of persons with disabilities who request accommodations generally decreases with age. Specifically, persons with disabilities ages 25–44 were more likely to have requested accommodations than those ages 45–64 (about 17.0% and 13.5%, respectively). This is consistent with previous research indicating that older workers who feel that their limitation is due to aging are less likely to request an accommodation (McMullin & Shuey, 2006). This should be a concern for employers, as accommodations are usually a low-cost way to enhance worker productivity and facilitate retention. If aging workers are hesitant to ask for accommodation and needed support, they may not be able to work to their full potential or might even be forced to leave the workforce because without accommodation, they no longer perform required job tasks.

Employers are making accommodations for their employees all of the time but often don't think about these as accommodations. Helping employers to recognize this as a common occurrence may assist both organizations and their employees to recognize that accommodation is a natural part of workplace good practice in facilitating productivity and retention for all employees. Table 14.1 below presents some interesting results from analysis of the Current Population Survey, demonstrating that there is no significant difference between workers who are less than 55 and 55 and over in terms of requesting accommodations, nor is there a significant difference between workers 55+ with and without disabilities. Close to 9% of all workers request an accommodation in both age groups. With a few important exceptions, even the types of accommodations are similar between age groups. Specifically, people age 55 and over are more likely to request physical changes to the workplace and less likely to request accommodation for family or personal obligation requests.

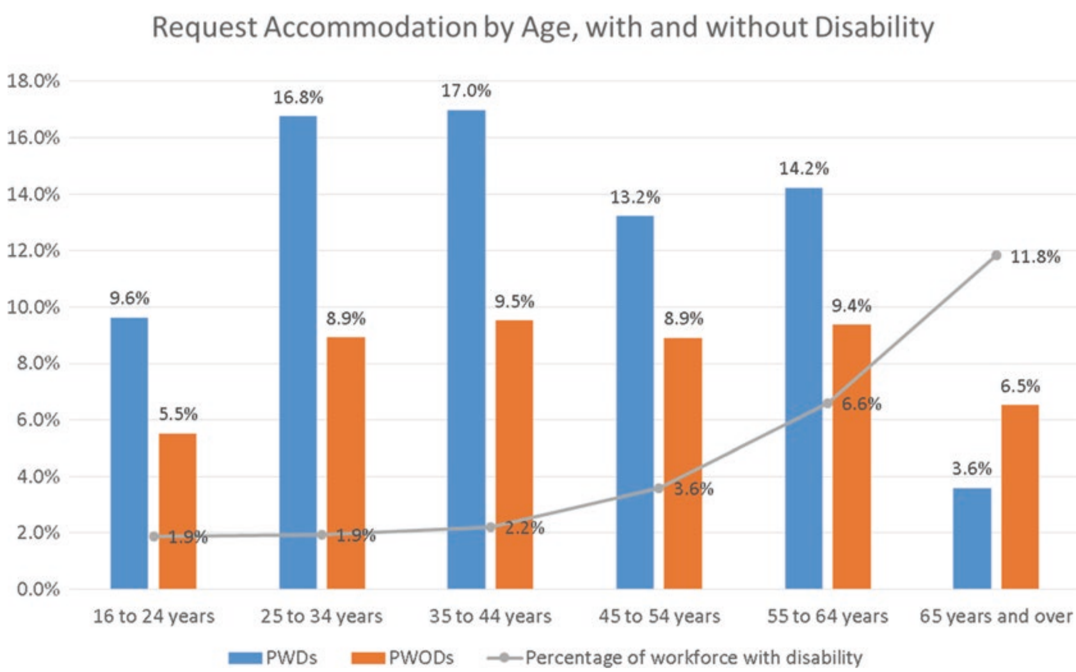

Fig. 14.4 Accommodation requests by age, for people with and without disabilities. (Data source: The figure was developed at the Yang-Tan Institute from data obtained from a disability supplement to the May 2012 Current Population Survey (CPS). The data are based on responses to the item: Have you ever requested any change in your current workplace to help you do your job better? For example, changes in work policies, equipment, or schedules. More information about survey items and approach is presented in von Schrader et al., 2014)

Table 14.1 Percent of workers requesting an accommodation and using flexible work arrangements by age group and the difference by disability status among older workers

	Percent of workers by age group			Difference between percentages individuals with and without disabilities for age 55+	
	Less than 55	55+	$p < 0.05$	55+	$p < 0.05$
Accommodation requested, %	8.7	8.9		1.8	
Among workers who requested accommodation, % requesting each type					
New or modified equipment requests	35.8	38.3		2.6	
Physical changes to the workplace	12.4	18.1	*	11.8	*
Policy changes in the workplace	22.3	24.7		−15.8	*
Change in work tasks, job structure, or schedule	47.1	45.4		−5.9	
Changes in communication or information sharing	15.8	16.6		−6.4	
Family or personal obligation requests	13.0	9.9	*	−1.2	
Training	13.6	13.5		−5.9	
Others	10.4	12.1		6.8	
Have flexible work arrangement					
Work from home, %	18.5	27.7	*	4.3	*
Flexible work hours, %	33.9	42.0	*	8.0	*

Data source: The table was developed by Hassan Enayati of the Cornell University Yang-Tan Institute from data obtained from a disability supplement to the May 2012 Current Population Survey (CPS). This table summarizes responses to the items: Have you ever requested any change in your current workplace to help you do your job better? For example, changes in work policies, equipment, or schedules. What changes did you request? (List is presented above in table. The category of Changes to Comply with Religious beliefs was not included as less than 2% indicated this type of change); Do you do any work at home for your job or business?; Do you have flexible work hours that allow you to vary or make changes in the time you begin and end work? For further explanation of the survey items and methods, please see von Schrader et al. (2014)

When comparing workers with and without disabilities in the 55+ age group (the last 2 columns of Table 14.1), there are some differences in the types of accommodations. For example, among those aged 55 and up, workers with disabilities are 11.8 percentage points more likely to request physical changes to the workplace and 15.8 percentage points less likely to request policy changes in the workplace. There are no significant differences between those 55+ with and without disabilities in other types of requests.

Also in Table 14.1, a different set of CPS items taps into flexible work arrangements; reviewing two of these items is helpful to understand how older workers with disabilities use these arrangements. Workers ages 55 and up are more likely to work from home and are more likely to have flexible work hours as compared to workers under 55. Those with disabilities who are 55+ are more likely to have these arrangements than their non-disabled peers. These findings suggest that workplace policies such as flex-place and flextime may be useful for older workers, practices further discussed in the section to follow.

Other Workplace Policies and Practices Facilitating Retention

Accommodation is a unique issue with major significance for the retention of older workers, particularly those who have or may be acquiring disabling conditions, which is why we have led with this and highlighted this importance. However, many other workplace policies and practices can also significantly influence a worker's decision to stay or leave the workforce. Employers seeking to retain their older employees may find that select HR practices work less well in meeting the needs of older workers and should examine sets of practices centered around development of existing skills, maintaining current levels of functioning, utilization of existing resources, and accommodation of new issues.

While discrimination in employment based on age is prohibited by both state and federal law in the US, EEOC statistics continue to show that discrimination charge rates are increasing and many of these charges are around practices that push older employees out of the workforce (von Schrader & Nazarov, 2016). When management is pressured to cut workforce expenses, one common solution is to attempt to reduce the number of older, higher-paid employees. This can be done by offering early retirement packages, but is sometimes accomplished by neglecting the retraining and development of older workers, shifting the terms of performance appraisals, or allowing biased and discriminatory behavior to create a hostile environment (Woolever, 2013).

In the remainder of this section, we discuss additional policies and practices that facilitate retention of older workers drawn from the literature and our own research with the Disability Management Employer Coalition membership poll.

Flexibility in Workplace Policies and Procedures Flexibility in the design of HR policies and procedures is seen repeatedly throughout the literature on retention of older workers (Barusch, Luptak, & Hurtado, 2009; Christensen & Pitt-Catsouphes, 2005; Claes & Heymans, 2008; Ng & Law, 2014; Pitt-Catsouphes & Matz-Costa, 2009; Pransky et al., 2016; SHRM, 2015; Timmons, Hall, Fesko, & Migliore, 2011). This also came up as a significant strategy for retention among respondents to the Cornell/DMEC survey. Within the open-ended responses, participants frequently identified flexibility as a key strategy, including flexibility in scheduling, working location, and leave and the availability of job sharing and phased retirement. Many of the respondents noted that their organization had implemented several of these policies (von Schrader et al., 2013).

Flexible scheduling was identified as critical so that older workers could take care of their own health and so that they had the ability to care for the needs of their parents. Part-time/seasonal schedules and phased retirement were frequently highlighted, including seasonal or other contract opportunities for retirees and older workers who are no longer working full time.

Several respondents identified *flex-place opportunities* (telecommuting or work from home) as having the potential to improve retention of older workers, for example, "Our organization has developed education into its programs to support use of a remote workforce as well as a flexible workforce that supports earlier return to work for injury and disability."

Flexible leave programs were mentioned by many respondents. Elder care can be one reason for requesting a leave; personal health issues can be another. Several noted that offering generous leave programs and increasing the flexibility of existing programs were particularly important for older workers, with one saying, "It seems that more employers are requesting leniency in the decision making process and adapting a 'treat them like family' attitude in managing absences."

Key points in this area included:

- Focusing on the value of the Family and Medical Leave Act (FMLA) in providing leave to care for family members
- A need for job protection and income replacement after FMLA, in part to "honor our long-term employees"
- Employees having options to buy additional coverage, if desired
- Providing more "consistent application and compliance" with the ADA, FMLA, and state-specific leave laws, with additional training and performance expectations for managers and supervisors who often are not familiar with these regulatory processes

One respondent highlighted the goal of flexible practices as "Building absence management programs that allow for flexibility/needed time off, and staffing practices that allow our managers to cover for folks who are off" (von Schrader et al., 2013).

Maintaining and Enhancing Benefits The way pension plans and health benefits plans are designed may very well incent employees to leave employment earlier than necessary. Traditional pension plans that are based on years of service and earnings at the end of career can discourage retention (Toder et al., 2008). The very design of these plans suggests a desired ending point of the person's career. While flexibility has many advantages for older workers, individuals who are no longer employed full time may lose access to needed or desired benefits, such as affordable health care and leave coverage. Poll respondents mentioned a variety of ways in which employers could respond to older workers' desire for continued benefits, including benefits education, bridging or enhancing benefits, and short- and long-term disability policies (von Schrader et al., 2013).

Benefits education was mentioned by several respondents. This included responses about the need to be sensitive to the benefit needs of older workers and suggests that employers could offer counseling as individuals approach Medicare eligibility.

Bridging or enhancing benefits was mentioned by several respondents, who suggested that "including part-time benefits to bridge the 60–65 age group" was an effective strategy for employees who may be phasing into retirement but are concerned about losing needed health-care coverage. One respondent noted that in their organization, continuation and/or extensions of leaves, providing coverage above and beyond age 60–65, and providing separate levels of benefits for a standard retiree vs. a disabled retiree were all increasingly common.

Short- and long-term disability leave policies were addressed by many respondents. Many poll participants noted that short-term disability (STD) and long-term disability (LTD) should cover all classes of workers, including part-time workers, and that long-term disability benefits should be made available at a reasonable cost.

One respondent also noted the advantages of automatically enrolling employees in disability coverage: "Few workers understand how the probability for an extended absence due to disability increases with age. So, in my prior role as a plan sponsor, I embraced automatic enrollment features with respect to long term disability coverage."

While many respondents identified the above practices as effective, one respondent pointed out the tension between these practices and organizations' actual decision-making:

> Despite the need to retain older workers, there is a growing trend where employers are reducing benefits for long-term employees, e.g., reducing paid time off. They are also eliminating the bridging of benefits when an employee returns to the employer (after leaving for a period of time). In my opinion, these practices work at cross-purposes for retaining older workers. (von Schrader et al., 2013)

Wellness Programming Healthy employees are key to continued productivity. Beyond health-care coverage, respondents to the Cornell/DMEC survey identified a wide range of wellness, disease management, preventive care, and employee assistance programming as effective ways to maintain and improve the overall health of employees. Respondents reported that employee data was used both to guide the deployment of limited resources in designing health and wellness programming and also to target specific health-care cost drivers (von Schrader et al., 2013).

Preventative health programming was reported as an important aspect of wellness programming. One respondent's organization had found that wellness programing promoting health awareness through education, resources, and training was effective in addressing the needs of an aging workforce. In addition, several respondents mentioned disease management programs as helpful in addressing conditions that might keep older workers from work. On-site wellness opportunities were noted as important for increasing participation, including preventative health programs and medical personnel on-site and massages and Tai Chi breaks.

Integration of wellness and health insurance was suggested as a strategy that promoted a healthier aging workforce with fewer and better managed chronic conditions by:

> Taking a very proactive approach to wellness programs by integrating them into our health insurance offerings. Employees and their spouses are required to have annual physicals and members identified by insurance claims as having a chronic condition are automatically referred to disease management. (von Schrader et al., 2013)

Incentives for participating in wellness, preventive care, and disease management programming were highlighted as a leading practice. One respondent's organization offered employees discounts on benefits premiums for achieving certain health goals. Another describes efforts to reduce disability claims proactively: "We do it on the front end by giving employees incentives to reduce their medical premium by living healthy life-styles." Another organization was expanding "preventive care efforts, providing better reimbursement for preventive services, offering incentives for Health Reimbursement Accounts (HRAs) and initiating a 'Know Your Numbers' campaign."

Other work-life resources mentioned include offering employees ways to increase economic security, hosting health fairs, allowing family participation in wellness activities, and sponsoring community health events.

Respondents stressed the importance of employee assistance programs (EAPs) as a leading practice for retaining older workers, particularly when included as part of an individual's choices in returning to work. EAPs support workers by providing counseling and referrals on a range of issues including personal relationships, mental health, substance abuse, and personal finance. One respondent noted that older workers may particularly value the use of EAP services for issues around aging, long-term care planning, dealing with aging parents, depression, anxiety, and losses.

Comprehensive health initiatives were recommended by many respondents as a leading practice. But, as one respondent observed, employer follow-through is imperative; there is a need for "better integration of health initiatives within the workplace, not simply a workplace policy that is essentially hand-waving and not put into practice" (von Schrader et al., 2013).

Safety Policy and Procedures Workplaces and jobs vary tremendously even within an organization or industry, from more physically demanding blue-collar jobs to white-collar jobs where the majority of time is spent at a desk working on a computer. Respondents from a wide range of perspectives pointed out the need to proactively assess safety in the workplace, including ergonomic assessment and worksite evaluations. Specifically, appropriate equipment and use of technology were noted by several respondents as key to ensuring workplace safety, especially for more physically demanding work: providing appropriate equipment for safe job performance, using technology more, and purchasing assistive devices and ergonomic equipment to reduce injuries. One respondent added that it is vital that employers "acknowledge the reality that we need to treat employees as assets not machines."

"Creating a culture of safety" was also described as critical to preventing and responding to workplace injury. Respondents reported they were providing tools such as patient lifts, looking at physical hazards, addressing the environment, making ergonomic assessments a regular part of employment, and stressing the importance of safety with increased training and messaging.

As with each of the sections of this Cornell/DMEC report, many companies who are working toward addressing aging workforce issues use a combination of proactive programming. One respondent observed: "The heavy duty work requirements within our industry are not going away. We have to continue to be innovative in how we get the work done." This individual reported working closely with other parts of the organization to review data on absences, safety initiatives, and return-to-work programs and that they had implemented a safety program and a proactive accommodation program (von Schrader et al., 2013).

Return-to-Work Programs Respondents mentioned several strategies for supporting and expediting employees' return to work after an absence, including personalized case management, stay-at-work and transitional assignments, and training/retraining programs. Personalized case management was mentioned as particularly critical following the onset of a chronic medical condition, because it is important to "ensure they receive medical and vocational case management services as soon as possible when they encounter difficulties performing their job as the result of a medical condition. The services need to be provided by a professional who is familiar with the employer's environment and culture." Aggressive case management approaches stressing early intervention mean that early complications can be addressed quickly and effectively.

Employer respondents in the Cornell/DMEC study noted that an individualized approach to case management was important in return to work; with older workers this may mean better understanding and addressing their motivation when returning to work. One respondent cited a belief that older workers may have lower motivation to return to work than younger employees:

> We have a specialized Return to Work program that evaluates each employee on an individual basis, and motivation to return to work is a large component. We've seen that older workers are less motivated to return to work, even with accommodation, so it is increasingly a challenge to figure out how to return these employees to gainful employment. (von Schrader et al., 2013)

As part of an individualized approach, one respondent described their organization's approach as "holistic" and that they address the entire employee: home life, stressors, and diagnoses. This program "provides resources that will help the employee understand their conditions and the bills that may come from the providers, so that they are in control of their decisions regarding their medical conditions."

Stay-at-work programs and transitional work assignments were also identified as a leading strategy. There is considerable evidence that getting an employee back to work sooner is better, but this must be done with attention to the ability of the worker. Development of a stay-at-work program focusing on ability of the worker was recommended. Several respondents noted that transitional work, including job modifications and job transfers to light duty, is often necessary when returning individuals, including older individuals, to work (von Schrader et al., 2013).

The return-to-work process, as discussed, is an integrated structure that incorporates transitional work and personalized case management. One respondent described it thus:

> [we p]rovide in-house return to work assistance, provide flexible scheduling, modified work assignment, as well as temporary work assignment in a different department. Employees not able to continue performing their jobs due to medical conditions, permanent restrictions, etc. are provided with [leave of absence] as accommodation and assisted to transfer to another position in the organization. (von Schrader et al., 2013)

Other specific policies select respondents noted were around transitional placements and return-to-work programs that allowed people to move within the organization, support for longer-term transitional assignments for workers making slow but steady progress, and programs that adjust work requirements as employee ability declines.

Respondents agreed that work training and career progression were sometimes necessary in order for employees to qualify for a modified work assignment. This could be part of a return-to-work process or an approach to keep older workers at work by offering a career progression: "We have a strong placement program that includes training and placing individuals to areas that are more suited to their abilities. Adaptive equipment is utilized as needed. A vocational disability manager and occupational therapist is on staff to assist" and "training opportunities are available so that employees may gain skills for less physical jobs as they advance in their careers." From an organizational perspective, one Cornell/DMEC survey respondent noted that it is important in planning to "Identify skill sets needed to retain, or prepare for succession planning, and look for opportunities to retain skilled workers in positions that provide more flexibility and options to transition within the organization" (von Schrader et al., 2013).

While retraining and planning for career progression were often cited as leading practices for retaining older workers, some respondents noted that an organization must be sensitive to possible implications; the transition of older workers into a position where they can remain productive must be clearly communicated as not being a demotion or loss of face within the organization (von Schrader et al., 2013).

Addressing Workplace Climate for Inclusion for Older Workers

While building an effective accommodation process and workplace/HR policies and practices that support and incent retention for older workers is critical, these efforts will not be effective unless workplace climate is also examined. Unwillingness to seek accommodation occurs in the larger context of workplace bias, in which older workers are seen by their managers and co-workers as having lower performance and costing more (Ciampa & Chernesky, 2012; Hursh et al., 2006). These perceptions are not factually based but continue to present barriers to older workers who would prefer to remain in the workforce (Ciampa & Chernesky, 2012; Ng & Law, 2014; Truxillo, Cadiz, & Hammer, 2015). Workers who experience age discrimination are more likely to leave their current employment setting and less likely to remain employed. Age-based stereotyping perpetuates discriminatory practices and discourages older workers from remaining in or returning to the workplace (Kampfe et al., 2008).

Many Cornell/DMEC poll comments focused on the workplace culture of the organization. In particular, several noted the importance of equipping frontline managers to understand issues around aging and to help them to improve communication. One respondent noted the need for managers who understand the issues of an aging workforce and are accessible to staff. Another noted that staff and manager training is one way to accomplish this goal: "Our company has employee training which incorporates aging workforce considerations so that our employees are more aware of this issue." Yet another suggested training could focus on "different communication styles when speaking with individuals of different generations." With improved understanding of aging issues and communications skills, it can be easier to address difficult issues, for example, "respectfully handling cognitive issues before they become safety problems" (von Schrader et al., 2013).

Mentoring was suggested by several respondents as a good practice for maintaining the engagement of older workers. One respondent noted: "We also need to support knowledge transfer and succession planning, so exploring opportunities for transitional positions to accomplish this." As another respondent noted, providing opportunities for mentoring can demonstrate that the organization "valu[es] their knowledge and experience."

While training can be one way to meet the needs of staff and managers around this area, another option was suggested for targeted support: "We have incorporated technical assistance specific to the aging workforce." Communication and recognition were mentioned by several respondents who recommended that employers ensure older workers "are engaged and feel their work efforts are appreciated and rewarded." Employers need to fully recognize the important contribution of older workers: "It's not simply recognizing the number of years that an employee has been with a company, but recognizing the importance of providing history and continuity of services depends on the experience of older workers."

Summary While the leading practices highlighted above have the potential to help retain older workers (and workers in general), respondents to the Cornell/DMEC survey and participants in post-poll interviews also discussed the role of strategic planning and implementation in achieving the best results. Rather than attempting to implement all of the practices above, respondents discussed the need to select approaches strategically based on specifically identified organizational needs. For example, while some organizations may benefit most from organization-wide disease management programming, other organizations may achieve better results by focusing on succession planning for specific positions. More than 50% of the 522 employer respondents reported that their organization analyzed workforce demographics; 17.8% reported that their organization did not, and 28.9% did not know. Such workforce analysis can inform employers' understanding of workforce trends. For example, these analyses can identify current issues (e.g., examination of claims) and help to anticipate issues that may arise in the future (e.g., aging trends among workers by position, function, or location), in order to allow informed decision-making about where resources should be focused.

Conclusion and Next Steps

The purpose of this chapter has been to discuss the value of retention in employment of older workers both to the individual and to the employer, the barriers which get in the way of extended job tenure for this population, and workplace policies and practices which facilitate greater success in keeping older workers thriving in the workforce. For a wealth of good reasons, such as financial, physical, emotional, and social well-being, workers are desiring to stay longer in the workforce. Workplaces are increasingly receptive to this but ill-prepared to enact the policies and practices which will contribute to the success of both the individual and the organization. This may result in behavior toward the older workers which can be perceived as discriminatory and policies and practices which discourage rather support older workers in staying at the workplace. In this final section, we briefly summarize a number of effective workplace retention strategies identified in the literature and our research and discuss the role that associations representing the interests of employers, workplace/HR professionals, and older workers can play in raising awareness, as well as the implications of these findings for the rapidly changing workplace and related future research.

Our literature review, analysis of national survey data, and survey of employer representatives all point to known barriers and ways to facilitate employment retention of older workers. Key practices for effective retention identified have included:

- Having a workplace accommodation process for all employees that sends the message that accommodations are a natural part of the employment process and can be used by everyone
- Flexibility in the design of HR policies and procedures, including flexibility in scheduling, working location, leaves, and the availability of job sharing and phased retirement
- Reviewing and revising of job descriptions to ensure they are accurate and properly identify essential functions of the job and associated functional capabilities
- Maintaining and enhancing benefits, including design of pension plans and health benefits plans to incent retention, the use of bridging or benefits for part-time work, extension of leaves, and provision of short-term (STD) and long-term disability (LTD benefits, which cover all classes of workers at reasonable cost, and benefits education
- Wellness and disease management, preventive care, and employee assistance programming, including integration of wellness and health insurance, incentives for participation, availability of employee assistance programs (EAPs), and better overall integration of health initiatives within the workplace
- Safety programs, including ergonomic assessment and worksite evaluations, the use of appropriate equipment and technology, providing appropriate equipment for safe job performance, using technology more, and purchasing assistive devices and ergonomic equipment to reduce injuries
- Effective disability management and return-to-work policies and practices, including personalized case management, stay-at-work and transitional assignments, and training/retraining programs
- Addressing workplace climate for inclusion for older workers. Approaches may include training for supervisors around respectful communication and providing accommodations,

and furthering strategies, like mentoring, to actively promote older worker engagement and knowledge transfer

Yet neither the workers themselves nor their employing organizations are using these repeatedly identified good practices to improve retention to the extent needed. Significant awareness-raising needs among all parties, and national associations of older workers and business interests, as well as corporate champions and business professionals, are emerging as critical allies in this process. Much of the information presented in this chapter is from a study conducted by Cornell University with the Disability Management Employers Coalition (DMEC), an organization whose mission is to facilitate worker well-being, health, and retention. Other major sources of information include similar employer and workplace professional leaders such as the Society for Human Resource Management (SHRM). These associations provide an invaluable role in describing effective practices, documenting the disparity between these best practices and highlighting what is occurring in the workplace to date. Organizations like these can also assist with raising awareness through educational campaigns to members about needed changes to workplace policies and practices to address the barriers that have been identified. These efforts are now global, as organizations such as the International Labor Organization and the International Organisation of Employers are pursuing them as well. These organizations will play an important role in the organizational context, informing employers of effective workplace policies and practices that will facilitate accommodation and retention.

At the same time, associations representing the interests of older workers, such as the AARP in the United States and aging services organizations worldwide, are beginning to work to raise the awareness of older workers about the new and different opportunities to stay at work productively that are resulting from this increased employer interest. These efforts are critical to increase older worker confidence and support their aspirations to work longer and request the accommodations that will support them in doing so.

Serious and targeted research is also needed to contextualize this interest in retaining older workers within the rapidly changing workplace. A recent review of effective practices highlights that all workers require ongoing career development and mentoring, as well as related training to assist them to stay current with technical and social skills needed to navigate the ever-changing nature of work. The need for technical skills continues to grow – not only to perform specific technical job tasks but also to navigate increasingly tech-intensive workplace processes. It is imperative that employers proactively design training and reward systems that incent their entire workforce to access the skills and mentoring needed to remain viable and productive employees. In addition, it will be important that organizations design work environments and workplace cultures that foster intergenerational collaboration, mutual respect, and mentoring.

For example, the emerging workplace designs now usually associated with technology industry settings, such as open design for collaborative projects and brainstorming, flex-place, and flex-time, are often seen as perks to specifically attract younger workers, rather than space and design elements for all workers, including seasoned ones. Yet these same space design features can facilitate building bridges across generational divides and promote reverse mentoring. Similarly, human resource policies that promote workplace and time flexibility for all employees may provide a needed accommodation for employees with a disability or chronic health condition.

Research into the tangible next steps required to make enduring and evolving change must occur. This includes attention to public policies needed to shape worker and employer incentives toward longer work organizational policies and practices which can facilitate retention, as well as increasing understanding about worker motivations and needed individual supports.

Further investigation about how Social Security benefits, Medicare, and employer-sponsored health and pension plan benefits currently incent individuals to leave or stay in the workforce is certainly one part of the puzzle and deserves further investigation (Toder et al., 2008). Examples of needed research on specific workplace retention strategies to improve retention are offered by Pransky et al. (2016) who suggest starting by following individual employees at an earlier stage of developing workplace concerns, earlier identification of at-risk workers with chronic conditions, the use of more innovative and flexible accommodation strategies, stronger integration of the workplace into ongoing rehabilitation efforts, and a better understanding of stigma and other social factors at work.

Finally, a continued focus on research that examines the needs and motivations of older workers to stay attached to the workforce, the benefits to them and their workforce in having them do so, and ways to best facilitate this at the individual worker level must be at the heart of any future research efforts. Only by engaging older workers themselves in the shaping of research questions, design, implementation, and analysis/understanding of findings will we have meaningful answers to make needed changes that support older worker employment success.

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15 Work and Aging: A Review from the Employer's Perspective

Mónica Herrera

We don't stop playing because we grow old.
We grow old because we stop playing.

—George Bernard Shaw

Overview

It is becoming more and more difficult for today's employers to fill their available positions. At the end of 2017, the *Canadian Federation of Independent Business* reported national vacancy numbers that exceeded 360,000 in the private sector. Both, the USA, which surpassed six million unfilled jobs in the summer of 2017, and Europe are experiencing similar challenges, highlighting an increased shortage of workers worldwide. A common characteristic is that they are predominantly skilled jobs. Many countries are trying desperately to close this gap by establishing programs for temporary migrant workers and incorporating additional training and education resources for younger generations. However, this is not enough! The younger generations will not be able to fill the void in the future. What is the good news? Employers have an opportunity to mitigate this serious situation, and they can achieve it by looking internally to their current workforce. The mature or older workers hold the key to change. This present chapter will focus on building a case for employers to engage their mid-age and older workforce to maintain employment longer by looking at the benefits, challenges, and methodology of keeping them employed.

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Facts and Regional Statistics

Are all employers conscious of the fact that almost all the increase of participation in the labor force will be done at the expense of workers age 55 and over? Last year, the projection for the labor force in the USA showed that, between 2016 and 2026, the general growth expected is 0.6% per year but, for the workers between 65 and 74 years old, it will be 4.2%; moreover, for the group 75 years and above, it will be 6.7% annually. Specifically, in 2000, 12.5% of 65 and over adults were working, and this increased to 18.6% in 2016. The numbers of workers under 35 years old from 1996 to 2016 remained unchanged, while the over-55 group grew 124%. In 2016, this group (over 55) was 35.7 million workers that will become 42.1 million in 2026, or, in other words, 1 in 4 US workers will be 55 or over in 2026 (Collins & Casey, 2017). On the other hand, Bélanger (2016) discusses the changes Canada had; in 1971 the population age 65 and over was 8% that, by 2014, increased to 15.7%, with the expectation it would grow to 23% by 2031. In comparison, the labor force participation for the group of age 55 and over increased from 10% in 2001 to 17% in 2009 and to 20.7% in 2016 (Statistics Canada, 2016). Before 2010, Canadians 65 and over surpassed the number of children 14 and under, and this gap is expected to increase. By 2063, the older group will outnumber children by 2 to 1 (Alberta. Ministry of Labour, 2016).

R. J. Gatchel et al. (eds.), *Handbook of Rehabilitation in Older Adults*, Handbooks in Health, Work, and Disability, https://doi.org/10.1007/978-3-030-03916-5_15

Besides the USA and Canada, the countries expected to have the largest older populations will be Japan and the EU. The EU population has grown, as has their life expectancy: from 1960 to 2006, they added 8 more years and expect to add another 5 by 2050. By that year, the age 15–64 group will have decreased 48 million, and the age of 65 and over will have gained 58 million more. Spain and Italy will have the oldest population (8, 16). As another example, in Sweden, the labor force participation is above 75% in the age group of 60 to 64 (Boot et al., 2015). The UK expects that one-third of its population should be over 50 by 2020 (Barnes, Smeaton, & Taylor, 2009). Finally, Japan's 65-year and over population was 27% in 2016 and is expected to rise to 35% in 2050 (Japan Statistics Bureau, n.d.).

It should also be noted that an important index is the *old-age dependency ratio* (OADR), which is the number of people older than 64 per 100 working age people (15–64 years). It was compared by the *International Monetary Fund* for different countries between 2010 and 2050: the USA went from 19% to 36%, France from 26% to 44%, Italy from 31% to 62%, Germany from 32% to 60%, China from 11% to 39%, Japan from 36% to 72%, South Korea from 15% to 66%, Brazil from 10% to 36%, Mexico from 9% to 32%, and India from 8% to 19% (the lowest OADR in 2010 and 2050; Chockalingam, Thakur, & Varma, 2017). This strikingly demonstrates the continuously growing presence of the older segment of population around the world. Indeed, we are at a special moment in history: world life expectancy is increasing, and the labor force worldwide is aging!

The "Baby Boomer" Effect

Every day in the USA, 10,000 "baby boomers" turn 65, and, after 2020, all of them will be 55 years or older. Born between 1946 and 1964, they are the generation born after WWII and the first to use oral contraceptives, thus decreasing the fertility rates and creating a reduced generation behind. In the EU, fertility rates fell from nearly 3 in the 1960s to 1.63 in the 2000s (Barnes et al., 2009). They have seen and prompted changes in educational structure, increased age at first marriage, healthier lifestyle, living longer, and, therefore, having a longer working life as well. With this in mind, they are "driving change" one more time (e.g., Alberta. Ministry of Labour, 2016; Ascentum, 2014; Banerjee & Blau, 2016; Eyster, Johnson, & Toder, 2008; Hedge, Borman, & Lammlein, 2006; Setting the stage, 2014). Thus, as a result, we have a generation that is "aging" slower than we used to see in previous cohorts. Moreover, they work until 65 years or more. Added to this, new technologies are decreasing the physical nature of job demands for a broad range of industries, increasing the probability for workers to remain engaged in formal or informal work. Self-employment is also higher in this group than in younger cohorts (Toossi & Torpey, 2017). The many reasons for this are work provides them a sense of purpose, helps them to stay fit and mentally sharp, and helps to maintain social connections that, in turn, increases their longer life-spans with quality of life (Roper, 2016). As with other previous generations, the higher motivator is money. Called the "sandwich" generation (a name invented by Dorothy Miller in 1981), it refers to the fact in this generation, are people (most of them workers) who take care of their children and their parents. Consequently, for many in this generation, savings are not sufficient to retire (Barnes et al., 2009; FICCDAT Conference, 2011; Roper, 2016). "Baby boomers" are the first generation that has many reasons and the advantage of the technology to be capable of working for a longer time than previously seen.

A Case for Retiring Retirement

Longer life expectancy has created an economic puzzle for governments, compelling them to adjust the age of retirement to the increased life-span and reversing previous policies and incentives for early retirement or introducing regulations intended to postpone these dates

(Magnavita, 2017). As an example, in the UK, the obligatory retirement age was eliminated in 2011, and state pensions were raised from age 60 to 65, becoming age of 66 in 2020 and the age of 67 between 2026 and 2028. The UK will review these limits every 5 years in order to balance them according to the life expectancy at that time (BMA, 2016). At the same time, Canada removed mandatory retirement in 2008 and is changing the OAS (Old Age Security) pension, to be payable from age 67 instead of 65, by 2029 (Bélanger, Carrière, & Sabourin, 2016; James, Kelly, & Blondin, 2015). The EU is no different. In addition, in 1999, Sweden changed its pension plans to a flexible benefit plan. This will allow, while the economy is good, that benefits will not decrease but, should the economy take a downturn, benefits can decline. Sweden has not yet experienced economic hardship to test this plan (Manpower, 2007). In the USA, the *Social Security Act of 1935* stipulated that the age of 65 will allow access to pensions because, at that time, the younger labor force was plentiful and not expensive. This decision was considered to have been taken based more on a cultural factor rather than on a biomedical reason (Hedge et al., 2006). Then, in 1986, Congress eliminated mandatory retirement.

It has been suggested that statistical organizations should expand "middle age," to be consistent with current life expectancy. Healthier older populations, and changes in pensions, should drive the stretch of the "middle age" definition to age 65 or 70 (Smith, 2009). Other government initiatives included the engagement with Academia, diverse organizations, and employers that are developing programs and providing the research to support how to extend the working life-span of people and find effective answers to current and future workforce shortages. Even though these strategies have become more common in the last decade, many industries are still unaware and have not evaluated the risks they have or how these issues could affect them, much less, generate solutions (Collins & Casey, 2017). A concomitant phenomenon has triggered retirees to return to work. As per a Canadian survey, 55% of them returned to work because they did not like retirement, because they wanted to help or were needed at work, and because of the intrinsic rewards of socializing, challenging tasks, and having purpose (The Mature Worker, 2008). Some have coined a name for this, "unretirement," where workers who have retired come back to work in some fashion, usually about 2 years into retirement. This tends to be present more for the younger retired group (mid-50s) than older ones (above age 65). Trends are showing something that could be coined an "encore adulthood," which implies that after retirement, the person would like to continue an active lifestyle, including continuing education, meaningful activities, community engagement, and paid or unpaid work in some capacity (Chmiel, Fraccaroli, & Sverke, 2017; Collins & Casey, 2017). Early retirees are seen more commonly in larger companies that provide greater stability of retirement benefits, mainly healthcare related. Organizations with poor retirement benefits – or none – will unintentionally compel older workers to stay until an advanced age (Collins & Casey, 2017). However, for many, getting to the day where they retire is a dream come true, and when the time comes, for most workers retirement is not just a valid possibility but a well-deserved working life conclusion.

With a growing trend toward unretirement, employers are still trying to comprehend how to incorporate these members into their staffing and workforce strategies to create an advantage for all parties involved.

Older Workers: An Essential Conversation

This topic is gaining momentum, and the discussion is "open and wide" about how employers perceive older workers. This conversation is being fueled by many research efforts, especially during the last decade, with a large volume coming out of Europe, where they have been supported by different countries' governments. Within the findings we see the desire to clarify abundant misconceptions regarding older workers, and this starts with their age. If we review the world life-expectancy charts, we will see that the colloquial saying that the "50s was the new 40s" is becoming real, as based on the World Bank data (2016), the mortality risk of a 50-year-old in 1970 is the same as a 61-year-old today. People now live longer and are more conscious about being physically fit and cognitively engaged in many subjects, including work. In this way, the overall capacity of the workforce has been changing, and consequently, how they engage with work.

As previously mentioned, there are almost interchangeable terms that define "older worker" or "mature worker." The ages they encompass have been delineated differently, depending on the researcher or the organization that is using the term. Some start this population group from age 40 (as per the US Age Discrimination Act) with 45, 50, and 55 being the most common, even though retirement age is usually at 65. For this present chapter, we use the age of 55, as the lower limit, unless otherwise indicated (Alberta Employment, 2008).

It is true that workplaces are becoming more and more diverse, and age is helping to expand this concept. This is changing how employers view an ideal worker, and this may be based on expertise and soft skills more than before, with the consequent positivism that this will bring to older workers as they are stronger with those skills (Carstensen, 2014). This is made evident by seeing older workers employed more in "white collar" professions than "blue collar" ones. Still, there are negative stereotypes that need to be discouraged and, instead, highlight the positive aspects to allow them to show effectiveness and productivity, two key elements that still drive the value of a worker for the employer (Chiesa et al., 2016; Collins & Casey, 2017; Turek & Perek-Bialas, 2013).

Learning, Training, and Education

One of those labels is thinking that older workers would not be able to learn new skills, especially to keep up with the pace of fast-technological advances; but this not correct for the many who have embraced the changes that technology has presented to them (The Mature Worker, 2008).

In 2015, a Nielsen Generational Lifestyle survey showed that, even though we may view millennials as the ones constantly connected to electronic devices, 52% of "baby boomers" and 42% of the silent generation (i.e., those born between 1925 and 1945), versus 40% of millennials who responded to this survey, stated that they use their technological devices while having dinner. An example of use or maybe overuse, a Norton Symantec survey in 2016 found that 44% of baby boomers use secure passwords, as proof of their technological knowledge. Still, though, many older workers may need to acquire new skills in order to keep up with the technological changes in their own knowledge area or current position or to change to other fields. Many employers may not provide these opportunities directly, and acquiring these new skills may not be easy and may pose a risk of unemployment. As per the US Bureau of Labor Statistics in 2016, 22.1% of the people in long-term unemployment (27 weeks or more) were 55 or older (Collins & Casey, 2017).

Employers with cultures that praise speed and efficiency think that these learning needs are a challenge, as learning can be slow and inefficient, and it would take too long for an already-older worker to get the knowledge they need. Consequently, some employers think that it is not the best investment, because older workers may retire soon. Some employers have changed this paradigm and, based on strategy, have prepared for this as part of the organizational culture, and the training has started earlier and, even better, is continuous. The *American Association of Retired People* (AARP) has found that large numbers of older workers do participate in training programs, showing the desire to learn. Based on this, some organizations are innovating, providing this training by younger peers in a bidirectional relationship. For multigenerational workplace programs like this, it becomes an advantage and a benefit to all (Adapting to an aging workforce, 2013; Employment Ontario, 2009). Joshua Hartshorne, a postdoc in MIT's Department of Brain and Cognitive Sciences, stated that "At any given age, you're getting better at some things, you're getting worse at some other things, and you're at a plateau at some other things. There's probably not one age at which you're peak on most things, much less all of them" (MIT News, March 2015). This is the biggest advantage an employer could have with an educated multigenerational workforce – a complementary network of intelligence to support the business!

Maintaining on Accumulated Knowledge Base of Workers

This network could help employers avoid losing larger groups of older workers at the same time, draining an accumulated knowledge base. Additionally, older workers can help to engage younger cohorts in the organization, as they increase workplace diversity. This assists in providing stabilization to stressful processes that some industries could expose to younger workers (Carstensen, 2014), as was shown by the American Psychology Association (APA) report in 2012 "Stress in America." Younger generations may perceive more stress than their older peers. Reframing assumptions and stereotypes regarding older workers, gaining clarity on their strengths and limitations, balancing their needs, providing education, and improving their relationships at work will all materialize into a competitive advantage for employers and a benefit for all workers.

Older Workers' Physical Abilities, Risks, Physical Hazards, and Associated Costs

The downsizing to aging is the unfortunate physiological reality of decreased function (some body organs will reduce their working ability) and a deterioration in the body's skill to compensate across different environments and situations. Eyesight will decline as visual acuity (starting in their 40s and 50s), and visual accommodation and adaptation are weakening. Voice discrimination gets harder as the ear loses the ability to hear higher pitches (Loretto & White, 2006). Despite technological advantages to ease the physical requirement of a job, highly physically demanding duties can be a work deterrent for older workers. Older workers are at risk for increased severity of a work injury, which may impact employers that require significant physical work, as this translates as a potential for higher payments to insurance companies and workers' compensation boards. As an example, in Canada, employers pay high or low assessment rates to the workers' compensation system, based on their own previous claim experience and the ones experienced by the group of employers in the same industry classification. The leading trades with the higher risk for injuries, and secondary insurance claims in different countries, are "blue collar" (warehousing, transport, mining, construction, manufacture, and forestry). Within the "white collar" group, healthcare is one that has higher risks.

The frequency of occupational injuries, overall, decreases with advancing age: there is a small increase for males between 50 and 60 years old and for females between 40 and 60 years old. After age 60, there is a decrease for both groups. Those injuries that do occur are more likely to be severe or fatal for those who are older (Japan Statistics Bureau, n.d.; Simpson, 2012; Alberta. Ministry of labour, documents, 2016). In 2012, the National Council on Compensation Insurance (Davis, 2012) showed a radical change in the profile of severity and cost among worker injuries. As all occupations are generally safe, injury frequency has decreased for all ages. The loss cost per worker has shown three marked groups with important differences among them. Workers aged 20 to 24 have low severity and cost, workers 35–65 have the higher severity and cost, and the ones between 25 and 34 are in the "middle ground" for both (James et al., 2015). The biggest driver of severity is the type of injuries by age group. As an example, older workers tend to have more rotator cuff and knee injuries, while younger workers have more back and ankle sprains (James et al., 2015).

Of course, injuries happen to all workers, and employers understand that it is the occupation and not age that drives the risk of injury, modified by prevention and hazard control (Crawford, Davis, Cowie, & Dixon, 2016). Even though some age-related changes could increase the risk, it is the ability to work and prevent that is important. Employers that leverage older workers' experience and provide appropriate risk identification and hazard control and prevention (including access to suitable accommodations) provide a positive balance for this challenge.

Table 15.1 Percentage of age groups who feel they are in "fair" or "poor" health, as well as those who have two or more chronic conditions[a]

Age group	"Fair" or "poor" health (%)	Two or more chronic conditions (%)
18–44	6.3	7
55–64	18.7	40
65 or more	21.8	62

[a]As summarized by the Special Committee on Aging, US Senate in the 2017 Report: "America's Aging Workforce: Opportunities and Challenges"

Table 15.2 Percentage of disabled workers by age group[a]

Age group	Disabled (%)
18–34	6
35–64	13
65–74	25
75 or more	50

[a]As summarized by the Special Committee on Aging, US Senate in the 2017 Report: "America's Aging Workforce: Opportunities and Challenges"

The Influence of Chronic Conditions

The prevalence of multimorbidity increases with age. After age 50, almost half of the population will have at least one chronic illness, and this will increase to 80% after age 65 (Centers for Disease Control and Prevention [CDC], 2016). In the EU, one-third of the population age 15 or more have one chronic condition, and this increases to two-thirds from age of retirement. The percentage of people in the USA who think that their health is "fair" or "poor" ostensibly increases with age, similar to reports of chronic conditions and disability. In the EU, less than 60% of ages 50–65 think their health is good or very good (Eurostat, 2016; for US, see Table 15.1).

Chronic conditions become a challenge for employers as they are a factor for increased absenteeism and presenteeism. Employers should address these situations through collaborative efforts with the workers and their unions, evaluating the need to link workers with proper recovery and rehabilitation services and/or formal work accommodations. For cases of older workers with chronic conditions and/or disabilities, at some point a measure of function and ability to work is essential. Leaving age stereotypes aside, it is important to provide the necessary information to support the worker in the workplace. Work accommodations can range from temporary to permanent changes in duties, schedule, rotation, or shift length. They may also need to provide team/peer support, modifications, visual and hearing aids, or ergonomic adjustments to workplace or environment. Most of these situations will end in successful accommodations, but, for the few that may prove to be unsuccessful, the result may be an exit from the workplace to receive disability coverage (see Table 15.2).

For workers with chronic medical conditions that impact their attendance, employers increasingly are using different programs to try to decrease the impact of such barriers. The most effective programs are shown to be the ones that are participation-based and focus on proper medical follow-up, preventative-care compliance, coaching for specific medical or chronic conditions, and providing accommodations and/or flexibility. These, in turn, have demonstrated less use of general medical pharmacy services and lower use of non-catastrophic payments to insurers (Martin-Matthews, 2011; Steenstra et al., 2017). The premiums employers pay for insurance in some countries to provide workers with access to long-term disability have a hefty price and, as age increases, the number and cost on the disability claims to insurers increase as well (Appelbaum, Wenger, Buitrago, & Kaur, 2016). Based on the amount payable on each claim, there is a point at which the financial cost to rehabilitate and return a person to work will be higher than to leave the claim to be finalized at retirement age, bringing no substantial advantage to employer or worker. Working together, workers, unions, and employers, by focusing on improving the work environment and supporting health improvement (coping skills, self-management tools, resilience) for workers who struggle with chronic conditions, can accomplish a great deal in preventing and/or mitigating long-term absences, allowing older workers to have a successful aging (Pruchno & Carr, 2017).

It is important to note that the participation in these programs is highly influenced by the worker's motivation. It is not infrequent to see workers who do not want to participate, as they see this as "another" commitment that will take away the little free time, resources, or energy that they still have. In addition, motivation (as with health and productivity) is dynamic and changes along the life-span, which makes these programs difficult to set up and define for each employer. Steenstra et al. (2017) found evidence that the programs that gather the most participation from workers are multidimensional. Employers can provide workers with opportunities to maintain social connections and maintain a positive self-concept, which are key motivators. When looking at the design and key features of a supportive program, it is important to understand that it is the individual ability to cope with the biopsychosocial stressors that will have an impact at the end of their working life, making some people better prepared, having more internal resources to cope with life and, as a result, a higher level of well-being and ability to work than others (Brooke, 2005; Magnavita, 2017). As N. Magnavita (2017) rephrases in an old saying "work affects health, and health affects work", it is not only true but essential.

The Sandwich Generation

Health affected by non-working environments and social issues are becoming a bigger problem today. As noted earlier, and even though initially coined to define people in their 30s and 40s, the situation to help parents and children while still working is now extended to people well in their late 50s and more. Due to world migration that saw 258 million people moving in 2017, two-thirds of them went to live in just 20 countries. The largest numbers reside in the USA, followed by Saudi Arabia, Germany, the Russian Federation, the UK, and Northern Ireland, with a median age of 39 years. This has a special importance, because the ties and the responsibilities are no longer local but worldwide (United Nations, 2017). Many immigrants are expected to provide financial resources to parents or children left behind, making the experience of caregiving in this "sandwich generation" even more complex. In fact, 34% of all caregivers are between the ages of 50 and 64, with 60% of them working full time. That is about one in four employees over the age of 50 in the USA. As of December 2013, unpaid family caregivers corresponded to $470 billion in unpaid long-term care for the country. As per natality (i.e., birth rate) charts, the average age of first-time parents in the EU and Asia is 27 years old, with 4 countries above 30; so, it would be common to see workers between the ages of 50 and 60 that still have children living at home. In 2016 in the USA, for the first time in 130 years, young people age 18–34 were more likely to live at home with parents than in any other living arrangement.

The consequent chronic stress in these working older adults may increase to become medical conditions in themselves, such as depression, anxiety, sleep problems, pain, and exhaustion. They have poorer physical and mental health and use more services from the employers than their peers who are not caregivers. Their stress results in higher paid or unpaid absenteeism and/or leave of absences. Estimated costs in Canada sit at $10 billion with the USA at $33.6 billion (FICCDAT Conference, 2011). These workers must bring financial security to their families at the same time as they care for themselves. Some employers have found that providing them a balance to take care of others, as they still maintain financial security, reduces absenteeism costs and increases retention (13, FICCDAT Conference, 2011).

Family-based caregiving saves healthcare resources for the country but generally depletes personal resources. Chronic conditions and disability in the workers' families (parents, spouses, in-laws, and others) are substantial challenges. Providing care to them should be an issue that is supported by governments, as well as employers. Some countries are leading this involvement and are supporting employers and workers to achieve this (FICCDAT Conference, 2011). Still, there is a long way to go to help improve the economic burden this presents to employers and workers. Employers are on their way to understanding that this is an important challenge that they need to address before it depletes the workers' mental and physical stability. Accommodating caregiver requirements should be integrated to the human resources strategies, because it has important repercussions for the workers and for the employer as improvements in production and organizational savings.

Advantages of Older Workers

Although challenges exist, older workers have proven advantages and have a role that is increasingly important for employers and their future. Some employers may still believe that older workers are more inflexible and less adaptable than their younger peers. Attitudes and beliefs can be difficult to influence, and employers could see this as a challenge or a source of possible tension across different age groups at work. On the other hand, employers who understand that mature workers take much pride in their work, offer experience, provide a respectful view of authority, and follow rules and regulations at their worksites can reap the benefits. In addition, teamwork, loyalty, dedication, service, and sincere regard for their organizations are certainly benefits that come from this age group. As many employers have eventually seen "myths debunked," productivity and adaptability may not decline with age, and older workers may be more productive than younger peers (Crawford et al., 2016; Munnell, Sass, & Soto, 2006; The Mature Worker, 2008). They learn to balance their functional abilities to maintain competencies (Abraham & Hansson, 1995), and other advantages described by employers include being more reliable, personal mastery, experience, maturity, work ethic, mentoring opportunities to younger generations, high-workplace engagement, lower turnover and increased productivity, greater level of commitment, and fewer accidents (Employment Ontario, 2009; Wright, 2006; Bureau of Labour Statistics, 2015). Indeed, there is general agreement that experience fosters greater loyalty, stability to internal processes, and many mentoring opportunities to younger generations. The two sides of older workers – challenges and advantages – are difficult to compare, as they present both quantitative and qualitative variables that differ with each organization and, sometimes, even further within them, making it more difficult to create balanced conversations. Nonetheless, the need of these workers should be the emphasis of any discussion, with a focus on highlighting their positive traits and looking at how to reduce any negative impacts in the workplace (Guzzo, 2014). At the end of the day, retaining older workers may become a way to succeed for many industries. As an example, for some industries that are service-based, they would cater to peers and mirror the age diversity in the communities where they are established (Roper, 2016). Supporting older workers at work is also a financially sound decision for most employers, and, as for the workers, work is a proven well-being factor that, in the long-term, will provide better mental and physical health and improve their quality of life (Collins & Casey, 2017).

Health Programs, Healthy Aging, and Well-Being

It can be seen – even with friends and family – that when an individual is no longer engaged in a specific activity, their rhythms change, and the potential to keep engaged in activities (even though not work) decreases. There is a disrupted continuum that causes older workers to lose their inertia (Magnavita, 2017). A job is, to a point, therapeutic and can reverse health consequences of unemployment or prolonged sickness absence. On the balance, work is good for health (Hobson, 2007). Let us not forget that, repeatedly, we see personal satisfaction as one of the leading reasons that older workers – and not so old ones – seek a job (Nakai, Chang, Snell, & Fluckinger, 2010). Despite that, the most commonly quoted reason for not working among workers ages 55–58 is disability; then, retirement becomes the primary reason for non-working at age 61.

The important question is "How to support healthy aging and decrease the incident of disability?" Since the mid-1980s, the MacArthur Model presented by Rowe and Kahn (2015) described a model for successful aging, changing the focus from a period comprised of illness and decline to one that emphasizes three elements: lowering risk-related disease and disability, maintaining high mental and physical function, and having a continuously engaged life (both socially and productivity-wise; paid activity or not). Since that time, this concept has been accepted and recommended by a wide array of organizations across the world (World Health Organization (WHO), United Nations, Organization for Economic Cooperation and Development, European Commission) (WHO, 2002). Healthy aging has been described as a "process of optimizing opportunities for health, participation and security to enhance quality-of-life as people age" (Schalk et al., 2010). Organizations, authors, and policy makers have created concepts that are used in parallel – or sometimes interchangeably – as active aging, healthy aging, successful aging, and productive aging. All of them are statements directed at empowering older people to maintain well-being, engagement, and function and highlighting the importance of contributing to society through work, caregiving, and/or volunteering (Magnavita, 2017; Pruchno & Carr, 2017). It is one more concept that encourages workers to remain active and retire later in life (Crawford, Graveling, Cowie, & Dixon, 2010).

Employers use well-being and wellness programs as the basis for all of the other programs directed to support older workers. A Harvard University analysis found that employers can reduce medical costs by $3.27, and absence costs by $2.73, for each dollar spent in wellness programs (Marsh & McLennan, 2014). Nevertheless, wellness programs for older workers cannot be used to replace the lack of proper management or uncomfortable situations that could be present at work for this (or any) age group. Active-aging programs will only be successful if they are part of an all-inclusive strategy for the employer. Programs with this strategy, and that are multidirectional in nature, are considered the best practice. Many are a component of the overall prevention strategy housed within employer health and safety departments. Novel components of these programs that relate to older workers include providing skills in self-management and other knowledge-based options offering tools on how to navigate the health system and how to find different choices for appropriate care, from their doctors and specialists, integrative medicine, and supporting health recommendations, to discern for over-the-counter (OTC) alternatives (Nakai et al., 2010).

It has been suggested that older workers could benefit from support groups, like other peer groups that create an ability to share and gain experience with coping strategies, and visibility impacting policies at work (Milligan, 2014). This, of course, increases their social networks and provides a sense of belonging and community which, otherwise, in a large organization, may not been found. This could serve as a protective factor for improving the worker's well-being. Employers may have different reasons to support older workers, human rights, fairness, and cost-efficient strategies, or because they want to use the experience and consistency of older workers as a key part of the organization (Barnes et al., 2009). Employers making these investments in health promotion and education see the work-related benefits as improved attendance, job performance, and less work disability. How successful a program is will be related to the relevancy of the information to the worker group it is targeting. The more diverse programs will reach a greater contingent of workers. In addition, those programs require well-identified indicators and the measurement of results to allow the possibility of further reframing, reshaping, or validation.

No matter which programs are in place, there always will be a group of workers that will not follow them. Being healthy requires active work throughout life, not just as aging comes. To be motivated to live a healthy, long, and financially secure life requires work and discipline, and some people will not accept the proven science. There will be older workers that will use these programs to their advantage to increase their skills for better lifestyle and those that will not. Finding resources and tapping into them helps explain why some workers have high capacity to work competently until an advanced age (Adapting to an aging workforce, 2014; Damman, 2016).

Work is a fundamental part of the social network of a person, and "social support as a determinant of health" (Chappell & Funk, 2011) is a concept that will have more visibility as older workers increase their numbers and their impact on work and their communities. Programs on active aging are fundamental and they should be supported by all. As the old saying goes, "It takes a village" will no longer apply just to talk about a child's need, but for the success of older workers, the support of the whole organization is necessary.

Job Demands

For an active-aging employee, engagement in productive activity is important. Working conditions will determine if this is viable for older workers, becoming a central concept for employers.

As defined by the International Labour Organization (ILO), working conditions range from working time (schedule, hours, and breaks) to remuneration, physical conditions, and mental demands that exist at work. For older workers, the perception of increased physical demands of a job is an indicator of a shorter-working life (Gommans et al., 2016). Good-quality jobs that have good working conditions will impact positively the health of the older workers and will provide a protective effect. Alternatively, a poor-quality job will likely facilitate a decline in health and/or amplify age effects (job quality is defined in terms of job outcomes, skills, job content, control, security, and the balance between effort or hard work and reward; Welsh, Strazdins, Charlesworth, Kulik, & Butterworth, 2016). In order to translate this to an employer's prevention and management strategies, the best method will be to use the *Work Ability Index*, created in the mid-1990s as an evidence-based concept by a Finnish group of researchers and defined as the balance between human resources and the demands of work (Tuomi, Huuhtanen, Nykyri, & Ilmarinen, 2001). The Index contains four dimensions that define work ability in order of impact: job demands and environment (physical components), work organization and work community (relationships at work; clarity of role; control, dissatisfaction, and use of knowledge), professional competence (job competence, retraining, and influence), and lifestyle (health and fitness). These dimensions can be used to refine support for older workers, with the most impactful being that of job demands. The key is to provide work duties that are balanced to the abilities of the worker, identifying those duties and tasks that may become unsustainable for an older worker, and providing a direction for change. Older workers are specifically challenged by shiftwork and more physically demanding tasks.

Ergonomics at Work

Older workers carry the impact of their whole life's work on their bodies. Some of them have been working for more than 40 or 50 years. At the beginning of their careers, they may not have had the advantages of mechanization or ergonomic support that we have presently, and many of them may have had high cumulative exposure, which could be a barrier for better health. Actions toward making duties less demanding, reducing the potential risks of the job, and offering positions that are easier on them are a relevant strategy that employers commonly use (Crawford et al., 2016). We now know that the decline of vision, hearing, strength, and stamina, cognitive factors, and fatigue can all be supported with ergonomically environmental design and changes to decrease evident risks and improve the relationship between duties and function. Having a periodic formal process that detects ergonomic discrepancies for specific job duties and that evaluates the impact for aging workers with the consequent recommendation for mitigation and control is the best practice. Examples that employers are already using (but could be important to see them improved, as well as used more extensively) include review and changes of lighting temperature, noise, and vibration, use of supportive technology like lifting devices, decreased repetition and multi-tasking, increase automatization, increased decision-making time, providing rotations of work assignments, review of heights, and protection barriers on work surfaces. Variations in worksite temperature, increased ventilation, easy access to water and bathrooms, increase frequency of bio-breaks, increasing size of fonts, and having brighter colors can also make the workday easier (BMA, 2016). Also, the use of proper shoes is important, because a third of people age 65 or older would have slips or falls that can have serious complications. Adding concomitant education and training to increase the use of these changes will provide maximum benefit (Alberta. Ministry of Labour, 2016; Čiutienė & Railaitė, 2015; Enos, 2009; Marsh & McLennan, 2014).

Compensation strategies and accumulated knowledge facilitate older workers to have a satisfactory performance at work, even though they may have some degree of cognitive decline. Jobs with more complex and intellectual activities will help workers to maintain better logic and problem-solving skills (Loretto & White, 2006). However, excessive pressure, multitasking, and chronic stress in older workers are a risk factor. In cases where cognitive assessment is needed, a very good tool that allows standardization for employers is the *Job Demands Analysis* tool from the City of Toronto. This is the redesigned tool after the merge of seven municipalities in 1998 by ergonomists that includes a psychological/cognitive demand rating system that helps to identify potential risk factors. It is simple and easy to use for employers (Toronto: City of Toronto, 2003).

Using these types of assessment tools to ensure older workers work within their abilities is a safe practice for all.

Shift Work

Social media is questioning if sleep deprivation has become the new smoking. This is not far from reality, and it is supported by many studies over the last few years which are showing the deleterious impact that shift work may have on health. Accumulation of the exposure to shift work for more than 10 years can impair cognition (Marquié, Tucker, Folkard, Gentil, & Ansiau, 2014). Employers are increasingly aware of this and of the vulnerability that older workers have in relation to shift patterns and length. It is accepted that shifts greater than 8 h are detrimental to older workers. Researchers suggest limiting or avoiding night shifts, if possible, using forward-shift rotations (day, evening, night), slow rotations (days for 6 weeks, then reverse) versus quick rotation (2 days, 2 nights, 3 days off, repeat), reduced workload, shortening the working hours, increasing rest pauses, and having health checks every 2 years and support with counselling in sleep, diet, stress management, and off-job activities (Alberta. Ministry of Labour, 2016; BMA, 2016; Bohle, Pitts, & Quinlan, 2010; Costa, 2005; Costa, Sartori, & Åkerstedt, 2009).

The impact of shift work on health seems to be more related to the number of years working rotating shifts than because of the workers themselves. Older workers have better performance on morning shifts over night shifts and require an extended recovery time after longer shifts (12 h) (BMA, 2016). For industries that are based on 24/7 functionality with rotations that are 12-h shifts (such as hospitals and other hospitality business employers), changes are not widely possible. Offering options to rotating 12-h shifts is difficult and less cost-effective, especially for healthcare employers. For this reason, the healthcare sector has been noted not to be as healthy as we may think it is or as it should be (Barnes et al., 2009). For example, a review of the contributing factors of early retirement of nurses showed the impact of the workload and rotation (Blakeley & Ribeiro, 2008). The protective factors that allowed them to stay longer at work included the ability to choose their working hours and having a lighter and less stressful job.

Employers have tried different strategies to help retain older workers in shift-based organizations. For example, Austrian manufacturer Polyfelt Geo-synthetics (Barnett, 2008) increased the number of rotation groups in order, to allow one group to take time to attend a "health promotion week" and to have education in self-management techniques (fitness, diet, sleep, stress management). This yielded improvements in the workers' lives and has decreased absences for this particular employer. In general, sleep education is needed, even if the employer has no overnight shifts, as poor sleep for older workers can mimic age-related deterioration of cognition (Altena, Ramautar, Van Der Werf, & Van Someren, 2010). However, shift work will continue to be needed across different industry sectors, and there is still a long road ahead to try new strategies and changes to rotations. Hopefully, these changes and adequate support will be able to decrease health risks for older workers.

Coaching at Work

Coaching provides the worker with a place to reframe ideas and a safe place to bring personal and job issues to the surface. Effective decision-making should be easy but, for an overwhelmed worker, it is not. In our current world with large amounts of public information, the choices open to workers can be confusing, and the decisions may not be clear or misdirected. To elicit positive health behavioral changes, including the improvement of sleep issues, coaching has shown positive outcomes. Workers could improve their ability to continue working, or prepare for retirement, while achieving personal goals and easing the interface of work and personal life. For some workers, even though knowing what the goals to a health life can be, they may not know how to reach their own goals; coaching can provide this support (Adapting to an aging workforce, 2014; CDC, 2016). Such coaching can prepare groups at work to have increase responsiveness in providing peer support. Stress and depression are strongly linked; high-stress duties are at higher risk of disease, but, if there is support from peers and supervisors, the benefits are more important than we tend to think. A study in job stress and presenteeism showed that, if both peers and supervisors are supportive, both conditions (stress and presenteeism) can be improved. When support was provided only by supervisors, only job stress improved, while presenteeism was not altered. This highlights the power that peer support can have (Taylor & Walker, 1998).

Coaching at work can also impact how the support for older workers is accomplished, by increasing coping skills and creating functional supportive teams that work effectively. Coaching can also be a great tool to address the phenomenon of having five generations working together, which may spark some intergenerational conflicts. These situations can become a positive source of cross-generational mentoring relationships (Roper, 2016), where older workers are mentoring younger ones and vice versa. For workers who find it difficult to come to terms with aging, worry too much how are they being seen by peers and the organization, are not able to keep up with technology, and are struggling to balance their own internal resources (Ng & Law, 2014), coaching services can provide the safe place to have those conversations (improve their ability to pivot on their own strengths to be successful) and create strategies to focus on their strengths to be successful.

Accommodating Workers

The importance of offering work accommodation options to elder workers to increase work retention cannot be overstated. Current efforts by employers (or lack thereof) are driving 57% of older workers to exit the work environment by age 62, with an additional 17% having to transition to another occupation to maintain employment (Collins & Casey, 2017). Some workers decide to change careers or retire, citing decreased energy, resilience, or a change in, or loss of, particular interests. However, a greater number of older workers (who wish to continue working) will require the employer's assistance to do so. Employers who see the value of older, more experienced workers will be open to providing ongoing development and work accommodations for workers and will, in turn, be rewarded by successfully maintaining a stable workforce. Those employers, who only see in older workers a decline in value, will focus in using a strategy of early retirement to remove these workers from the workforce (Zacher, Kooij, & Beier, 2018). These employers' organizational culture is referred to using the terms depreciation versus conservation models. Unfortunately, it appears that this strategy—that of removing older workers due to a perceived decline in value—continues to be dominant among EU employers according to 2015 data by Van Dalen, Henkens, and Wang (2014).

The frequency of formal requests of accommodation that employers receive increases, relative to the physical nature of the job duties involved. One of the main reasons for this is that workers from trades and/or industries which require prolonged physical labor tend to encounter more difficulties finding a job that matches their physical needs, as their trade-related skills are not easily transferable to other industries with jobs of a more sedentary nature (Collins & Casey, 2017). Usually, when this happens within the employer's process, the employer, government, or insurance provider will provide workers with support, accommodation, and, if needed, training to gain the new skills required. Larger organizations may have the advantage of multiple sites and different job positions with different job-demand options that smaller organizations may not have. Consequently, the latter are unable to offer the same flexibility in accommodating workers. Even though legislation is common for all organizations regardless of size, there are some provisions to support small employers, as noted previously. As an example, portions of the *Americans with Disabilities Act* (ADA) have limited exemptions for businesses that employ fewer than 15 people. (Job Accommodation Network, n.d.).

Gender may also be important for some industries, as the ones that are male-dominated (metal mechanics, transportation) are much less likely to provide age accommodation when compared to industries dominated by women, where age accommodations are more common (Barnes et al., 2009).

In the case of informal employment—or other forms of employment (casual, temporal, part time)—the possibility of having or accessing a job that provides all the accommodations needed is not common. For this reason, 42% of workers who retired earlier than expected cited disability as the driving factor in their decisions. Of people 55 or older, 13% are not currently working due to disability, making it the most common cause of unemployment (Collins & Casey, 2017). A survey in 2015 of 2133 managers in Belgium's private sector found that 17% used accommodations to adapt to the health requirements of older workers (Verbrugghe, Kuipers, Vriesacker, Peeters, & Mortelmans, 2016).

Basic Guidelines for Accommodation Processes

Work accommodations and adjustments are a tool that employers use to allow nondiscriminatory access to work through improving skills and/or changing work conditions, thereby increasing the probabilities of success in a new or modified position that matches job demands and work abilities.

Even though accommodations can be granted under various grounds of discrimination, the most common reasons are physical or mental disabilities. It is important to understand that accommodations exist to remove discriminatory barriers, not to provide workers with preferences. An accommodation is not required if undue hardship is reached (this is an exemption that employers have at their disposal if the accommodation requested is unreasonable—either through costs or operational requirements—or places a disproportionate burden or obstacle for the employer).

Likewise, accommodations cannot be provided if bona fide occupational requirements (the core requirements of positions that are essential for workers to effectively and safely carry out their job) are not met. Accommodations are established under Human Rights bodies or organizations designated specifically to provide a framework for the protection of people's rights. ADA, as an example in the USA, provides workers and employers information and support following the Americans with Disabilities Act of 1990. They do not have a list of medical conditions that imply disability; all decisions are based on the functional capacity of the worker. Similarly, there are not specific stipulations for older workers (72, 76). In addition, the *Canadian Human Rights Act* (R.S.C., 1985, c. H-6) and the European Commission (based on the United Nations Convention on the Rights of Persons with Disabilities – CRPD) have both adopted specific strategies, commissions, and educational agencies to provide the same background or support.

For the employer, work adjustments or accommodations are based on a formal process that is carried out, usually within collective agreements. This is a fact for larger employers, private or not. Some employers have processes that are more contingent on the requests workers submit. Barnes et al. (2009) found that to accept this flexible work, more than one approach was evident, since the volume of requests to accommodate age was minimal compared to the number of medically related requests. In general, responses from employers could be separated into three tendencies: one that is granted under very special circumstances and in only a few cases, the ones that are deemed appropriate (versus others that are assumed inappropriate – usually based on the objectivity or apparent subjectivity in the nature of the individual claim – the later cases being declined), and a last group that leave employers with a very ample spectrum of acceptance criteria (from business cases to paternalism) and find many diverse motivations valid (Barnes et al., 2009). These accommodations can be provided under a temporary or permanent status: temporary to provide more time to help with a lengthy recovery plan or permanent to change specific duties or job tasks. They address specific limitations and restrictions. But, we must appreciate that more than one-half of the population over 55 have chronic conditions, and some researchers think that "aging is the most important risk factor for human disease in developed countries" (Martin-Matthews, 2011). These chronic conditions over time are a factor and increase the risk of presenteeism, absenteeism, and disability that is more evident in physically intensive-related industries. Elements like the inability to cope at the same level as age passes and the physical accumulative effect of work may deplete them. Evidence of this fact is highlighted when looking at the differences between a blue-collar and white-collar worker, where Barnes et al. (2009) found a 20-year gap between the presentations of the same extent of illness. Accommodations are more difficult in small organizations, as there are far less opportunities to tailor duties or tasks and, in addition, some small employers are not well-informed regarding the due diligence they are responsible for (Barnes et al., 2009). Still, in small or large organizations, we see informal accommodations that are highly dependent on the supervisory level, rather than the policies of the employer, and they vary depending on the size of the organization and job duties. "Self-accommodation" is another type of informal accommodation. These tend to occur when an older or ill worker finds a way to continue working, changing their own duties in a (usually subtle) way that has low or no impact to the workplace at the time of the changes. There is usually not a formal request or process to change those duties, and they become accepted tacitly by the direct supervisor. They only become an issue when processes or workplaces are changed or when the direct supervisor leaves and the next one finds the situation inappropriate.

Accommodations can create conflict. If alternative options that are offered only to older workers create conflict between the workers, then a possible solution is to standardize the offer to all workers, regardless of age. The important part of the process will be to outline the criteria, with no specific age range (Victorian State Services Authority, 2008). Accommodations should be based on a "win-win" situation for all involved, and, when they are offered, the employer has an expectation that workers will be responsible and do their best to actively work toward a successful (productive) outcome of their accommodation.

Family Accommodation

There are accommodations to assist workers who have family obligations that create a barrier to attend work. Some countries, such as Canada, have regulated the support of this group of workers under Human Rights. This is not a "one-size-fits-all" solution, providing the employee with a list of questions to answer that includes relationship to the person receiving care, specifics of the care needed, time frame for recovery, rationale for why the worker should be the one providing the care, why this is an obligation and not a choice, if there are alternatives, what other efforts have been tried, and what is the specific accommodation needed from the employer (Canadian Human Rights Commission, 2014). These regulations can be very narrow, and the accommodation can often be hard to provide, as they are usually intended for extreme cases. The challenge in this area involves the workers that are not able to comply with all the prerequisites of the rule and are not offered accommodation, even though they still have the need for it or firmly believe they have this need. Employers can witness an impact on other types of absenteeism that are used instead of the family accommodation. It is not difficult to wonder if more flexibility and strategies to implement further support for those cases might produce a positive and greater-than-expected "ripple" effect. More research that includes the government is needed to support these caregiver situations, because they are becoming more frequent in our society.

Unions

Unions have been fighting age discrimination since the postwar years. They focus on direct and indirect measures to decrease age discrimination: from obvious manifestations of discrimination such as age limits to less evident forms such as offers of early retirement. This pressure (together with the cutting of some benefits which are likely to be used more by older workers) makes workers consequently more likely to retire (Banerjee & Blau, 2016). Shifting the paradigm and supporting older workers to stay at work and not retire, even at retirement age, are a new chapter for unions. Although not yet common, some trade unions are starting to call on employers and governments alike to change the way older adults are assisted in their search to find jobs (Binstock, 2010). This is one step in the right direction. If, at times, it seems as if there is not a clear pathway for employers, there is perhaps less clarity in how unions are embracing this topic. Unions that work for better wages, more benefits, and improved working conditions will now have to begin advocating for increased access to work flexibility. This is not an easy task, as collective agreements tend to be homogenous, where individualized needs yield to collective needs. Flexibility needs are different for diverse types of workers and work departments within one employer. It seems that when it comes to how effectively unions can lobby for flexibility in the workplace, the size of a union is not as important (and a less reliable indicator of success) as the fervency with which it supports the initiative. Consequently, it is evident that even the smallest of unions can lobby successfully for increased flexibility in the workplace (Berg, Kossek, Misra, & Belman, 2014). For example, a group of health-sector unions had agreed to work jointly with employers to support accommodation processes. As a result, unions were finding that the disability management programs in BC, Canada, have varied results and were not standardized throughout healthcare employers in the province. This triggered the development of the *Enhanced Disability Management Program* (EDMP), an employee-centered, proactive, and customized disability management program for employees with both occupational and non-occupational illnesses and injuries. It includes accommodations and covers "struggling at work" to be considered. This has shown to be a successful experience and has improved existing support for participating workers (HEABC, n.d.). Seniority is also a critical topic for many unionized organizations. How the current (and rather strict) seniority rules in collective agreements will impact the ways age management can be supported is still to be determined (Inder & Bryson, 2007).

Human Resources and Management Support

For employers, older workers are both a challenge and a great opportunity. Human resources departments and consultants may compel organizations to become aware of age differences and to perceive older workers without stereotypes. Human resources lead conversations which are, at times, difficult to have, as they can elicit the opposite reaction, and be seen as age discriminatory, producing resistance instead of engagement. Ideally, these conversations should generate active participation, so that employers still have processes that could be considered punitive (such as pressuring workers to opt for retirement, instead of offering support or assessing if an accommodation is needed, or not paying the first or the few initial days when a worker calls in sick). An initial conversation about age barriers within specific organizations, which includes a discussion on how to minimize or clear them, has proven to be a great starting point. (48, 58) Employers have acknowledged the efforts which are necessary to prepare strategies to facilitate engagement with older workers, but only some employers are acting upon these discussions. A survey of employers showed that 80% of them support workers past 65 years of age, but only 39% had flexibility in shifts, and only 31% allowed changes from full to part time (Collins & Casey, 2017).

A 2002 study of older workers and collective agreements (Fourzly, 2002) found the following issues that are important to both union and employer:

- Provisions for special considerations when determining flexibility and work-time arrangements.
- Provisions for leaves of absence to allow time off for transitory breaks from work.
- Provisions for education and training – these are directed to all the workers.
- Recognition that seniority rights, which are organization-wide versus department-wide, are better for older workers, as they allow more lateral, rather than vertical, movements.
- Provisions to support employment equity and no discrimination for older workers.
- Provisions to support transitions from work to retirement. (Employment Ontario, 2009)

Human resources working for governmental organizations, compared to ones working for private companies, have differences in their responses to the observed trends of aging workers. As an example, in the USA in 2017, a sample of employers showed that 50% were not making preparation for older workers and that the other 50% (73% [government] versus 46% [private]) had begun making preparations in response to the trend of the aging workforce (Boot et al., 2015; Collins & Casey, 2017). It was also clear in this sample that there are governmental organizations that recognize and thoroughly follow their duties related to the Americans with Disabilities Act and Age Discrimination in Employment Act (Brown, 2017; Collins & Casey, 2017; Roper, 2016).

This lag in preparation and planning should prompt a review (especially in larger organizations where long careers are common and where we may find workers who started in their mid-20s and may work past 65 years of age). Workers with more than a 40-year work span could have changed from a very physical job to one that is not at all physical. The matter of how a worker can move within the organization should be deliberated upon, with the goal of increasing the benefits to all involved. As human resources and managers define the impact of new policies or technology on older workers, they should seek options, such as adjustments of competencies and skills. Having a mid-career "moment to consider" is a best practice process and could include a change of pathways or interests in lateral or alternative positions. At the same time, organizations should have a clear idea where or which are the key roles that they want or need to preserve and how these conversations may assure their continuity. In this way, organizations may improve the consequent years of work with more attuned attributes for those workers and a better fitting role for that organization (Manpower, 2007).

Practices like the ones previously described may change the thoughts of some of the current mid-career workers longing for the day they finally turn 65 to retire and encourage them instead to stay at work for a longer career. Changes like this prevent those workers from staying in positions that are not the best fit for them and/or have more stress and discomfort than successful experiences and who would otherwise retire early. Now, with these mid-career conversations, it could alternatively provide them the opportunity for a longer work-life duration. In addition, it is customary that successful workers advance in their careers to a supervisory position (vertical movement), but the stress that may accompany these types of positions could be a negative trigger for an otherwise stable older worker with a balanced chronic condition(s). Employers could foster the normalization of lateral or horizontal movements as potentially successful and valid options for workers who seek less stressful mature years.

All workers (and especially older workers) should have processes or strategies in place at work that are transparent and based on fairness and justice. Providing better organizational justice to older workers (Ybema, Van der Meer, & Leijten, 2016) while empowering them increases the control they have on their work and makes it easier to manage job demands and resolve work-related issues when they become a problem. This will help to decrease "burn out" and facilitate options to move to other career pathways throughout the work life and, when retirement comes, will provide workers with the opportunity for an elegant transition (Stynen, Jansen, & Kant, 2017).

Older workers pose challenges to employers, but it is expected that this group will continue to grow. Employers have yet to master the challenges that older workers are creating and yet to exploit the benefits that they can bring. Some industry sectors are ahead of others, but all will have to bring strategies to the table to improve the working years of older workers and leave aside any attitudes that could become another barrier to work. What is most important is that many of these strategies will be of benefit not just for the older workers but to all the age groups, as the changes must be addressed proactively across all generations and as early as possible (Barnett, 2008). Employers may find it difficult to performance manage some older workers, but this is due, most of the time, to not being old but for having had problems with performance that were balanced with other positive-production traits that may not be present once the worker is older (Case Studies, 2014). Still, this is not about having an easy way or to allow underperformance or to leave safety issues unattended. This is about inclusion, fairness, and support but also productive and safe work as well (James et al., 2015; Alberta. Ministry of Labour, 2016). Education and training should be part of the solution, and not just a sad exchange of poor performance for a request of retirement (Barnes et al., 2009).

Researchers have observed that performance in a person is a lifelong characteristic. It can be compared to a homeostatic balance that seeks stability, and, when age or disease disrupts it, a person will try to find other skills (or alternate tools) to compensate and continue with the same level of performance. Sometimes this is not realistic, or it is not satisfactory or depletes all the resources the employer or worker may have. An all too common and difficult question has been how to differentiate between performance and medical needs. Now, this will have a new element: age decline. This could increase the gray area we already have when appraising and facilitating a continued level of performance, so it is of the utmost importance that employers define how the organization will manage age decline. Human resources' departments should lead in the definition of values, missions, and new practices or policies, as well as their planning and implementation, and in seeking the early commitment of all parties (including employer representatives, workers, and unions.) They should provide the direction for workforce assessment, and consequent education and training in age-awareness, so as to set a respectful tone for communications. Finally, regular monitoring, evaluation, and assessment of the changes create a dynamic process, as the next generation of older workers will not have the same characteristics as the present one.

Flexibility and Its Benefits

In Europe, from a group of companies that together employ more than 3.4 million workers, 84% of employers (BMA, 2016) recognized the need for changes in flexibility to retain older workers. However, workers may not ask for these changes, as they do not see themselves entitled to those changes. Another assumption that decreases flexible opportunities is that some employers think that older workers want to work as much as possible in order to earn as much as possible before retiring (Barnes et al., 2009). A US survey of employers (17th Annual, 2017) showed that just a bit more than one-third of them offer flexible shifts, less than a third offer changes to part-time jobs, and less than a quarter let them change to a less stressful or demanding position. This further confirms that there are many opportunities to formally increase more flexible jobs to workers that may need them. Of course, the benefits of flexibility can be extended to other groups of workers, promoting a positive culture at work (Barnes et al., 2009; Costa et al., 2009). "Bridge jobs," for example, are a great way to offer a post-retirement activity, at the same time providing a way for employers to deal with workers shortage (Chmiel et al., 2017). In countries with a high ability to find part-time jobs, the labor supply is higher, being of benefit to employers and workers alike (Been & Van Vliet, 2017). These part-time workers can promote mentoring to younger peers, increasing options for knowledge management (knowledge translation and retention) within organizations (Čiutienė & Railaitė, 2015). The "Blended Job" is a flexible option that includes location flexibility at the same time as time flexibility. It requires high levels of management of communication, connectivity, and to be proficient with the required hardware and software. In a society that is increasingly technological, the labor force participation of higher-educated age groups of 55–59 and 60–64 (knowledge or white-collar workers) is increasing and can stay at work in higher percentages than blue-collar workers. For them, this is a good possibility to allowing them to stay at work and be productive. For any worker, a disadvantage could be the lack of delimitation of the boundaries between private life and work, and, for all as well, the advantages are the prospect to gain comfort, autonomy, and of course flexibility (Damman, 2016; Laun, 2017). Table 15.3 presents the different possibilities to provide flexibility.

Self-employment is more common as we age, from 6.4% for workers age 16–55 to 15.5% for the group age 65 or more. This comes as a response to the work situations for older workers that may present as not completely satisfying, less interesting, less challenging, not up to their expectations, or having a lower pay rate. Self-employment has shown to provide a higher satisfaction than other forms of work in later life, and some workers retain the relationship with previous employers – only the status changes – and they could provide project work, cover vacations and holiday periods, provide consultation, or be independent contractors (Čiutienė & Railaitė, 2015; Collins & Casey, 2017; Inder & Bryson, 2007). The inevitability of retirement is changing, and it should be viewed as a process, more than a destination. Self-employment, unretirement, encore adulthood, and flexible and bridge jobs present changes to the traditional work structure that more and more employers are aware of, but few are taking actions to fully use to their benefit. The possibilities for this time of transitions should be part of the yearly performance review to allow time, incorporation, planning, and coordination with managers and employers.

Table 15.3 Different possibilities to provide work flexibility

Workplace	Work hours	Work schedule	Career
Adjusting schedule and hours Telecommuting: work from home or work from more than one place Snowbird programs	Wind down: another name for part time, mix work, or reduced commitments Periodic leaves or sabbatical Shorter weeks Job sharing Seasonal positions Per diem work or casual	Compressed workweeks Split shifts (full day, divided in two segments) Self-scheduling Compensatory time Annualized hours (full number of yearly hours divided in blocks to allow longer time off)	Extended leaves Step down – lower responsibility Career coaching Lateral secondments, (may become a delegate for a committee like Health and Safety) Retraining Adapting the job to the worker Lateral moves Phased retirement

From: (Barnes et al., 2009; BMA, 2016; Carstensen, 2014; Čiutienė & Railaitė, 2015; Eyster et al., 2008; FICCDAT Conference, 2011; Inder & Bryson, 2007; Kuenen et al., 2011; Tishman, Van Looy, & Bruyère, 2012)

Traditional employer-benefit plans are a deterrent to many of these arrangements, either for the worker who may need full wages to continue saving for retirement or for the employer, as it may not be attractive to pay two benefit packages to fill one full-time position. Employers, governments, and researchers are questioning how the pay structure should change, or how they can be prorated for these cases of flexibility. Some ideas that have been explored are attached to performance and hours worked, as base and bonuses in the case of wages, and increases or changes to the insurance package or health benefits offered (Parry, n.d.). The difficulty to manage a differential of payments and benefits decreases the motivation to formalize some of these options. Maybe this is, in part, the reason why, in 2004, the *Bureau of Labor Statistics* reported that, while more than 25% of workers have flexible schedule, only 10% were formal programs.

Many organizations have taken steps in the right direction, as seen in Tables 15.3 and 15.4. Some of the most relevant strategies followed by various organizations are noted. Special mention goes to the US "Snowbird" program at CVS Pharmacies that allows workers to change sites for part of the year and, also, to AT&T where about 30% of their management staff is completely "virtual." In Canada, Bell allows workers to swap positions, and Coast Mountain Bus rehires retired workers to drive small community busses on a more flexible schedule. From the Netherlands, Achmea provides training and career development after employees reach age 45 and provides paid time off to study.

Still, there is more to do reorganizing the way employers are designing their processes to allow more and more variated opportunities.

Key Recommendations and Best Practices

Start early, and be aware. Employers can look conscientiously at the country's labor market to understand how this translates to the industry segment and to the composition of their own workforce. Does the employer have all the basic information to plan, analyze, and take decisions? What are the employer's demographics? What is the age of the workers at the beginning of their work and retirement with the employer? What are the critical processes, knowledge translation, or productivity that could be impacted by the aging process of your workers?

After that, plan and implement. Consider developing a short-term plan to deal with the current cohort of older workers and a longer one to deal with the next older generation. This plan should engage young workers and mid-age workers. Ideally, these strategies should start as early as possible, because the process to have a long successful working life (for the worker and employer) and healthy aging is a lifelong process (Carstensen, 2014). Employers should develop resources directed to help, support, and provide

Table 15.4 Types of flexibility offered by different companies

Type of flexibility offered	Workplace	Work hours	Work schedule	Career
Volkswagen of America	✓	✓	✓	
Lee Memorial Health	✓	✓	✓	✓
Abbott Laboratories (USA, EU, Japan)		✓		
Dow Chemical Company				✓
AT&T	✓			
Lancaster Labs		✓		
CVS Pharmacies	✓			
Marriott International			✓	
Central Baptist Hospital				✓
The Mitre Corporation				✓
Bell Canada				✓
Deloitte Consulting				✓
MIT		✓		✓
Polaroid		✓		
Coast Mountain Bus (Canada)				✓
Achmea (Netherlands)				✓
The UK Oil Company				✓
UK FirstGroup		✓		
Hoffmann-La Roche Inc.				✓
Procter and Gamble				✓
General Electric				✓

From: (Eyster et al., 2008; James et al., 2015; Mitre, 2011; Tishman et al., 2012)

tools to improve the worker's professional and personal life (Tuomi et al., 2001). Workers are at work as many, or more, hours than most of them spend with their families, and this is an advantageous situation to educate and support, and thus improving production and attendance. Other areas are highlighted below.

- *Develop Professional Resources*. Within the professional resources to be developed, ongoing education is a central element. Technical training to improve core competencies following modernization of the organization can be supported by internal work promoting bidirectional mentorship between younger and older workers, through collaboration or partnership with schools, colleges, or universities (Carstensen, 2014). In addition, Crawford et al. (2016) found that, for older groups, of critical importance (as to all workers) was to maintain updated and refreshed education in skills and techniques in proper ergonomics, management of tools, materials, work procedures, and risk prevention.
- *Improve Resources to Allow Ergonomic Changes and Work Adaptation to the Needs of Older Workers*. This is a must. Job demands analyses (physically and cognitively) are needed for critical job positions, identifying which are at risk of becoming a challenge for older workers. Evaluate the potential cumulative effect, mentally and/or physically. Depending on the industry, at least some jobs may stand out, and, with the mediation usually by health and safety departments, these functional gaps will be evaluated. Job, task adjustments or the use of alternative tools to decrease the physical or mental pressure may allow older workers to continue performing at their best.
- *Human Resources Need to Develop Policies to Promote These Strategies of Flexibility and Educate the Organization to Support Them*. Directing support to older workers and merging efforts with health and safety, disability teams, and managers are key to improve the work environment and to balance motivation, attitudes, and value of older workers (Crawford

et al., 2010; Tuomi et al., 2001). Managers and supervisors are a pivotal resource in modifying attitudes, assumptions, and stereotypes. At the same time, they may identify trends or job positions in the organization that have higher challenges and may require changes in function for aging workers. Their assessment will activate preventative or mitigating approaches as accommodations. Managers and human resources should prepare for an increase in the number of these accommodations. As with longer working life, the request for them will be more and more common, expecting that undue hardship should be an infrequent outcome. Either as an external resource provided by short-term disability insurance or as an internal resource, the disability management team should provide programs like stay (or recovery) at work, early return to work, and work adjustments or accommodations (permanent or temporary) mitigating the impact of lengthier recovery times after injuries or illnesses in older workers.

- *Develop Personal Resources*. Employers should provide tools and skills to facilitate maintenance of good health and functional capacity, as they should be the most important single responsibility of the workers. Health promotion programs to increase physical activity (exercise) and lifestyle (nutrition, weight control, and adequate sleep) should start with younger workers and provide active aging skills and coaching in different personal areas (psychological, social, and financial skills). In addition, mid-career workers should plan for later in their working life, including their career objectives. These programs are of special importance for blue-collar workers who are the ones that often have the lowest physical activity, even though this seems contradictory (Bohle et al., 2010; Leopold, 2016). Moreover, as older workers can be more vulnerable to stress and burnout, health programs add protection factors and positive elements for good mental health (such as increasing resilience and coping skills) that added to a healthy lifestyle and increased their engagement in social relationships, including artistic and recreational activities that can protect older workers from stress and isolation (Bohle et al., 2010). Successful well-being and health programs are based on multicomponent interventions. To highlight the variety of components needed to be successful, Hobson (2017) found that programs which increase work participation of older workers should feature at least two of the following three components: health service delivery, coordination of services, and work modifications. As some of those services are government based, employers can partner with them to increase the breadth of the programs offered to older workers to improve opportunities while also caring for others. Professional and personal resources amalgamate in the concept of age management, adapting the workers' skills to meet the ongoing changes to their abilities and health in a dynamic process. That will preserve optimal function and productivity (Tuomi et al., 2001).
- *Flexibility*. Social, family, and personal reasons may have a vast impact on older workers, making flexibility as the single most relevant recommendation to allow better coping strategies, balance health, function, and increased working life (Barnes et al., 2009). Flexibility should be part of a multicomponent program that encompasses primary prevention, education, skills training, and health and safety support, recognizes caregiving needs, and offers incentives, personal growth, and strong support from directives, human resources, and managers. With flexibility, workers can continue to work while having the added advantage of an active and healthy life (Alberta. Ministry of Labour, 2016; CDC, 2016; SHRM, 2015).
- *Program Evaluation*. Organizations should strive to define their own standards or best practices; benchmark and exchange of best practices, by organizations or the industry segment; increase understanding of successful elements for program implementation; define key performance indicators and variables to measure success; and support current courses of action or provide information for adjustments or for change of direction. As with new

trends in precision medicine, the rules for processes that are shaped to fit all workers into a determinate organization should, at the same time, provide a personalized outcome tailored to individual risks and conditions, treating workers as unique as they are.

Research Directions

How can we help in elucidating better ways to succeed when implementing age-management strategies at work? What can we do to support older workers? European research groups have done great work over the last two decades leading trials and programs that merge the needs and ideas with employers, but still there are more questions that need to be answered. From work organization to partnerships with government and unions, the following are some ideas and topics intended to provoke interest and options for research:

- Requests for job adjustments are increasing in number, and even more employers are finding it difficult to identify positions suitable for the needed accommodations. Should the work organization (schedules, rotations, and interchangeable positions) change, and in what degree or way? Should employers have a variety of possibilities available, and how can they be embraced by workers and unions? Especially for employers that require personnel for 24/7 services or labor, this would benefit from further direction.
- Other, especially larger, organizations tend to subcontract workers for entry-level, basic-skilled positions or for temporary assignments. These positions are no longer available to be used for accommodations, decreasing the capacity of the employer to find jobs for workers that require more basic duties or high flexibility. The lack of finding a suitable position for an accommodation may likely leave the worker in a disability status that implies further costs in insurance or workers' compensation boards' premiums. Comparing the subcontracting of these job positions, versus retaining them for accommodation purposes, could provide differences in practices that may benefit both workers and employers. Another challenge that is common for employers is that, usually, accommodations are based on symptomatic, established medical/chronic conditions. A line of "preventative" accommodations with the idea of providing workers with job changes before they are needed is necessary to avoid exhaustion or complications from the current condition. How can they be assessed and assigned? How can the regulations, based on a functional objective disability, be reframed? Further research on the benefits and costs, and how to manage these processes, would resolve questions that employers, workers, and unions presently have. In addition, guidelines and clarification on components for active-aging programs, that improve coping skills and can increase or stabilize attendance or improve the opportunities to manage flexibility, are questions that could benefit further from practical research and best practices.
- Another type of absence, one that is due to workers being caregivers, is another challenge and an added cost to employers. This is a problem with its roots in social needs that may benefit from more clarification on its impact and a cost-benefit analysis that provides information to governments and employers. Options for bipartite programs may ease the burden on these workers, change opportunities for work and care, or provide information on flexible options supported by governments and employers.
- Different health programs for workers, based on digital applications and texting, are products that are especially popular at present. Employers receive many offers in this respect, but none are directed toward older workers or long-term health management that includes work elements. Blending the current digital world with the needs of older workers may provide benefits to all, especially to the newer

generations of older workers who may be more digitally inclined.

- Lastly, the management of wages for potential work options that provide flexibility is currently a gray area that would benefit from more clarity. This is needed for employers and may differ by country, as this depends on the types of retirement income and disability structures available to workers. Information and evidence on how to define and provide a framework to these programs would be welcomed by employers.
- Older workers who remain at work are changing practices and policies for employers, unions, governments, nongovernmental organizations, and workers' compensation bodies. Employers have the challenge to lower the barriers and deterrents that older workers face to thrive at work, increasing inclusion and diversity. Workers will need to have a genuine desire to embrace the dynamism that active aging includes with acceptance and commitment and to nurture and embrace new possibilities. This will keep the skills and expertise within organizations and guarantee healthier older workers, and, in the end, changes like this will have a largely positive impact on society.

Summary and Conclusions

At present, we have an aging population and an aging workforce, with the highest percentage of workers age 55 or more. This comes as a result of longer education, followed by starting to work later in life, better health at the same age than in previous generations, longer life expectation, work that is more automated and less physically demanding, retirement age that is increasing in many countries, and increasing financial debt that is being carried into retirement. All these reasons explain why the older workers' labor force segment is going to continue to increase, while the other segments (young and middle age) have shown a tendency to remain the same or even lower in some countries. Consequently, increased work life for older workers is not a matter of taking over jobs that otherwise would have been allocated to younger workers (Carstensen, 2014); instead, what the reality is showing is that the low unemployment rates are pressuring employers to absorb new young workers and still require the expertise and the extended participation of the older ones. Workers with the right skills, no matter what age they are, will be needed. Consequently, improving the retention and hiring practices for the older group is a necessity. Helping these workers to be productive mentally and physically past the age that now is that of retirement would be a good strategy for employers. Many organizations are aware of this but still lag in strategies and management tools designated to improve the engagement with this group. Stereotyping still plays a strong role – thinking that aging workers are not productive or that they lack the desire to learn or increase their technological skills – but the current cohort of older workers is more adaptable than before, and their contributions should be seen in perspective and not as negatively as they were previously. This is a concept that employers should actively reframe in their organizations. Aging workers should be one of the top priorities for employers but, so far, that is not the case. It is a concern that not many employers have formalized or addressed this through reflecting policies and processes.

Employers should look at education and support throughout the working life as a lifelong engagement. We do not all age the same, as genetics and environment – including work and lifestyle – are variables that may have been in place long before old age. If prevention and mitigation over those factors start sooner than later in life, the outcomes will be better for the worker and employer. In addition, employment provides income, self-esteem, and social relationships and can be a well-being element in the worker's life, counterbalancing losses in executive functions, aggregating years of life, and improving health and social connections. Treating all workers with no discrimination, respect, role clarity, proper compensation, opportunities for career advancement, retraining (or accommodations if needed) a place in a team, to be recognized, and to feel in the right place are employer strategies that benefit all workers. Lastly, motivation is essential. Employers can provide support, but it is up to each worker, as masters of their own health, who will be the ones that will materialize the difference.

> Aging is not 'lost youth' but a new stage of opportunity and strength. (Betty Friedan)

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16 Interdisciplinary Pain and Disability Programs for Older Adults

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Overview

Rehabilitation is a very important therapeutic intervention for older adults because of the high incidence and prevalence of disability in this population. Musculoskeletal pain caused by injury, repetitive motion, overuse, disuse, and/or poor posture is a major cause of disability in older adults, and it affects quality-of-life and productivity (Relieving Pain in America, 2016). Chronic pain costs the United States up to $635 billion each year in medical treatment and lost productivity (Relieving Pain in America, 2016). Older adults with musculoskeletal pain are also likely to be at an increased fall risk (Centers for Disease Control and Prevention, 2005). Burns, Stevens, and Lee (2016) report that there has been a large increase in the medical costs associated with falling over the last several years. In 2012, the direct medical costs for nonfatal fall injuries were $30.3 billion and $616.5 million (Burns et al., 2016). As of 2015, the average cost per person of a medically treated fall was $9780, with nonfatal fall injuries costing $31.3 billion and $637.2 million, respectively (Burns et al., 2016). A national veteran's study (French et al., 2006) reported that older adults with healthcare encounters related to a fall were prescribed significantly more CNS-category medications than subjects in the age- and sex-matched comparison group. Therefore, despite advances in therapeutic treatments and evidence-based treatments available to today's older adult, the number of falls (CDC), pain medication prescription (French et al., 2006), and the cost of the treatments are increasing (Burns et al., 2016). Because all of these associated links between musculoskeletal pain, falling, pain medicine prescription, and medical costs, there is a vital need to improve the efficacy and cost-effectiveness of pain management and rehabilitation in older adults, as well as to prevent falls by using interdisciplinary programs where there is a relationship between several different types of healthcare practitioners and the patients (Gatchel, McGeary, McGeary, & Lippe, 2014).

Interdisciplinary Care

Interdisciplinary care focuses on the whole person by using appropriate healthcare providers to address the therapeutic and lifestyle changes necessary to achieve optimal health and healing, but it also involves the integration of their services as well as communication among them (Gatchel et al., 2014). There is often confusion between *Multidisciplinary Pain and Disability*

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Programs and *Interdisciplinary Pain and Disability Programs* (Gatchel et al., 2014). Although both involve more than one healthcare provider interacting with the patient to achieve health outcome goals, many multidisciplinary programs lack the integrative communication that is essential for true interdisciplinary care (Gatchel et al., 2014). Interprofessional collaborative practice (an interdisciplinary program) allows primary practitioners to work alongside other healthcare professionals as well as with the patient, family, and community to formulate, implement, and evaluate the care and services in an effort to enhance health outcomes (Core Competencies for Interprofessional Collaborative Practice, 2018). Within any well-designed interdisciplinary program is the biopsychosocial approach (Fig. 16.1) to treatment, where the care focuses on treating the body's responses to the pain and disability, rather than on just treating the pain and disability alone (Gatchel et al., 2014). Interdisciplinary rehabilitation prescription for older adults requires that the primary diagnosis and comorbid conditions be factored in, as well as the effects of aging and overall disuse, while also including social factors (Roig, Worsowicz, Stewart, & Cifu, 2004). Therefore, it is important to engage a team of different healthcare practitioners that will be able to address the primary diagnosis and any comorbid conditions. Table 16.1 represents a sample of a typical interdisciplinary healthcare team with their common roles. The dynamics of the rehabilitation team depend on the clinical context (Stott & Quinn, 2013), and each situation will likely be different. However, a physician is necessary to coordinate the interdisciplinary healthcare team when the patient is suffering from an acute decline in function within the context of an illness or comorbidity (Stott & Quinn, 2013). As time progresses and medical problems are stabilized, other team members may take the lead role as the focus is more geared to the psychological and social aspects rather than only the biological aspects (Stott & Quinn, 2013). Different team members should be responsible for the biological, psychological, and social aspects, related to rehabilitation plan for pain and disability.

Interprofessional Education (IPE) and Interprofessional Practice (IPP)

Interdisciplinary care in healthcare is a high priority as healthcare costs rise and patient safety remains a concern (Bainbridge, 2010). There are two components to interdisciplinary care that should be addressed: (1) interprofessional education (IPE) and (2) interprofessional practice (IPP). IPE is when students from two or more professions learn *about*, *from*, *and with* each other to enable effective collaborations and *improve health outcomes*. IPP is when multiple health workers from different professional backgrounds *work together with patients*, *families*, *caregivers, and communities* to deliver the highest quality care (Thistlethwaite & Moran, 2010). IPE should be a required component in professional and post-professional education programs in all allied healthcare programs. The 2003

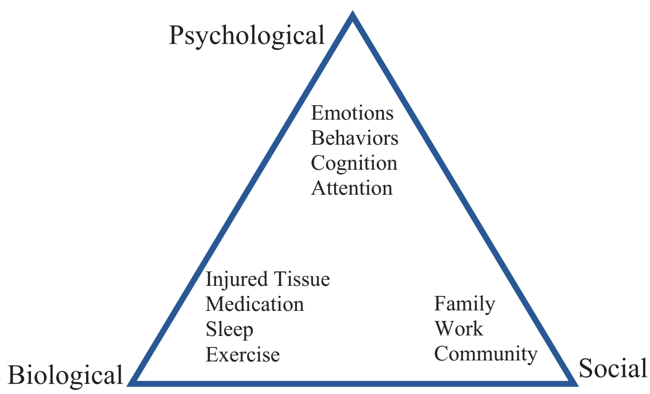

Fig. 16.1 Biopsychosocial model of pain

Table 16.1 Healthcare providers within an interdisciplinary pain and disability program[a]

Healthcare provider	Common roles[b]
Physician	Medical director Direct role of medical management for patient Coordinates interdisciplinary care Evaluates and monitors treatment outcomes Directs the communication between the team members
Nurse (RN) or nurse practitioner (NP)	Assists physician/case manager Provides for follow-up procedures Evaluates and monitors treatment outcomes Actively participates in communication between team members
Physical therapist (PT) or Athletic trainer (AT)	Educates on physiological basis of pain Applies therapeutic interventions Teaches and monitors appropriate exercises Teaches appropriate body mechanics/ergonomics Evaluates and monitors treatment outcomes Actively participates in communication between team members
Occupational therapist (OT)	Addresses vocational issues associated with disability Teaches techniques to manage pain at work or activities of daily living Communicates with employers or living facility Evaluates and monitors treatment outcomes Actively participates in communication between team members
Psychologist	Provides full psychological evaluation Assesses patients' psychological strengths and weaknesses Uses cognitive behavioral treatments to approach psychological issues Evaluates and monitors treatment outcomes Actively participates in communication between team members
Social worker	Helps patient problem solve and cope with problems in everyday life Works with family, community, and social policy to provide for needs Clinically can diagnose and treat behavioral and emotional issues Evaluates and monitors treatment outcomes Actively participates in communication between team members
Nurse's aide, PT aide	Assists supervisor in the accomplishment of duties related to patient care Actively participates in communication between team members

[a]Adapted from Gatchel et al. (2014)
[b]The roles are only defined in general as each interdisciplinary team brings unique aspects and will assign duties

Institute of Medicine report *Health Professions Education: A Bridge to Quality* included the following vision statement: "All health professionals should be educated to deliver patient centered care as members of an interprofessional team, emphasizing evidence-based practice, quality improvement approaches, and informatics"(Knebel & Greiner, 2003). Interprofessional opportunities and socialization are critical features to the professional education of healthcare providers and are especially relevant in our healthcare environment where no practitioners should practice in isolation. According to Barwell, Arnold, and Berry (2003), there are five important elements of IPE, including (1) practitioners understanding their own roles and the roles of other professionals; (2) practitioners from varying professions learning to communicate with each other in a collaborative, responsive, and respective manner; (3) practitioners learning to effectively deal with interprofessional conflict; (4) practitioners learning to work together with other professionals, as well as with patients, families, and community to formulate, implement, and evaluate care and services to enhance health outcomes; and (4) practitioners understanding the principles of team dynamics and group processes to enable effective collaboration. There are also five key outcomes of IPE: (1) its recognition by the World Health Organization that multiprofessional learning leads to better interprofessional working; (2) the provision of better teamwork between health professionals improves patient outcomes; (3) helping students to appreciate the importance of personalities and interpersonal skills of a variety of healthcare practitioners; (4) helping practitioners to understand that institutional hierarchies can hinder communication and negatively affect patient care; and (5) encouraging more research on IPE and the need to implement it at all levels of education, including at the graduate level in professional schools (Core Competencies for Interprofessional Collaborative Practice; Bainbridge, 2010). Students should be prepared as *team members* in their classroom and clinical experiences, and they should think, practice and act *as a team member*. The goal of IPE is IPP. IPP is a *partnership* that provides a collaborative and coordinated approach to shared decision-making around health and social issues of the patient. The outcomes of IPP include team members speaking freely, team members supporting and trusting each other, effective collaborative problem-solving, and having a clear sense of direction, with adequate information for patient care and goal accomplishment (Core Competencies for Interprofessional Collaborative Practice, 2018). Team performance is made up of knowledge, attitudes, and skills (Clancy & Tornberg, 2007; King et al., 2008). Salas and Fiore (2004) reported that high-performing healthcare teams hold a shared interdisciplinary care model, have clear roles and responsibilities, have clear and a shared vision, optimize resources, have strong team leadership, engage in regular feedback, develop a strong sense of trust and confidence, and can create mechanisms to cooperate, coordinate, manage, and optimize performance outcomes. Equally important in interprofessional practice is involving the patients in their own care by partnering with them and their family members. Including patients in discussions with other healthcare providers, conducting "pass offs" in specific types of care in front of the patient, providing the patient with tools to communicate with the healthcare team, involving patients in key decisions, and actively enlisting the patients' participation are several suggestions from TeamSTEPPS® training (Clancy & Tornberg, 2007; King et al., 2008). TeamSTEPPS® stands for *Team Strategies and Tools to Enhance Performance and Patient Safety*. Training is available using the TeamSTEPPS® toolkit, and it is meant to encourage situational awareness and communication by all team members and to encourage mutual respect regardless of their roles. It is based on the concept of a "just culture," which values input from all members of the team despite their perceived positions, and it emphasizes that all have an obligation to voice patient-safety concerns. Overall, IPE and IPP can encourage students and practitioners to develop competent behaviors in knowledge, attitudes, skills, and behaviors that will allow each of them to work collaboratively as a part of an interdisciplinary program for pain and disability (Bainbridge, 2010). The framework of IPE and IPP is likely to continue to evolve and change over the coming years, but will always emphasize teamwork and the biopsychosocial approach to patient's well-being (Clancy & Tornberg, 2007).

Evidence That Interdisciplinary Care Works

Many studies have been completed that have investigated the use of interdisciplinary pain and disability programs. The purpose of this chapter is not to review all studies in a comprehensive way but to highlight the results from several studies that involved rehabilitation for musculoskeletal conditions.

A systematic review from 10 years ago demonstrated that complex interdisciplinary interventions helped elderly people live safely and independently by helping elderly people to continue living at home simply by the prevention of the need for nursing home care because the rate of falls was reduced (Beswick et al., 2008). The authors also noted that each program can be tailored to meet the individuals' needs and preferences (Beswick et al., 2008). Kurklinsky, Perez, Lacayo, and Sletten (2016) demonstrated that a Pain Reduction Clinic (PRC) in Canada, with a 3-week outpatient program that utilized an interdisciplinary approach to treat people with chronic pain, resulted in clinically meaningful changes in a 6-min walk test and subjective occupational performance measures. The main elements of the PRC were physical therapy, occupational therapy, cognitive behavioral therapy, and medication management. The medical staff oversaw the tapering of opiate analgesics and other symptom-targeted treatments. Therefore, this approach of integrating care and communication resulted in both objective and subjective changes in patients suffering from chronic pain. Moreover, Lee et al. (2011) investigated the effects of an interdisciplinary geriatric team on adults over 65 who were medically stable but had experienced acute functional declines during a hospitalization in Taiwan. Conclusions revealed that a short-term inpatient physical reablement program improved the physical and mental function, ambulation, nutritional conditions, and mood of post-acute patients when treatments were conducted by an interdisciplinary geriatric team in a community hospital (Lee et al., 2011). In addition, Niemistö (2003 and 2005) reported that physician visits and manipulative treatment, along with stabilizing exercises, was more effective in reducing pain intensity and disability in chronic back pain sufferers than physician consultation alone. In the initial study, 204 chronic low-back pain patients were assigned to an interdisciplinary care team involving physical therapy (4 weeks; 4 times/week) or a physician consultation alone and self-care. Questionnaires were completed at intake and at 5- and 12-months post-therapy. Both pain intensity and disability as measured by the Oswestry Disability Index decreased significantly at 5- and 12-months and were greater for the interdisciplinary care group. Research on both older and younger patients with non-cancer-related pain (Darchuk, Townsend, Rome, Bruce, & Hooten, 2010) also demonstrated that a 3-week interdisciplinary pain rehabilitation program (based on cognitive behavioral models that incorporated physical therapy, occupational therapy, biofeedback and relaxation training, stress management, wellness education [i.e., diet and sleep], pain management trainings, and chemical health education based on opioid withdrawal) was successful in improving long-term psychological, social, and physical functioning in both the old and young. However, older patients reported increased physical and social functioning, along with perceived control of pain at discharge and even 6 months after the treatment ended (Darchuk et al., 2010). Thus, the support for interdisciplinary pain and disability programs has been strong, but many questions do remain regarding optimal ways to deliver, monitor, and evaluate care, especially in a geriatric population. As a start, Stott and Quinn (2013) identified several questions to guide future research, including the following: "What is the optimal content of rehabilitation? Does the model of therapy (e.g., biopsychosocial) delivery matter? What is the best method to evaluate complex, multifaceted rehabilitation evaluations?" Therefore, continued research is encouraged in the area of interdisciplinary programs for pain and disability. Recently, the *Pain Program for Active Coping and Training* (PPACT) has been initiated at several primary-care practices in the United States (DeBar et al., 2018); results are likely to be published in the coming years. The interdisciplinary interventions are designed to help patients develop skills to self-manage their condition and involve a comprehensive intake evaluation coordinated by the patient's primary-care physician and then participation in 12-weekly group sessions that focus on cognitive behavioral therapy to improve pain coping skills and adapted movement (DeBar et al., 2018). The PPACT study is supported by the *National Institutes of Health* (NIH) Common Fund, through a cooperative agreement (UH2AT007788, UH3NS088731) from the Office of Strategic Coordination within the Office of the NIH Director.

Practice Recommendations

As has been reviewed, there is growing evidence for the effectiveness of interdisciplinary pain management programs with aging adults. These have been modeled after those successful ones for younger adults. The only difference is that older adults require more attention to specific risk factors, such as more disability issues, slips and falls, medication overuse, potential cognitive impairment variables, and the need for more social support.

Future Directions in Practice and Research

Again, many questions still remain regarding the optimal ways to deliver, monitor, and evaluate interdisciplinary care for a geriatric population. As a starting point, Scott and Quinn (2013) have delineated several issues that need to guide future clinical research with older adults. Some of these are as follows: What is the optimal content of interdisciplinary care for older adults? Is the biopsychosocial model of rehabilitation delivery the best for older adults? What is the best method to evaluate the complex pain and disability rehabilitation issues commonly presented by older adults? Although research studies such as PPACT have already been initiated, a great many more will be needed for the different types of pain often encountered by older adults, such as musculoskeletal pain and disability, neuropathic pain, and specific disease-related pain. Fortunately, we already have a good biopsychosocial-based interdisciplinary pain management model to use as a "boiler plate" in developing clinical approaches to these other types of pain often seen in older adults.

Conclusions

There is mounting concern both societally and politically regarding the increased cost of caring for the aging population and the economic stress this will be putting on the healthcare delivery systems (e.g., Stott & Quinn, 2013). Although changes in immediate care may reduce costs and improve outcomes, they do not address the necessary services that older adults are likely to need after a medical incident, such as falling. Rehabilitation is probably the most important therapeutic intervention for older adults because of the prevalence of disability in this population. Therefore, our current healthcare providers, and our generations to come, must be formally educated and encouraged to participate in interprofessional education and interprofessional practice in an effort to allow for the development of rich and evidence-based programs designed to provide the best interdisciplinary care (using a biopsychosocial model) when treating older adults.

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17 Other Pain Management Techniques for Older Adults

Kelley Bevers and Robert J. Gatchel

Overview

Many traditional pain management regimens consist of pharmacotherapy and a physical activity plan. However, for older adults, traditional physical activity is not always a viable option. They tend to face physical restrictions and sometimes believe that exercise will exacerbate painful areas, such as the back and hips, and, therefore, they avoid such activities. Research has shown the benefits of exercise, but continuing and sustainable movement is part of "reaping those benefits." For example, cardiovascular exercise requires more than a single session of heart rate-increasing activity. Furthermore, there is evidence of supplementing aerobic activity with resistance training, to build muscle, improve posture and balance, as well as reduce the likelihood of injury from daily activities such as standing, bending, sitting, or reaching. If older adults are not exercising regularly or semi-regularly, they are not likely to be lifting weights, particularly in a safe or productive manner. Part of the problem is patients knowing where to start, but many are hesitant because they do not believe the activities will benefit them or because going to a gym or other facility is intimidating and overwhelming. A great deal of this anxiety could be avoided with proper education and access to appropriate resources. There are clear psychosocial benefits resulting from exercise including decreased depression and stress levels, better sleep, and increased social interaction and perceived social support (Belvederi-Murri et al., 2015; Chennaoui, Arnal, Sauvet, & Leger, 2015; Knapen, Vancampfort, Morien, & Marchal, 2014; Kvam, Kleppe, Nordhus, & Hovland, 2016; Schuch et al., 2016).

Additionally, some clinics rely heavily on pharmacological interventions to manage painful conditions, which can also be problematic considering that, on average, older adults take several different medications daily (MacFarlane, et al., 2012; Polatin, Bevers, & Gatchel, 2017). Medications also carry risks of dependence, tolerance, drug interactions, and issues of comorbidity with other conditions. Older adult populations tend to have multimorbidities that affect appropriate treatment courses, and such conditions must be considered when determining a treatment regimen. Many traditional pain management regimens include medications that carry common and sometimes severe side effects. Many patients experience sedation as a side effect, which is not helpful when it comes

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to getting the patient moving and exercising to build muscle and combat pain long term (Polatin et al., 2017). Other side effects, such as nausea, vision problems, and balance problems, can lead to further injury like falls or sickness (Polatin et al., 2017).

Due to these complications, many patients decide to explore alternative options. The umbrella term *complementary and integrative medicine* (CIM) is often used to describe such methods, such as acupuncture, massage, and Eastern medicine or natural remedies. Previous research suggests that the majority of older adults have sought care using CIM methods, with interest increasing all the while (Astin, Pelletier, Marie, and Haskell (2000). Many CIM methods are attractive to older adults as they tend to be less invasive and can be combined with other therapies they may be currently undergoing or will need in the immediate future. For example, either in addition to, or in lieu of, the more traditional approaches, many are looking elsewhere for relief. Different physical interventions, Eastern medicine, and holistic approaches are becoming increasingly popular for managing pain in older adults. In fact, many CIM methods produce the best results when they are part of a tailored program, as opposed to a "stand-alone" treatment (Abdulla et al., 2013; Antall & Kresevic, 2004; Middaugh & Pawlick, 2002). This chapter will focus on some such options, including myofascial release therapy, acupuncture, hypnosis, nontraditional pharmacological interventions, and emerging procedures.

Massage and Myofascial Release Therapy (MFRT)

Massage is a popular treatment for a number of ailments, such as pain, arthritis, and sleep disturbances, and as a relaxation method (Bervoets, Luijsterburg, Alessie, Buijs, & Verhagen, 2015; Nelson & Churilla, 2017; Qingguang et al., 2015). Often, relaxing the mind can have positive effects on the rest of the body. Relieving stress can allow muscles to relax and alleviate tension, headache, muscle ache, and promote wellness behaviors. Qingguang et al. (2015) found that massage therapy produced significant improvements in pain relief, stiffness, and physical function. Bervoets et al. (2015) also found improvements in physical function following massage, when compared with no treatment. However, some conditions require a more thorough and focused approach, such as *myofascial release therapy* (MFRT). This approach targets pressure points of hardened, tense muscle that can cut off blood flow to an affected area. By releasing this pressure, it allows the muscles to restore proper blood flow and to relax, resulting in an analgesic effect (Bevers, Brecht, Jones, & Gatchel, 2018; Gerwin, Shannon, Hong, Hubbard, & Gevirtz, 1997; Wolfe, Simons, & Fricton, 1992). Previous research has shown that MFRT can lead to significant increases in function, and decreases in pain severity, anxiety, depression, and sleep disturbances (Castro-Sanchez, Mataran-Penarrocha, Arroyo-Morales, et al., 2011a; Castro-Sanchez, Mataran-Penarrocha, Granero-Molina, et al., 2011b). Professionals will sometimes incorporate stretching and heat into the therapeutic sessions, to enhance pain relief. MFRT can also be complementary to other techniques like acupuncture, transcutaneous electrical nerve stimulation (TENS), herbal aids, and/or chiropractic visits. In addition, MFRT can provide physical and psychosocial benefit, making it an attractive option to pain patients. Furthermore, many treatments can be replicated at home with minimal equipment following minor training from a professional (Gatchel et al., 2017; Hughes, 2017). It is important to note that massage therapies may not always be appropriate, particularly for older adults. MFRT may exacerbate certain conditions, such as bleeding disorders, nerve damage, muscle rigidity secondary to a disorder such as Parkinson's disease, or those taking certain medications such as blood thinners. Careful consideration of comorbid physical conditions and current medications is essential before beginning a MFRT course.

Yoga, Pilates, and Tai Chi

Activities such as yoga, Pilates, and Tai Chi have become increasingly popular as relaxation and pain relief strategies. Research in this area is emerging, and more work needs to be done to show clear relationships between pain relief and these modalities. However, there is some evidence that yoga and Tai Chi result in moderate pain relief and intensity (Aboagye, Karlsson, Hagberg, & Jensen, 2015; Hall, Maher, Lam, Ferreira, & Latimer, 2011; Nambi, Inbasekaran, Khuman, Devi, & Shanmugananth, & Jagannathan, 2014; Qaseem, Wilt, McLean, & Forciea, 2017; Sherman et al., 2011; Sherman, Cherkin, Erro, Miglioretti, & Deyo, 2005; Tekur, Nagarathna, Chametcha, Hankey, & Nagendra, 2012; Weifen, Muheremu, Chaohui, Wenge, & Lei, 2013; Williams et al., 2009). Interestingly, a recent study highlighted that mindfulness and meditation reduced pain in comparison with placebo analgesia, supporting the notion that meditative therapies like yoga can be valid pain management therapies (Zeidan et al., 2015). Additionally, Keosaian et al. (2016) found yoga improved mood, reduced stress, and enhanced relaxation, increasing mindfulness and pain acceptance, suggesting again that yoga has potential as a pain management therapy. In contrast, another study found yoga can cause musculoskeletal pain, examining participants at a 1-year follow-up, though this occurred in only 10% of their sample (Campo, Shiyko, Kean, Roberts, & Pappas, 2017). The study also found that pain was relieved most in the lower back region following yoga participation (Campo et al., 2017). Unfortunately, there is no support for Pilates in pain relief (Gagnon, 2005; Qaseem et al., 2017; Rajpal, Arora, & Chauhan, 2008; Wajswelner, Metcalf, & Bennell, 2012), which may be due to the demanding physical nature of the activity.

Electrical Muscle Stimulation

Electrical nerve stimulation (ENS) is a method in which electrical pulses are transmitted to musculature nerves in various frequencies and amplitudes (Bevers et al., 2018; Johnson & Martinson, 2007). Both *transcutaneous electrical nerve stimulation* (TENS) and *percutaneous electrical nerve stimulation* (PENS) involve low-voltage electrical stimulation to painful areas. Repeated treatment has shown improvements in healing, nerve signaling, and reported pain levels. Meta-analysis of ENS treatment found significant reductions in pain when compared to controls for treating chronic musculoskeletal pain (Bevers et al., 2018; Johnson & Martinson, 2007). This method is noninvasive and easy to administer, which could be particularly attractive for older adults. Whether this treatment has shown specific results in terms of age is unclear, and more studies geared specifically to older adults need to be conducted.

Acupuncture

Acupuncture is an ancient form of Eastern medicine, combining relaxation techniques and the insertion of thin needles at pressure points. Support for acupuncture is mixed, often showing greater efficacy when combined with other treatment modalities such as MFRT, chiropractic work, or electrical stimulation methods (Abdulla et al., 2013; Bevers et al., 2018; Cevik, Anil, & Iseri, 2015; Vernooij & Marcelissen, 2017; Vickers et al., 2017; Yap, 2016; Yuan, Guo, Liu, Sun, & Zhang, 2015). Older adults with CLBP have reported reduced pain levels and reduced anxiety following acupuncture treatments (National Center for Complementary and Integrative Health, 2017). Moreover, a meta-analysis found that actual and sham treatments produced similar results yet were still more effective than no treatment (Yuan et al., 2008). This could speak to the power of patient "mind-set" or a placebo effect, although there is some evidence that these concepts may be unrelated (Gatchel et al., 2017; National Center for Complementary and Integrative Health, 2017). A more recent meta-analysis found support for acupuncture as a chronic pain treatment, highlighting that effects cannot purely be explained by placebo effects (Vickers et al., 2017). Support is growing, with more research efforts dedicated to evaluating long-term pain relief, even in some chronic cases (Vernooij & Marcelissen, 2017; Vickers et al., 2017).

Acupuncture is sometimes covered with private insurance, but Medicare does not offer benefits for these treatments, which may be a deterrent for older adults. Additionally, while the needle pricks do not tend to be painful or concerning, multiple treatments are generally recommended for pain management. More research is still needed on the mechanisms of action and controlling for extraneous variables, particularly in older adults.

Chiropractic Adjustment

Chiropractic work has become increasingly popular to treat several prevalent musculoskeletal pain conditions, with more than 18 million adults seeking treatment in 2012 alone (Clarke, Black, Stussman, Barnes, & Nahin, 2015). Many benefit from the release that chiropractic adjustments provide, such as allowing gas to escape the muscle junctions between bones, providing a release of tight muscles and tendons. The evidence on efficacy as a pain management method is mixed, and whether we can consider adjustments a "stand-alone" treatment method has met some resistance (Bishop, Quon, Fisher, & Dvorak, 2010; Dagenais, Haldeman, & Manga, 2014; Lyons et al., 2013; Weigel, Hockenberry, Bentler, & Wolinksky, 2014). For older adults, this method could be particularly inviting as it requires no physical ability on their part and is sometimes covered by insurance plans. Medicare Part B currently covers 80% of costs after qualified professionals to correct a subluxation (Medicare, 2017). Outcomes of chiropractic manipulations, however, may be short lived in terms of pain relief, requiring repeated, ongoing treatments from professionals. The treatment has also shown efficacy in reducing pain disability and increasing flexibility in CLBP patients (Bishop et al., 2010; Lyons et al., 2013; Meade, Dyer, Browne, Townsend, & Frank, 1990). However, side effects can include temporary discomfort or increased pain, headache, sleep disturbances, and lethargy (National Institutes of Health, 2017). The temporary discomfort or sometimes lasting pain following an adjustment could be a deterrent to some patients, especially older patients with mobility problems who are seeking relief. Much like an avoidance to exercise, patients could imagine their pain worsening, and these thoughts, even if temporary, are enough to disregard the treatment method altogether. Serious complications such as strokes have been reported, though whether the adjustment caused this issue is unclear (Gatchel et al., 2017; National Institutes of Health, 2017).

Hypnosis

Another complementary method with mixed results is hypnosis. The field has gained some recognition in specialized areas such as smoking cessation and weight loss and may show promise for pain relief (Cuellar, 2005; Gatchel et al., 2017; Stoelb, Molton, Jensen, & Patterson, 2009). Hypnosis is defined as an altered state of consciousness where one is more receptive to suggestion. The clinician puts the patient in a relaxing situation while having him/her focus on an object or narrow range of vision as suggestions are presented. This can be beneficial for pain patients as pain often has a psychosocial component, where attitude and thought can have great influence. For example, a meta-analysis, using weighted average effect sizes, found roughly 75% of the population could benefit from hypnotic suggestion for pain relief (Montgomery, DuHamel, & Redd, 2000). This claim seemed to be driven by an assessed suggestibility of the patient, as those who were high in suggestibility were most receptive to hypnosis and, therefore, benefitted more from treatment than those who were low in suggestibility (Montgomery et al., 2000). This method can be particularly attractive to older populations as the treatment could be easy to administer and is sometimes covered by insurance (American Society of Clinical Hypnosis, 2017; Cuellar, 2005; Stoelb et al., 2009). Previous research has noted that hypnotic therapy has generally resulted in a reduction of intensity and frequency of pain and was associated with a decrease in the need for pain medication (Stoelb et al., 2009). Many of the hypnosis studies were conducted on with females for labor, delivery, and post-delivery pain (Smith, Collins, Cyna, & Crowther, 2006). More research targeting older adults, however, is still needed to assess viability for this population.

"Natural" Medicine and Nontraditional Pain Relievers

Eastern medicine has long used a variety of herbal supplements to address health concerns, including those of pain. Where Western-style treatments tend to be focused around medications, surgeries, physical therapies, or injection treatments, Eastern styles take a more holistic approach with "natural"-based remedies like herbs, teas, acupuncture, or nutrition. Some practitioners have adopted a blended approach in which they aim to find a balance of natural and synthesized methods, in an attempt to find an effective management plan tailored to the individual needs of the patient. Some patients prefer to exhaust the more "natural" avenues before participating in more Western techniques like surgery and medication regimens. Herbal remedies are not generally approved or regulated by the FDA and not always supported by the medical community. Certain compounds have been studied clinically and shown to have beneficial properties, but many others lack evidentiary support of efficacy (Hosseinzadeh, Jafarikukhdan, Hosseini, & Armand, 2015; Lee et al., 2015; Xue & O'Brien, 2015). Commonly used natural products include garlic, ginseng, *Echinacea*, ginkgo biloba, and glucosamine supplements. One analysis found that roughly one in five adults used natural products as a complementary treatment method (Barnes, Powell-Griner, McFann, & Nahin, 2004).

Antidepressants

Antidepressant compounds have been used as part of pain management programs for quite some time. However, in older adult populations, there are several special concerns that must be considered before beginning such a medication regimen. These concerns include things like comorbid medical conditions, other medications taken, cognitive ability, history of mental health, social support, and adherence ability. Firstly, a number of conditions often seen in older adulthood can severely affect the effectiveness and safety of taking antidepressants for pain relief such as cardiac disease, multiple sclerosis, Parkinson's disease, dementia, delirium, and metabolic deficiencies (Polatin et al., 2017). Some conditions, like PD, can include or lead to delirium and dementia onset, as well as exacerbate pain and decrease adherence (Polatin et al., 2017).

Older adults tend to take an increased number of medications as well, and adverse drug reactions (ADRs) are an important concern. Antidepressants also carry their own risks and side effects including heart disease, glaucoma, dry mouth, headaches, depression, sedation, tremors, muscle weakness, increased appetite, insomnia, vertigo, rash, photosensitivity, heartburn, edema, seizure, gastric symptoms, agitation, nausea, and urinary retention. Patients on these medications should undergo routine blood testing and visits with a qualified practitioner to assess mental state and progress. Unfortunately, antidepressants are often ineffective for many patients who experience depression because of dementia onset.

Topical Agents

Topical compounds are sometimes a good option due to their low-risk administration. They are easy to use, although often need reapplication and sometimes are not powerful enough to penetrate the affected area. For superficial pain, they are generally effective and low cost, and many can be purchased "over the counter." Topical medications are often used in conjunction with more traditional physical therapies like heat or cold application, exercise, and stretching. Another administration route is the transdermal patch, which is easily applied to the skin where the medication can be absorbed into the body. Currently, several compounds are available in the patch form, including antiemetics, heat emitting patches, and strong pain relievers like buprenorphine. However, certain compounds require a particular release schedule to be effective in managing pain and not overwhelm the system. It is important to note that not every medication is available in either of these alternative forms, and these methods of administration may not be possible or feasible for each kind of pharmacotherapy.

Deep Brain Stimulation (DBS) for Pain Relief

Stimulation of brain tissues to treat pain is a long-used methodology. In the case of deep brain stimulation (DBS), this is a technique requiring surgical placement of electrodes into brain structures targeted to relieve the pain condition. Surgeons perform the procedure, by placing the electrodes in the designated area(s), and connect wiring to a stimulation receiver, usually placed in the shoulder or clavicle area. Depending on the type of pain the patient is suffering from, the electrodes can be placed in several different areas. Previous research has discussed some of the areas, such as the anterior cingulate (AC), nucleus accumbens (NAc), somatosensory thalamus (ST), centromedian-parafascicular complex (CMPf), periventricular gray matter (PVG), periaqueductal gray (PAG), motor cortex (MC), internal capsule (IC), and combinations of these brain areas that have been targeted in attempts to manage pain with DBS (Hollingworth, Sims-Williams, Pickering, Barua, & Patel, 2017). For nociceptive pain, the PVG and PAG are often targeted, and the MC is popular for central pain, where for neuropathic pain, the ST, IC, and CMPf may be preferred for stimulation (Adams, Hosobuchi, & Fields, 1974; Barua & Patel, 2018; Bittar et al., 2005; Hollingworth et al., 2017). Meta-analysis of pain relief reported 50% of patients experienced a long-term pain relief (Barua & Patel, 2018). However, the range of success rates was broad (19–79%), although still pointing at long-term pain management success mostly for those with nociceptive pain (Barua & Patel, 2018; Levy, Lamb, & Adams, 1987).

The DBS procedure shows a high rate of long-term successes in managing several pain conditions, such as trigeminal neuropathy, failed back syndrome, post-cordotomy dysesthesia, low back and skeletal pain, atypical facial pain, and lumbar arachnoiditis (Bittar et al., 2005; Hosobuchi, 1986; Kumar, Toth, & Nath, 1997; Levy et al., 1987; Richardson & Akil, 1977; Turnbull, Shulman, & Woodhurst, 1980; Young, Kroening, Fulton, Feldman, & Chambi, 1985). For example, a meta-analysis conducted in 2005 showed that DBS had the highest success rates in treating peripheral and nociceptive conditions (Bittar et al., 2005). However, PAG/PVG targets can also be subject to tolerance effects and be unsuccessful in long-term pain management (Hollingworth et al., 2017). Moreover, although the procedure has had some success, there is also a history of failure and side effects. DBS devices and procedures have been evolving since the 1950s and have contributed valuable insight into the necessity for interdisciplinary care surrounding chronic pain and DBS as a treatment. One such necessity is for psychological screening prior to DBS surgery for cognitive impairment and psychiatric disease (Barua & Patel, 2018). Psychological screening is of particular importance for older adults, as they tend to have higher rates of cognitive impairment from disease maturation and age-related decline (MacFarlane, et al., 2012; Patel, Guralnik, Dansie, & Turk, 2013). Now that DBS has become a more common surgery for other conditions, such as Parkinson's disease, and the techniques have improved, more research is needed regarding pain management.

Platelet-Rich Plasma (PRP) Injections

Platelet-rich plasma (PRP) *therapy* involves separating the patients' platelets from blood samples and injecting them into damaged areas to promote healing. Platelets contain high amounts of growth factor proteins to stimulate the healing process and have shown effectiveness even when injecting into general areas as opposed to specific sites. A double-blind independent randomized controlled study (RCT) found that PRP injected directly into affected disks significantly improved pain levels over an 8-week follow-up. Control patients in the same study were almost six times more likely to report dissatisfaction than those who received treatment. Those receiving treatment also had significant improvements in function and pain over the subsequent year, without any reported side effects of infection, herniation, or other injuries (Tuakli-Wosornu et al., 2016). Future work aims to focus on long-term tracking of both treatment and control groups. Other studies should focus on an older adult population to determine if this therapy is effective and sustaining in older patients.

Prolotherapy

Prolotherapy is a method in which a solution, usually a dextrose solution, is injected into affected areas by stimulating inflammatory pathways and promoting healing (also known as growth factor stimulation injections or regenerative, nonsurgical reconstructions) (Hackett, Hemwall, & Montgomery, 1991; Rabago, Slattengren, & Zgierska, 2010). There are multiple approaches to this type of therapy based on the solution used and schedule of injections. Studies have used weekly, bi-weekly, and monthly dextrose- and lidocaine-based injections (Klein, Eek, DeLong, & Mooney, 1993; Ongley, Klein, Dorman, Eek, & Hubert, 1987; Yelland, Glaszious, Bogduk, Schuler, & McKernon, 2004). Rabago et al. (2013) compared *prolotherapy* with an exercise intervention and a control group of 90 knee-pain patients and found improvements in a pain-related quality-of-life survey scores on the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC), in addition to high patient satisfaction levels. Many studies have excluded patients on opioids or with certain comorbidities, so results may not be generalizable to the older adult population (Dagenais, Mayer, Haldeman & Borg-Stein, 2008; Slattengren, Christensen, Prasad, & Jones, 2014). Additionally, treatment is not generally covered under insurance or Medicare, and patients must undergo repeated injections, and finding a provider nearby can be a challenge. However, more research needs to be done specifically with older adult populations, taking their unique health concerns in mind.

Unique Considerations in Older Adults

When it comes to pain management programs, it is necessary not to overlook the importance of social and emotional support. In the case of older adults, social support can be crucial to a patient engaging in physical exercise or therapy. Prevalence of comorbid disorders in older adults is an important consideration, as many disorders are associated with aging. Common conditions include shingles, cancer pain, rheumatoid arthritis, osteoarthritis, and malnutrition (Kaye et al., 2014). Older adults may often develop movement disorders such as Parkinson's disease or multiple sclerosis and face cognitive deficits from Alzheimer's or dementia. Due to many of these conditions, adherence must be closely evaluated, particularly when medication is part of the pain management program.

Furthermore, older adults tend to have decreased muscle mass, increased body fat, and experience internal metabolism changes (particularly in the liver and kidneys), all of which affect efficacy and absorption of medications in the body (Kaye et al., 2014; Polatin et al., 2017). Such changes can cause accidental overdose, poor pain management, or exacerbate side effects and comorbid medical conditions. As such, the risk of experiencing side effects increases. Older adults should be carefully and more frequently monitored when on medication management programs for these reasons.

Key Research to Practice Message

Essentially, interdisciplinary, tailored strategies are crucial for pain management in older adults. Individual health factors and lifestyles must be considered when designing a program, maximizing benefit to the patient. Pain management cannot rely on medications or use "one size fits all" approach. Older adults face unique challenges that can complicate more traditional pain management strategies, making it essential to keep aware of current research and complementary approaches.

Future Directions in Practice and Research

Future research should include studying both noninvasive and invasive methodologies to find the most effective pain management strategies. For example, for severe patients, further exploration into the DBS procedure to manage pain conditions warrants research, as this is a lasting, yet modifiable, method that could stimulate brain areas not otherwise reached or maintained with other strategies. Effective noninvasive methods are ideal, and we should continue researching options such as acupuncture and yoga, seeing the support is growing, especially in long-term pain management. Additionally, pharmacological methods that reduce or eliminate abuse and addiction potential, such as prodrugs, or those working with the anti-reward pathways could be considered. Research specifically targeting older adult populations should include strategies that would be ideal for the demographic, not relying on vigorous physical activity are helpful.

Summary and Conclusions

Individualized and interdisciplinary care is necessary to design the most effective pain management program for each patient. While this approach leaves room for discretion, it is also flexible enough to allow individual differences to be considered. It is clear there is not a "one-size-fits-all" approach to pain management. And each patient will face specific challenges that may alter a traditional course of treatment. This is particularly true for older adults, considering the frequency of comorbid conditions, average number of medications taken, and their unique psychosocial concerns. Given these obstacles, some traditional therapies will not be appropriate for older adults, and less traditional routes should be considered. As discussed in this chapter, acupuncture, massage therapies, surgical procedures, injection therapies, alternative medications, and hypnosis are some of the currently available methodologies to aid in pain relief. Finding an effective and manageable alternative may take some sampling and should be monitored by a qualified practitioner for safety.

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18 Cardiovascular Rehabilitation

John D. Akins and R. Matthew Brothers

Introduction

Cardiac rehabilitation (CR) is a field of medicine and rehabilitation that can be traced back over 200 years. Over that course of time, the practice of CR has undergone some radical changes to become the multidisciplinary approach that it is today. The focus of CR is to improve the health of new and returning cardiac patients so they can return to their lives unencumbered by disease and attempt to live in the best way possible. While it may seem that any medical treatment would be enough to accomplish this goal, CR has an optimal blend of techniques that help produce tremendous improvements in longevity and quality of life in the patients that undertake the intervention. CR is not limited to a cardiac patient type either. A variety of conditions, from heart failure to coronary artery disease to myocardial infarction, have all been suggested as good candidates for a CR program. CR is also important for older adults who have suffered from some sort of cardiac issue. The aging process has inherent physiological changes that may make the elderly more susceptible to cardiovascular (CV) events and CV disease (CVD) later in life. Furthermore, the increase in the likelihood of frailty may lead to increased sedentary behavior, further contributing to CVD. Fortunately, CR is aimed at preventing the progression of the disease to a fatal or incapacitating point. To take these patients from a hospital bed to functioning members of society, interventions such as exercise, diet modification, and counseling are all employed by a team composed of professionals, friends, and family. As patients progress through the program, there is the hope that each one returns to the best possible condition. To see how this is accomplished, this chapter will look at the history of CR to first see where the intervention came from and how it became the modern version of today, describe a variety of patients that are indicated for the program, and outline the techniques used to accomplish the goals a CR program attempts to reach.

History of Cardiac Rehabilitation

CR is an ever-evolving field that derives itself from a multidisciplinary approach based on scientific and clinical findings. It is important to first look at how modern CR evolved as the intervention underwent a series of transformations that would eventually become the CR used today. Perhaps the earliest identification of what might be considered CR was during the late eighteenth century by a physician named Heberden. His observations made note of a subject that

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participated in an extended physical activity regimen after being diagnosed with a chest disorder (Certo, 1985). Within a few decades, additional observations had been made by Parry (1799) regarding the efficacy of exercise to reduce the symptoms of angina. Amazingly, these observations and reports carried tremendous insight given the capabilities of the period. In addition, these very early notions connecting physical activity and angina or chest disorders occurred before science had a semblance of CVD.

After this early period, it has been noted that the positive attitude toward physical activity and exercise as it relates to what were ultimately cardiac patients fell off (Certo, 1985), which is represented by the sparse amount of literature on the subject. However, during the late nineteenth and early twentieth centuries, interest in myocardial infarcts (MIs), angina, and the relationship between physical activity/exercise and cardiac patients took root again (Certo, 1985; Herrick, 1912; Mallory, White, & Salcedo-Salgar, 1939; Squires, Gau, Miller, Allison, & Lavie, 1990). Interestingly enough, despite the early observations of Heberden and Parry regarding the benefits of physical activity, the observations made by Mallory et al. (1939) regarding the process of necrosis and formation of scar tissue led to recommendations of complete bed rest for a minimum of 3 weeks post-MI. This increase in physical inactivity was a detriment to the cardiac patients involved as they were often misguided with little counseling and would descend to the point of not returning to work or seen as a burden to society (Certo, 1985). At this point in the early history of CR, there was little to no structure in place for patients. However, this would soon change.

After a brief bit of promise in 1940 when the New York Heart Association assisted in creating the work classification unit to evaluate work capacity, aid in job placement, serve as an educational unit, and research cardiac patients, productivity again declined as it relates to CR advancement (Certo, 1985). However, a series of research noting that simple changes in body posture reversed the reductions in functional capacity and general mental well-being challenged, which spurred the discussion regarding the adequate management of cardiac patients (Levine & Lown, 1952; Squires et al., 1990). After a few years of research, Turell and Hellerstein (1958) came forth and presented a collection of diverse exercise testing methods to evaluate cardiac function and subsequently provide adequate prescriptions for cardiac patients. Astonishingly, the tone outlined in this paper seemed to admonish the practice of bed rest and lack of direction laid forth by physicians. This exclusion they admonished was made to be injurious and that the best course of action was to practice inclusivity that emphasized safe performance rather than avoidance.

At this point, discussion regarding the handling of cardiac patients identified that physical capabilities and physical activity were important components in what was becoming CR. However, these programs also seemed driven by notions such as return to work, especially in positions suitable for the cardiac patient, changes in tobacco usage, dietary education, and psychosocial counseling (Katz, Bruce, Plummer, & Hellerstein, 1958; Williams & White, 1961), which suggests that the consensus for proper CR was changing. Additional research demonstrated the reduction in physical capacity due to prolonged bed rest (Deitrick, Whedon, Shorr, Toscani, & Davis, 1948; Saltin et al., 1968) and suggested that the period in the hospital immediately after cardiac events was the most crucial and potentially most useful for mortality reduction (Moss, DeCamilla, & Davis, 1977). The importance of this early rehabilitation period led to the development of a variety of inpatient and outpatient rehabilitation programs aimed at improved recovery and quality of life (Bruce, 1957; Certo, 1985; Grant & Cohen, 1973; Tobis & Zohman, 1968; Wenger, 1969). This research became crucial in the shift from the previous school of thought of extended bed rest and emphasized the need for physical activity and a holistic approach to CR.

The focus of CR continued to expand each component (Balady et al., 1994) as medicine was able to identify further risk factors or modifiable targets to improve treatment. However, it is important to note that, despite the early alternating viewpoints regarding activity post-MI or cardiac event, CR is not just recommended to focus on exercise. Rather, modern CR includes components previously mentioned as well as risk factor management (e.g., lipids, hypertension, weight, diabetes, and smoking), vocational counseling, and the addition of cardioprotective drugs (Balady et al., 1994; Balady et al., 2007; Fletcher et al., 2013; Leon et al., 2005; Menezes, Lavie, Milani, et al., 2014). CR has also reached a point in which the patient population is extremely diverse and the types of intervention have increased, each aimed at meeting the patient's needs (Perk et al., 2007). Given the vast pool of research and evidence, modern CR may thus be best defined as a long-term program that involves exercise engagement, medical evaluation, risk factor reduction, patient education and counseling, and pharmacotherapy designed to improve long-term outcomes related to cardiac disease and potentially stabilize or reverse the symptoms and formation of new disease (Fig. 18.1) (Schopfer & Forman, 2016).

Referral for Cardiac Rehabilitation: Patient Populations

Despite the nature of early CR focusing mainly on MI, the number of possible treatments and the variety of cardiovascular procedures that are done have greatly expanded, which means that CR should be essential for many more patients. This suggests the inclusion of individuals that have encountered cardiac valve issues to those with cardiac myopathies and to those who have had an MI, among other cardiac disease states, surgeries, or treatments (Table 18.1) (Balady et al., 1994; Perk et al., 2007; Wenger, 2008). Despite the variety of patient subtypes, there may be no indication that one type of CR may be more effective than another (Perk et al., 2007), but that does not insinuate a one-size-fits-all approach to CR. Rather each individual should have a program that it tailored to their physical capabilities, their emotional and mental well-being, and their financial limitations in an attempt to provide the best care possible. The greatest limiter for these patients may lie in their capacity to engage in exercise and physical activity. With markedly reduced cardiovascular function in most cases, these individuals may not be able to adequately provide for the metabolic costs of daily living. Thus, it is important to anticipate these limitations and design a program that will allow them to return to normal functionality. However, reaching this point may be difficult enough as cardiac patients are often under-referred to CR programs severely limiting the recovery and prevention processes (Leon et al., 2005; Menezes, Lavie, Milani, et al., 2014; Perk et al., 2007). Beyond this, focusing CR on older adults and the aging population is also crucial. In 2015, approximately 15% of the US population was over the age of 65 (older adults, OAs). This population percentage is also expected to grow to 20% as early as 2030, which, when coupled with the growing total population, represents over 70 million individuals (Ortman, Velkoff, & Hogan, 2014). Simultaneously, the rate of CVD that affects OAs is disproportionately high. As recently as the early 2000s, the mortality from all-cause CVD in OAs accounted for approximately 84% of total CVD deaths, with a large proportion coming from heart disease (Arias, Anderson, Kung, Murphy, & Kochanek, 2003). The rising number of OAs and the greater incidence of CVD in this population emphasize the need for comprehensive CR programs here to improve post-cardiac event outcomes.

Valvular Heart Disease

Valvular heart disease most commonly originates from mitral valve disease but may also manifest itself in one or more of the other heart valves. However, when considering a CR program for these individuals, especially when determining the exercise and physical activity component, four main factors should be considered: (1) the procedure or prosthesis used, (2) the anticoagulant treatment being used, (3) the overall function of the myocardium, and (4) the patient's level of conditioning (Perk et al., 2007).

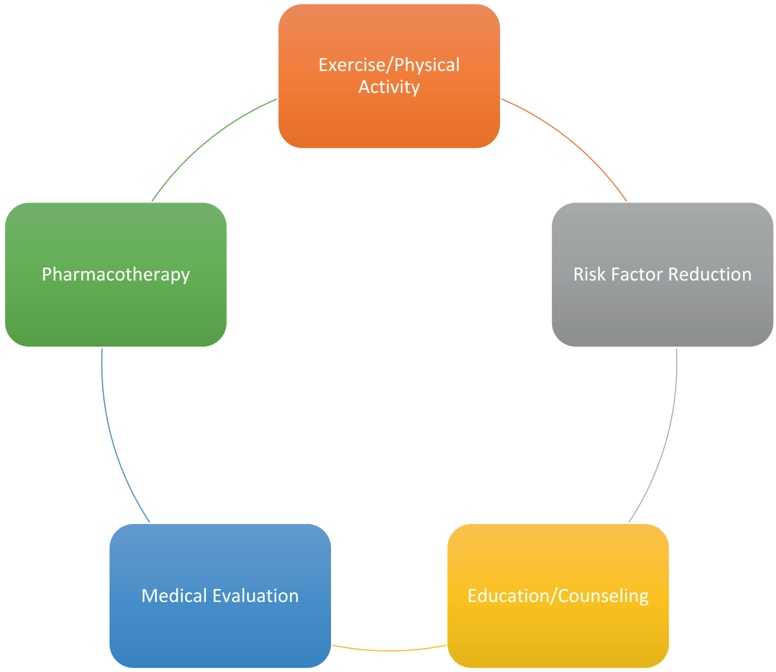

Fig. 18.1 Recommended approaches to designing a successful cardiac rehabilitation program

Table 18.1 Selected cardiovascular diseases referred to cardiac rehabilitation

Disease	Possible cardiac rehabilitation options
Valvular heart disease	Pharmacotherapy (antihypertension, infection prophylaxis, anticoagulation), exercise/physical activity, counseling
Coronary artery disease	Pharmacotherapy (β-blockers, aspirin), improvements in obesity, lipids, and blood pressure, exercise/physical activity, counseling
Cardiomyopathy	Pharmacotherapy (β-blockers, diuretics, ACE inhibitors), moderate exercise/physical activity, counseling
Heart failure (HF)	Pharmacotherapy (ACE inhibitors, β-blockers, diuretics, antithrombotics), management of HF-related diseases, exercise/physical activity relative to ability, counseling
Myocardial infarction (MI)	Pharmacotherapy (aspirin, β-blockers, nitroglycerin, warfarin, and statins), exercise/physical activity, risk factor reduction
Cardiac transplantation	Pharmacotherapy (immunosuppression, corticosteroids, infection prophylaxis), exercise/physical activity relative to ability

The ability to distinguish what valve was targeted during surgery or intervention is important as something that unassuming makes a tremendous difference in what recommendations should be given. For instance, individuals that underwent aortic valve replacement demonstrated a substantially better exercise tolerance than those with mitral valve replacement (Gohlke-Barwolf et al., 1992), which comes back to the notion of individualized treatment. Pharmacotherapy is one of the first avenues of treatment through prophylaxis against infection and prevention of hypertension (Nishimura et al., 2014). The use of anticoagulants is also highly recommended postoperative treatment to reduce the risk of thrombosis (Butchart et al., 2005; Fitzmaurice & Machin, 2001; Perk et al., 2007), but it is important to apply proper precaution as it has been noted that anticoagulants can increase the risk of severe complications from exercise- or activity-related insult (Perk et al., 2007). Finally, the function of the myocardium and the level of patient conditioning both influence the ability to perform exercise and physical activity and complete the appropriate CR program designed for the subject. The evaluation of exercise capabilities and prescription of exercise for CR will be covered later.

Coronary Artery Disease

Coronary artery disease (CAD) is driven by a complex atherogenic process and subsequent arterial remodeling that can lead to a wide combination of stenotic and non-stenotic forms of the disease. CAD has a few common clinical manifestations: (1) angina pectoris, (2) acute coronary syndrome, and (3) silent myocardial ischemia each of which are by-products of atherosclerosis in the coronary arteries (Libby & Theroux, 2005). Angina pectoris is the general occurrence of chest pain caused by a reduction in blood flow to regions of the heart. Silent myocardial ischemia, on the other hand, is the same reduction in blood flow to the heart but with the absence of symptoms (e.g., angina) (Cohn, Fox, & Daly, 2003). Interestingly, it has been estimated that 2–4% of middle-aged men are asymptomatic despite having significant CAD and that prevalence rises to approximately 10% when these individuals possess two or more risk factors (Hanson, Fareed, Argenio, Agunwamba, & Hanson, 2013). Acute coronary syndrome is driven by the rupturing of the protective fibrous cap covering subendothelial plaque. When this plaque is released, it can lead to severe thrombosis. There are a few other processes that may lead to acute coronary syndrome such as intraplaque hemorrhaging, superficial erosion, and calcium nodule erosion (Libby & Theroux, 2005).

When it comes to treatment of CAD, surgery is an option to restore blood flow to occluded arteries (Hanson et al., 2013). However, much like other cardiac diseases and cardiac surgeries, CAD patients are good candidates for CR. Pharmacological therapy is often prescribed for CAD via a variety of drugs, such as β-blockers or aspirin (Hanson et al., 2013), but exercise may be a good option for these patients as well (Hambrecht et al., 2000; P. D. Thompson et al., 2003). Through a combination of risk factor reduction, such as improvements in cholesterol, obesity, and blood pressure (P. D. Thompson et al., 2003), and improvements in endothelial-dependent vascular function, which is normally impaired in patients with CAD (Hambrecht et al., 2000; Heitzer, Schlinzig, Krohn, Meinertz, & Munzel, 2001), exercise and physical activity have the ability to improve patient outcomes and reduce overall mortality in CAD when included in a CR program (Heran et al., 2011; P. D. Thompson et al., 2003).

Cardiomyopathy

There are a few major types of cardiomyopathies: (1) congestive/dilated cardiomyopathy (DCM), (2) hypertrophic cardiomyopathy (HCM), (3) restrictive cardiomyopathy (RCM), and (4) arrhythmogenic right ventricular cardiomyopathy (ARVC) (McNally, Golbus, & Puckelwartz, 2013; Olsen, 1975). DCM commonly refers to the enlargement of all four chambers of the heart, particularly with a reduction in muscular function, but without any change in heart valves or septae. HCM is the process of myocardial thickening, particularly of the left ventricle, without changes in ventricular volume (McNally et al., 2013; Olsen, 1975). Next, RCM is perhaps the least common condition but is interesting in that it most closely resembles the normal morphology of the heart. In this form of cardiomyopathy, while a slight endocardial thickening may occur, the most prominent change is an infiltration of fibrotic tissue, which impairs the filling of the heart (McNally et al., 2013; Olsen, 1975). Finally, ARVC appears to have changes that mirror that of both DCM and RCM, as the right ventricle is susceptible to both a thinning of the walls and an infiltration of fibrotic tissue (McNally et al., 2013).

Treatment for cardiomyopathies may include surgery, including transplantation, septal reduction therapy, and implantable cardioverter defibrillators; however, for those not electing the surgical route, pharmacological management is a common option. Perhaps the most recommended drugs for cardiomyopathy patients are angiotensin-converting enzyme (ACE) inhibitors, β-blockers, and diuretics (Gersh et al., 2011; Jefferies & Towbin, 2010). Beyond pharmaceuticals, exercise seems to have some promise as it may prevent and possibly reverse the severity of cardiomyopathy via cardiovascular adaptations to exercise (Konhilas et al., 2006; Perk et al., 2007). However, the intensity of exercise needs to be carefully monitored and maintained at or below moderate intensity. This is due to the increase in the likelihood of sudden cardiac death when the intensity increases above a moderate level (Gersh et al., 2011; Perk et al., 2007).

Heart Failure

Heart failure (HF) is not necessarily a disease on its own but rather a collection of different cardiac diseases occurring at one time, including cardiomyopathy, hypertensive cardiac failure, valvular heart disease, and ventricular dysfunction, to name a few (Perk et al., 2007). Providing individuals with a comprehensive CR regimen may prove challenging given the multifactorial nature of HF, but it is possible. The first major aspect to note is that HF patients often have a reduced exercise capacity (as surrogated by maximal oxygen uptake [VO_{2max}]) which has been attributed to a reduction in cardiac output and subsequent hypoperfusion of the metabolically active tissue (Sullivan, Knight, Higginbotham, & Cobb, 1989; Wilson, Martin, Schwartz, & Ferraro, 1984). This problem may only be exacerbated in older adults as VO_{2max} continues to decline with aging (Rogers, Hagberg, Martin, Ehsani, & Holloszy, 1990; Schopfer & Forman, 2016). Although seemingly contradictory, exercise should accompany a good CR program for these patients despite their lower exercise tolerance.

Exercise training has been recognized as safe in this population, and the numerous benefits that the training provides could be argued to outweigh the risks. Along with improved exercise tolerance, HF patients see improvements in functional capacity, endothelial function, peripheral oxygen extraction, lactate threshold, and reductions in hospitalizations (Perk et al., 2007; Yancy et al., 2013). Beyond the use of exercise, a CR program for HF patients should include the seamless implementation of several measures including pharmacotherapy (ACE inhibitors, β-blockers, diuretics, antithrombotics), management of HF-related diseases, patient counseling/education, and psychological support (Perk et al., 2007). This combined approach is important as the malignancy of HF has been compared to that of many common cancers (S. Stewart, MacIntyre, Hole, Capewell, & McMurray, 2001).

Myocardial Infarction

Seen as a by-product of CAD, and perhaps as a subset of acute coronary syndrome, MI presents in two forms: ST-segment elevation (STEMI) and non-ST-segment elevation (NSTEMI). The major difference comes from this ST-segment differentiation, as the concomitant release of necrotic biomarkers, such as creatine kinase-MB (CK-MB) or cardiac troponin, occurs in both conditions (Anderson et al., 2007; O'Gara et al., 2013). Following an acute MI, immediate hospitalization is ideal as a reduced time to treatment leads to more favorable outcomes. During this medical intervention, the use of pharmaceuticals, such as fibrinolytics and anticoagulants, and surgical, such as coronary artery bypass, and nonsurgical options, such as percutaneous coronary intervention, are all common options to immediately address MI (Anderson et al., 2007; O'Gara et al., 2013). However, after immediate medical intervention, these patients are prime candidates for CR as a well-implemented program can improve morbidity and mortality outcomes while also alleviating symptoms and improving quality of life (Anderson et al., 2007; O'Gara et al., 2013; Oldridge, Guyatt, Fischer, & Rimm, 1988; Suaya et al., 2007).

Accompanying a patient's release from the hospital should be the introduction of a CR intervention. Part of this intervention is the continued use of medications to control symptoms and prevent a reinfarction. Among the common medications prescribed for patient use are antiplatelet drugs (e.g., aspirin), β-blockers, nitroglycerin, warfarin, and statins, among a host of other possibilities (Anderson et al., 2007; Jneid et al., 2012; O'Gara et al., 2013). Beyond medications, lifestyle modifications such as increased physical activity, dietary changes, and risk factor reduction should all be utilized. Furthermore, a long-term cardiac rehabilitation program that emphasizes exercise may further reduce mortality and morbidity in post-MI patients, especially when the intensity of exercise is carefully monitored and prescribed for the patient (Anderson et al., 2007; O'Gara et al., 2013; Oldridge et al., 1988).

Cardiac Transplantation

In some circumstances with the disease states previously discussed or not mentioned here, cardiac transplantation is the only option to improve a patient's condition. When it comes to CR for transplantation patients, the approach needs to address two points: pre- and posttransplantation (Perk et al., 2007). Regarding pretransplantation, there appears to be a lack of literature suggesting the proper course of action. However, as these patients have most likely elected to be placed on a waiting list for transplantation, the goal during this time is to mitigate any further cardiac impairment and deconditioning. This is achieved via methods similar to a standard CR program and may include exercise, patient education, and risk factor management (Perk et al., 2007). Due to a continued organ shortage, achieving transplantation in a timely fashion is not necessarily possible. As the technology has continued to develop, left ventricular assist devices (LVADs) have been increasingly implemented as bridge-to-transplantation therapy. Although LVADs are not without risk, the improvements in quality of life, functional status, and survivability for a period of at least 6 months warrant their use (Miller et al., 2007; Trivedi, Cheng, Singh, Williams, & Slaughter, 2014). The efficacy of LVADs, however, has led to them being recommended as a destination therapy for many patients, especially those ineligible for transplantation (Haeck et al., 2015; Milley et al., 2016). One of the most common contraindications for heart transplantation, unfortunately, is age as older individuals are more susceptible to complications particularly in the long term (Abecassis et al., 2012). However, other research suggests that individuals over the age of 60–70 years have no increase in morbidity and/or mortality compared to their younger counterparts (Daneshvar et al., 2011). For those that do undergo transplantation, a different focus is required.

Early implementation of a CR protocol for cardiac transplantation patients is crucial for ensuring adequate recovery and return to daily living. During the immediate post-surgery stabilization phase, the risk of rejection and infection is elevated. The early use of immunosuppressants helps reduce the risk of an immune system-mediated rejection of the transplant (Costanzo et al., 2010; Perk et al., 2007). Immunosuppressants are used in two phases: induction therapy and maintenance therapy. The former deals with an intensive treatment process to reduce the risk of rejection when the immune response is greatest posttransplantation, while the later refers to a lower dose treatment aimed at achieving host-graft adaptation while reducing the risks of infection (Hunt & Haddad, 2008; Perk et al., 2007). During the maintenance phase, a triple therapy generally consisting of corticosteroids, a calcineurin inhibitor, and an antiproliferative agent is used (Hunt & Haddad, 2008). Due to the nature of immunosuppressives, the risk for infection during this period is high and must be adequately controlled. A combinatory approach to infection reduction is taken. Lifestyle modifications to avoid infections, such as frequent handwashing, avoidance of infected individuals, and avoidance of environmental carriers of viruses and bacteria (e.g., public baths, compost, etc.), are recommended, and prescription of medical prophylaxis is given to reduce complications (Perk et al., 2007). However, certain drugs may reduce the immunosuppressive effect (Costanzo et al., 2010), so a carefully balanced approach needs to be considered to ensure adequate prevention of rejection and infection.

As with most other cardiac diseases that require rehabilitation, transplantation CR should include an emphasis on physical activity and exercise that is within the limits of the patient. This is predominantly due to the tendency of patients to avoid activities that exacerbate their symptoms. However, this avoidance leads to inactivity and subsequent degradation of an already precarious situation (Perk et al., 2007). The benefits of exercise for transplant recipients have been outlined numerous times and can represent improvements in VO_{2max}/peak oxygen uptake (VO_{2peak}) of 25–50%, which can greatly improve quality of life for these patients (Hsu et al., 2011; Kavanagh et al., 1988; Kobashigawa et al., 1999). While the absolute changes of 3–4 mL•kg^{-1}•min^{-1} may be on the smaller end, this represents a large improvement for this population and allows for greater capacity for free living.

Barriers to Successful Cardiac Rehabilitation Referral

Despite the diverse set of cardiac patients that are indicated for CR, there remains a disparity in successful referral to a program. Approximately 70–80% of eligible patients are not referred to or do not participate in a CR program (Boyden, Rubenfire, & Franklin, 2010; Colbert et al., 2015; Grace et al., 2011; Menezes, Lavie, Milani, et al., 2014; Thomas et al., 2007). This disparity is multifactorial and is driven by population demographics as well as patient health and lifestyle (Balady et al., 1994; Colbert et al., 2015; Menezes, Lavie, Milani, et al., 2014) (Table 18.2).

The notion for the disparity in CR referral and retention rates has been described as a referral and attendance bias, which is well demonstrated via the sex differences in CR. Despite the overexpression of CV morbidity and mortality, particularly in aging, women are often less referred to CR. Furthermore, when they are, they tend to be older with more clinically relevant comorbidities, suggesting that potentially sicker patients are deprived of a suitable rehabilitation program (Colbert et al., 2015). Even with a successful referral, women have been noted to have lower participation rates chiefly due to traditional home roles, older spouses/family members, living alone, and a lower probability of owning/driving a vehicle (Boyden et al., 2010). While these factors have been highlighted in women, some of these may apply to men, but other factors, such as accessibility to a CR program, low socioeconomic status, and pressure to return to work, all influence CR referral retention (Menezes, Lavie, Milani, et al., 2014). Along these lines, as aging is a factor reducing referral and adherence rates, older adults are disproportionately underrepresented in CR use (Menezes, Lavie, Milani, et al., 2014; Suaya et al., 2007). This would suggest a similar bias toward aging individuals. However, whether this disparity is caused by an increasingly high incidence of CV complications with aging (Perk et al., 2007) or as a by-product of the aging process (e.g., less likely to drive, financial status during retirement, etc.) does not seem to be discussed. However, many older adults are likely to have comorbidities such as diabetes, arthritis, and chronic obstructive pulmonary disorder, which increase the difficulty of participation in CR for these patients, causing many to opt out (Schopfer & Forman, 2016). Therefore, an approach to increasing all-patient referral and retention rates with an emphasis on disadvantaged

Table 18.2 Barriers to successful cardiac rehabilitation (CR) programs

Stage of CR	Limiting factor
Referral	Sex (women)
	Race (nonwhites)
	Age (elderly)
	Geographical region (rural)
	Socioeconomic status (low) [SES]
	Chronic disease state (e.g., renal disease, diabetes mellitus, COPD, etc.)
Enrollment and retention	Poor physician recommendation
	Body mass index (high)
	Poor functional capacity
	Tobacco use (predominantly smoking)
	Depression
	Inaccessibility to programs
	Poor patient education/counseling
	Pressure to return to work
	High insurance co-pays (builds on SES)
	Chronic disease state (e.g., renal disease, diabetes)

populations, especially the elderly, needs to be carefully considered.

To address the referral and retention issues common among all populations, an automatic and liaison-based referral strategy has been recommended (Boyden et al., 2010; Grace et al., 2011). This automated system has been noted to increase eligible population referral up to 93% of patients by including conditions that some physicians might not recommend for CR (Grace, Evindar, Kung, Scholey, & Stewart, 2004). A liaison-based referral strategy also significantly improves the rate of referral of patients for CR, but additional research suggests that a combined strategy (e.g., automated plus liaison-based) produces optimal outcomes using currently studied strategies (Grace et al., 2011). Once these patients have enrolled in a CR program, the best way to improve retention seems to be in the form of at-home visits and telephone calls to provide reinforcement and encouragement as well as specific CR counseling (Balady et al., 2007; Boyden et al., 2010). These interventions have the specific goal of improving patient retention and show results that do just that. Thus, to improve participation in CR, a combined approach using automated referral and liaison-based referral/support and counseling should be used for optimal outcomes.

Implementation of Cardiac Rehabilitation

As has been previously established, CR combines several disciplines into one comprehensive program aimed at alleviating symptoms, reversing disease progression, and improving quality of life in CV patients (Schopfer & Forman, 2016). As evident in the variety of prescriptions for CR in different populations, CR can take components from each area that is currently recommended for use. For instance, not all conditions may be able to complete a rigorous physical activity or exercise regimen due to limitations in physical capacity. Therefore, the following components need to be carefully considered in their implementation to ensure appropriate effectiveness.

Exercise Implementation

Increased exercise has often been seen as a cornerstone of a successful CR program, even when limited by a patient's condition (Perk et al., 2007). The inclusion of exercise is predominantly driven by the reductions in CV risk factors and the improvement in CV function following this sort of program (Menezes, Lavie, Forman, et al., 2014; Perk et al., 2007; Schopfer & Forman, 2016; Wenger, 2008). When referring to exercise in relationship to CR, the predominant form referenced is cardiorespiratory exercise. As it relates to the cardiac population, this would be reasonable as these patients have a lessened capacity for cardiorespiratory work, which may be further exacerbated in certain conditions (Dugmore et al., 1999; Sullivan et al., 1989). To achieve improvements in this diminished capacity, a few guidelines have been implemented. Interestingly, these recommendations do not depart much from exercise recommendations for healthy individuals (Garber et al., 2011) outside of the additional supervision recommended. Recommendations for exercise include a total duration greater than 150 minutes per week, ideally done on at least 3–5 days and at a moderate intensity (Table 18.3) (Perk et al., 2007; Piepoli et al., 2010; Price, Gordon, Bird, & Benson, 2016).

While these recommendations seem rudimentary, adherence to a well-designed program can produce tremendous relative improvements in cardiorespiratory fitness. Exercise training following these guidelines may produce improvements in VO_{2max}/VO_{2peak} of up to 25–50%, depending on the population (Guiraud et al., 2012; Hsu et al., 2011; Kavanagh et al., 1988; Kobashigawa et al., 1999; Lavie & Milani, 2011). Interestingly, despite the current recommendations for exercise in cardiac patients, some research has highlighted the impact of high-intensity interval training (HIIT) on improvements in cardiorespiratory fitness in this population. These improvements may often be double what would normally be accomplished using the recommended exercise without any increase in observed risk (Guiraud et al., 2012; Hannan et al., 2018). Whatever approach is used,

Table 18.3 Exercise recommendations for cardiovascular rehabilitation

	Component	Recommendation
Cardiorespiratory	Total duration	≥150 min/wk Ideally 3–4 h/wk
	Frequency	3–5 sessions/wk
	Duration	20–60 min/session
	Intensity	Moderate to vigorous intensity; start at ~50% VO2max or maximal workload and gradually increase to 80%
	Mode	Walking, jogging, and biking are preferable and may consider other endurance activities
Resistance	Frequency	2–3 sessions/wk
	Duration	1–3 sets of 8–10 different upper and lower body exercises
	Intensity	10–15 repetitions performed to moderate fatigue
	Mode	Combination of body weight, resistance band, and free weight exercises

it is important to note that this exercise training helps drive improvements in other CV risk factors such as endothelial function, blood lipids, insulin sensitivity, inflammation, and systolic blood pressure (Lavie & Milani, 2011; Leon et al., 2005; Menezes, Lavie, Forman, et al., 2014). Between the enhancements in CV function as well as risk factor improvements, the addition of cardiorespiratory exercise into a CR program tremendously helps reduce mortality in these patients. Overall reductions in mortality of 20–30% are not unreasonable to see (Lavie & Milani, 2011). Other research has also noted specific drops in mortality caused by improvements in measurable cardiorespiratory fitness. Specifically, every 1 mL•kg^{-1}•min^{-1} improvement in VO_{2peak} can lead to a 9–10% reduction in mortality for some of the lowest fitness groups (Kavanagh et al., 2002, 2003). A more reasonable estimate for fitter patients is approximately a 10% reduction in mortality per one metabolic equivalent (MET) improvement in capacity (Dorn, Naughton, Imamura, & Trevisan, 1999). As previously discussed, these improvements in cardiorespiratory fitness are critical for older populations due to the natural age-related decay in cardiorespiratory capacity (Rogers et al., 1990; Schopfer & Forman, 2016). Improvements in VO_{2max}/VO_{2peak} may not only help older cardiac patients circumvent the deleterious effects of their disease but also those associated with their aging, subsequently improving quality of life by expanding the opportunities these individuals have.

Despite the tremendous impact cardiorespiratory exercise has on morbidity and mortality in cardiac patients, resistance exercise also plays a crucial role. Current recommendations for resistance training include 2–3 sessions per week during which patients perform 1–3 sets of 10–15 repetitions of 8–10 different exercises. These exercises should target both upper and lower body muscles and can be done with body weight alone or with a variety of free weights, resistance bands, and machines (Table 18.3) (Balady et al., 2007). Added resistance training might greatly benefit quality of life and independence via improvements in strength, flexibility, and coordination (Menezes, Lavie, Forman, et al., 2014). While potentially not seen as a key contributor in CR due to the lack of a direct connection to the heart, resistance training helps improve mobility, which allows patients to capitalize on aerobic capacity improvements from cardiorespiratory exercise. Furthermore, resistance exercise plays a key role in promoting overall well-being in older cardiac patients due to its ability to prevent sarcopenia and general frailty and to increase strength (Johnston, De Lisio, & Parise, 2007; Schopfer & Forman, 2016). Resistance training has the potential to greatly improve muscular strength, such that fitness measured from cardiorespiratory testing is improved (Vincent, Braith, Feldman, Kallas, & Lowenthal, 2002), prevent losses in freedom for activities of daily living (Penninx et al., 2001), and improve body composition (K. J. Stewart, 2005) in older adults. Overall, these improvements allow patients to fully participate in daily activities (e.g., carry groceries, ascend stairs, etc.) while also preventing falls and injuries that may lead to increased sedentary time.

Before entering into any sort of exercise or physical activity program, however, each patient should be adequately tested to determine individual limitations. Despite the numerous absolute and relative contraindications many cardiac patients would fall into (Fletcher et al., 2013), the benefits of exercise training and testing outweigh the risks for these patients (Balady et al., 2007; Perk et al., 2007). In fact, the risk of a cardiovascular extent reaches only two events per 1.5 million patient-hours of exercise (Leon et al., 2005). Thus, the goal is safe monitoring and evaluation of each patient during each session to ensure a successful exercise and physical activity implementation. Patients are generally attached to a 12-lead electrocardiogram and are tested using a ramp protocol on either a treadmill or a cycle ergometer. During this period, key information that is obtained includes heart rate/rhythm, blood pressure, onset of symptoms, ST-segment changes, and, in some cases, pulmonary or valve gradient pressures (Perk et al., 2007). These stress tests may additionally help with patient diagnosis, but they predominantly establish what a patient is capable of to guide the design of an exercise program.

Physical Activity Intervention

Despite the common notion that exercise is medicine, it may not be the only activity that individuals need to reduce the risk of future CV complications or improve current conditions. The physical activity goal for most CR patients is to accumulate 30–60 minutes of moderate to vigorous activity on at least 3–4 days per week but preferably most days of the week (Balady et al., 2007; Piepoli et al., 2010). The goal with this increased physical activity is to avoid excess sedentary time which has been linked as a risk factor for increased mortality due to changes in metabolic/vascular function and bone health (Balady et al., 2007; Ekelund, Steene-Johannessen, & Brown, 2016; Tremblay, Colley, Saunders, Healy, & Owen, 2010). Furthermore, elderly patients have an increased likelihood of sedentary behavior as a side effect of the natural aging process (Chodzko-Zajko et al., 2009), which, when coupled with the decline in physical capacity and health post-cardiac event, presents a precarious situation. Thus, patients are recommended to try to incorporate extra bouts of physical activity throughout the day via activities such as parking further away to increase walk time, taking the stairs instead of the elevator, and taking a walk break at lunch (Balady et al., 2007). Increased physical activity may be beneficial in reducing risk factors much the same as an exercise intervention. Among the physiological changes that may occur with increased physical activity include a reduction in lipid levels, reductions in stress and depression, improvements in endothelial function, predominantly driven via nitric oxide, and improvements in antithrombotic properties of the blood (Menezes, Lavie, Forman, et al., 2014). However, these recommendations may not be adequate to completely reduce risk factors. Current research is beginning to highlight the need for increased physical activity, regardless of whether a patient is exercising, to fully reduce certain risk factors and mortality (Ekelund et al., 2016; Kim, Park, Chou, Trombold, & Coyle, 2016). Subsequently, patients may need to be counseled so that they understand that the physical activity goals they should meet are separate from whatever exercise they do and that they should attempt to replace sedentary time whenever possible.

Diet and Medications

A proper diet and the addition of pharmacological therapy are two arms of CR that are often used to further reduce risk factors and alleviate symptoms and should often be prescribed for all patients in CR. To start, diet is critical in these patients as a poor balance of macronutrients and micronutrients can lead to the development of CVD or the worsening of a disease state. For instance, hypercholesterolemia, hypertriglyceridemia, and increased sodium consumption caused by a poor blend of fats and salt in the diet can lead to atherosclerosis and hypertension (Balady et al., 2007; Mozaffarian et al., 2016; Perk et al., 2007). This poor diet may only be exacerbated in the elderly, particularly due to numerous factors from social, economic, and physical factors that prevent adequate procurement of healthful food (Payette, Gray-Donald, Cyr, & Boutier, 1995; Wylie, Copeman, & Kirk, 1999). To combat the increase in CV risk and improve recovery during CR, several dietary recommendations have been made. The most substantial dietary change comes from a reduction of foods consumed containing high concentrations of saturated fats, trans fats, cholesterol, sodium, and refined carbohydrates, particularly added sugars (Balady et al., 2007; Lacroix, Cantin, & Nigam, 2017; Piepoli et al., 2010). While some of these recommendations are still contested, potential ways to meet them are avoidance or limitation of highly processed foods, red meat, sugar-sweetened beverages and foods, and refined grains (Lacroix et al., 2017; Mozaffarian, 2016). To replace these foods, items containing more monounsaturated and polyunsaturated fats from vegetable and marine sources should be consumed with no more than ~30% of calories consumed coming from fat with less than one-third of that being saturated (Piepoli et al., 2010). Additionally, a focus on a variety of foods with emphasis on fruits, vegetables, nuts/seeds, some types of dairy, and whole grains should be employed (Balady et al., 2007; Mozaffarian, 2016; Piepoli et al., 2010).

This shift away from foods high in saturated fats, sodium, and refined carbohydrates also helps fill the diet with more micronutrients essential to life. Deficiencies in micronutrients such as calcium, zinc, copper, selenium, and magnesium have been reported as side effects or contributing factors in a variety of cardiac diseases (Perk et al., 2007). Improving these deficiencies may produce a cardioprotective effect and improve long-term prognosis in cardiac patients. Although these recommendations help guide CR patients, there are still some concerns to be addressed. Given the higher likelihood of poor diet in the elderly, these patients may also need some sort of social or in-home support to ensure they achieve these guidelines by providing a way to procure these recommended foods (Wylie et al., 1999) (Table 18.4).

Table 18.4 Recommendations for dietary changes for patients in cardiac rehabilitation

Recommendation	Type or source
Consume more	Polyunsaturated fats (vegetable and marine sources)
	Fruits/vegetables
	Nuts/seeds
	Some types of dairy
	Whole grains
Consume less	Saturated/trans fats/cholesterol
	Sodium
	Refined carbohydrates (particularly sugars)
	Highly processed foods
	Red meat

Along with diet, proper medication prescription can help improve quality of life and slow the advancement of symptoms or prevent a future cardiac event. A few drugs used in pharmacotherapy for CR have already been mentioned, which demonstrates that there is an assortment of drugs used with each patient's condition requiring a different approach. Antihypertensive drugs are often some of the most prescribed for those in CR to reduce the risk of repeat events (Perk et al., 2007; A. M. Thompson et al., 2011; Yusuf et al., 2011). However, antihypertensive drugs come in a variety of forms; diuretics (thiazides, loop, antialdosterone), β-blockers, calcium antagonists (dihydropyridines, verapamil, diltiazem), ACE inhibitors, and angiotensin II receptor agonists/angiotensin receptor blockers (ARBs) are all common antihypertensives used. Unfortunately, these drugs are generally not well tolerated in high doses (Perk et al., 2007; A. M. Thompson et al., 2011). However, most patients that begin antihypertensives start with a low dose of one medication and, if that single medication does not effectively reduce blood pressure, then are placed on a low dose of a second medication, reducing the risk of negative side effects. Furthermore, some combination therapy is particularly effective (e.g., diuretics and ACE inhibitors, calcium antagonists and ARBs, etc.), which, when coupled with lifestyle changes, can adequately control hypertension (Perk et al., 2007).

Antihypertensives are also useful in a variety of patient populations (e.g., HF, post-MI, CAD, etc.) in an attempt to limit symptoms and progression to an advanced disease state (A. M. Thompson et al., 2011).

Beyond antihypertensives, statins are another often used class of drug due to their ability to attenuate hypercholesterolemia and, hopefully, risk of mortality from CVD progression. These drugs are designated for individuals with abnormal blood lipids, particularly those with a 10-year risk of fatal CVD greater than 5% (Perk et al., 2007). Once on statins, the primary goal for CR patients is to reduce low-density lipoprotein (LDL) cholesterol to less than 100 mg/dL and ideally less than 80 mg/dL (Balady et al., 2007; Piepoli et al., 2010). Secondary to the reduction in LDL, high-density lipoprotein (HDL) cholesterol should be greater than 40 mg/dL in men and 45 mg/dL in women; total cholesterol should be less than 175 mg/dL, ideally below 155 mg/dL; and fasting triglycerides should be less than 150 mg/dL (Piepoli et al., 2010). While there are a variety of statins, including simvastatin, pravastatin, and lovastatin, targeting the same cholesterol production in the liver, the general application of statins has favorable results, such that risk of mortality in patients with prior CVD is reduced up to 30% (Afilalo et al., 2008). However, statins can have some serious side effects that need to be considered. Among these side effects are skeletal muscle, metabolic, and neurological symptoms. The statin-associated muscle symptoms are of particular concern as patients may experience myalgia, cramps, and weakness in the large muscle groups, including the thigh, buttocks, back, and shoulder girdle (P. D. Thompson, Panza, Zaleski, & Taylor, 2016). As elderly patients are already at risk for sarcopenia, the administration of statins to an elderly CR patient should be well monitored to ensure their condition is not exacerbated, and they can continue to live independently. Fortunately, the general ability of changes in diet, exercise, and physical activity to reduce lipids allows for a lower dosage of statins to be used, subsequently avoiding the possible negative side effects.

Other predominant pharmacological treatments used in CR include antiplatelet drugs and anti-ischemic drugs (Perk et al., 2007). Several antiplatelet drugs have been developed including aspirin, thienopyridines, dipyridamole, and platelet $\alpha_{II\beta}\beta_3$ (glycoprotein IIb/IIIa) receptor antagonists. Aspirin is the most commonly prescribed antiplatelet drug, while the other three classes are used to complement the therapeutic effect of aspirin (Behan & Storey, 2004). The goal with these drugs is to prevent thrombosis and subsequent cardiac complications. Moving to anti-ischemic drugs, the three most commonly prescribed drugs are nitrates/nitroglycerin, calcium antagonists, and β-blockers. The goal of the first two drug classes is to influence vasodilation in coronary and peripheral arteries, while the latter is to slow heart rate, producing a condition in which myocardial oxygen delivery is increased and demand is decreased, helping prevent ischemia (Perk et al., 2007). One last class of drug that has been used in CR is antiarrhythmic drugs. However, research has shown that surgical options to correct the arrhythmia produce better outcomes than the use of these drugs, subsequently reducing the need in CR (Jaïs et al., 2008; Kuck, Cappato, Siebels, & Rüppel, 2000; Perk et al., 2007) (Table 18.5)

Unfortunately, despite the improvement in condition that many of the previously mentioned drugs elicit, the use of pharmacotherapy in CR is still underutilized by eligible patients. For instance, antihypertensives and statins are used by only 40% of possible patients or less. While some of the gap is made up by utilizing other pharmaceuticals, when over half of the population is not using pharmacotherapy as a part of CR, a deficit is being formed (Yusuf et al., 2011). This deficit seems to be driven primarily by socioeconomic factors of the population. Patients from lower-income countries are less likely to use pharmacotherapy than their counterparts in higher-income countries. This disparity may be furthered when comparing urban and rural areas (Yusuf et al., 2011). Fortunately, older patients are more likely to be on pharmacotherapy (~32%) than younger patients (~25%), but the rate of

Table 18.5 Selection of drug types and examples of each used in cardiac rehabilitation

Drug class	Examples
Antihypertensives	Angiotensin-converting enzyme inhibitors
	Angiotensin receptor blockers
	Diuretics (thiazides, loop, antialdosterone)
	β-blockers
	Calcium antagonists (dihydropyridines, verapamil, diltiazem)
Statins	Simvastatin
	Pravastatin
	Lovastatin
Antiplatelets	Aspirin
	Thienopyridines
	Dipyridamole
	Platelet $\alpha_{II\beta}\beta_3$ (glycoprotein IIb/IIIa) receptors antagonists
Anti-ischemic	Nitrates/nitroglycerin
	Calcium antagonists
	β-blockers

participation is still extremely low (Yusuf et al., 2011). To bring the overall usage rate up, some sort of intervention needs to be applied to improve access to affordable and effective drugs and to improve prescription of these drugs.

Other Lifestyle Modifications

Beyond the changes discussed in activity levels, diet, and medication, other modifications that need to be made for a successful CR program include weight management, tobacco usage, and diabetes monitoring and modifications (Balady et al., 2007; Perk et al., 2007; Wenger, 2008). First off, CR patients that are classified as overweight or obese (body mass index >25 kg•m^{-2} or waist circumference >40 inches in men (102 cm) and >35 inches (88 cm) in women) are advised to lose weight (Balady et al., 2007; Schopfer & Forman, 2016; Wenger, 2008). This advised reduction in weight is due to the mitigation of other cardiac risk factors generally correlated with obesity. Among these are hypertension, dyslipidemia, and HF (Menezes, Lavie, Milani, et al., 2014). Fortunately, weight loss via CR does not require much more than has already been discussed. Increases in physical activity and exercise coupled with positive improvements in diet constitute two-thirds of the approach to weight loss and are generally included in a CR program to begin with. Changes in diet, outside of healthy eating habits, should also include the practice of caloric restriction. The last component is weight management counseling which is geared at helping patients make positive behavioral changes that keep them focused on set goals and the changes in diet and activity (Balady et al., 2007; Wenger, 2008). One thing to keep in mind is that weight loss in the elderly is not always a positive outcome. This is due to the increased probability of frailty with weight loss with a concomitant decline in exercise tolerance. However, when coupled with an increase in physical activity and exercise, this weight loss is a valuable benefit (Schopfer & Forman, 2016).

Tobacco usage (in particular, smoking) is still a tremendous risk factor for the development of CVD (Mozaffarian, 2016; Perk et al., 2007). Subsequently, it comes with little thought that complete cessation of tobacco usage should be an integral part of CR (Balady et al., 2007; Leon et al., 2005; Perk et al., 2007; Schopfer & Forman, 2016). In fact, patients that quit smoking can reduce their odds of a recurrent CV event by almost half (Perk et al., 2007; Wenger, 2008). However, tobacco cessation is not a trivial process and should be met with adequate support from the CR team due to the addictive nature of nicotine often found with tobacco. Patients should be provided with medical counseling as well as a support structure composed of the CR team, family, and friends. In addition, pharmacological support may be necessary to overcome the short-term withdrawal from nicotine. (Balady et al., 2007; Perk et al., 2007; Wenger, 2008). Last, a set of steps should be followed to ensure optimal adherence to cessation and avoidance of relapse. These steps are "ask," "advise," "assess," "assist," and "arrange." The first three steps set the stage for the patient to be made aware they need to stop tobacco usage and provide them a platform on which to stop. The fourth ("assist") step ensures the patient has an adequate support unit, while the fifth ("arrange") helps establish a long-term follow-up care plan that is designed to prevent relapse (Balady et al., 2007; Perk et al., 2007).

Lastly, individuals with diabetes mellitus (DM) that are also going through CR need special consideration given the nature of monitoring and control both DM and CVD require. The major issue with DM is that on its own, it serves as an independent risk factor for the development of CVD (American Diabetes Association, 2014; Menezes, Lavie, Milani, et al., 2014). As with general CR, diabetes also has a recommended treatment plan of activity, diet, and lifestyle changes with additional pharmacotherapy as necessary (American Diabetes Association, 2014; Balady et al., 2007; Perk et al., 2007; Sigal, Kenny, Wasserman, Castaneda-Sceppa, & White, 2006). Overall, these interventions seem to reduce the risk of CV complications (Perk et al., 2007; Sigal et al., 2006). However, evidence for these reductions does not appear to be conclusive (American Diabetes Association, 2014) and may, in fact, be due to other physiological changes caused by these interventions rather than simple DM management (Sigal et al., 2006). Nonetheless, CR patients with DM are currently recommended to at least achieve the same amount of physical activity and exercise as other CR populations while also changing diet, with a particular focus on low-glycemic carbohydrate sources and unsaturated fats, and undergoing patient counseling (Balady et al., 2007; Perk et al., 2007; Sigal et al., 2006). Particular care needs to be taken for exercising patients to avoid problematic changes in blood sugar, particularly hypoglycemia. In DM patients that are concurrently undergoing insulin pharmacotherapy, proper timing needs to be utilized as combined insulin injection and exercise can lead to hypoglycemia as glucose uptake into the cells is excessive. Furthermore, exercise should be avoided if pre-exercise blood glucose levels are less than 100 mg/dL (Balady et al., 2007; Sigal et al., 2006). Fortunately, these recommendations predominantly apply to individuals on insulin therapy. Patients taking other drugs, including metformin, alpha-glucosidase inhibitors, and/or thiazolidinediones, should measure blood sugar before, immediately after, and several hours after exercise for 6–10 sessions to determine individualized blood sugar responses (Balady et al., 2007; Sigal et al., 2006). Overall, patients with diabetes should follow similar guidelines as a standard CR protocol but with greater attention to diet and pharmacotherapy interactions with the other CR components (Table 18.6).

Table 18.6 Other recommended modifications for cardiac rehabilitation patients and possible interventions for each

Modification	Intervention
Weight management	Diet (healthy eating/caloric restriction)
	Exercise/physical activity
	Behavioral counseling
Tobacco cessation	Pharmacotherapy (nicotine replacement)
	Support system (doctor, friends, family)
	Counseling
Diabetes management	Diet (healthy eating/caloric restriction) with a focus on types of carbohydrate and fat
	Pharmacotherapy (insulin, metformin, alpha-glucosidase inhibitors, and/or thiazolidinediones)
	Exercise/physical activity

Patient Education and Counseling

Patient education and counseling are important cornerstones of CR to help ensure the preceding recommendations, and changes are followed as best as possible. This can come in the form of nutritional counseling/education, weight management counseling, pharmacotherapy counseling, activity counseling, vocational counseling, and psychosocial management (Balady et al., 2007; Leon et al., 2005; Perk et al., 2007; Piepoli et al., 2010; Schopfer & Forman, 2016; Wenger, 2008). Some of these counseling-related topics have already been covered in how they are managed, but it is important to highlight that individual counseling is beneficial for ensuring adherence to the

CR program. For instance, nutritional counseling can help improve identification of healthier foods (Racine, Troyer, Warren-Findlow, & McAuley, 2011) and help lower LDL cholesterol (Ockene et al., 1999). However, the effectiveness of this counseling on adherence to an appropriate diet is still conflicting, but this may be due to a lack of behavioral change (Racine et al., 2011). Beyond this, other modalities of counseling are conducted with the expected outcome of patient adherence to these lifestyle changes and to improve their independence and quality of life.

Of the modalities mentioned, the only one yet to be discussed is the psychosocial aspect of CR. Given that the diagnosis of CVD can be a substantial change in a patient's life, psychosocial distress may often accompany this news (Wenger, 2008). Furthermore, everyday stressors can contribute to an increased risk of CV event particularly in individuals with pre-existing disorders (Pogosova et al., 2015). Oftentimes, patients may find themselves in states of depression, anger, anxiety, or hostility and may be in situations of social isolation, substance abuse, family/marital distress, or sexual dysfunction/adjustment (Balady et al., 2007; Leon et al., 2005; Piepoli et al., 2010). Potential reasons for the advancement or worsening of CV symptoms due to these psychosocial issues generally derive from an overall lower adherence to the rest of the CR program and a reduced probability for risk factor modification (Pogosova et al., 2015). To combat this, patients should be initially tested to determine if any of these psychosocial conditions exist. When a positive result is returned, patients should be directed toward opportunities for either individual or small group counseling that gives them information and support to adjust to CVD, manage stress, and make changes to their lifestyle (Balady et al., 2007; Piepoli et al., 2010). Furthermore, some conditions, such as depression, may need additional pharmacotherapy to reduce symptoms (Pogosova et al., 2015). While research is still attempting to determine the complete efficacy of psychosocial counseling on future CV event reduction, there is unequivocal evidence that this component of CR helps improve quality of life, meaning it should remain an integral part of CR (Balady et al., 2007; Leon et al., 2005; Pogosova et al., 2015)

Effectiveness of Cardiac Rehabilitation

Without some level of effectiveness, referring patients to CR and putting them through the process toward hopeful recovery would be futile. Perhaps the best way to determine the effectiveness of CR is to look at improvements in morbidity and mortality in the patient population. As has been discussed throughout this chapter, different components of CR have different levels of mortality reduction. Improvements in cardiorespiratory fitness can lead to reductions of 9–10% in mortality for every 1 $mL \bullet kg^{-1} \bullet min^{-1}$ improvement in VO_{2peak} or 1 MET improvement (Dorn et al., 1999; Kavanagh et al., 2002, 2003). However, the cardiorespiratory fitness improvements might not be the only contributing factor to effective reductions in mortality in CR.

The overall cardiorespiratory and risk reduction (e.g., blood lipids, weight, etc.) driven by exercise in CR can help produce reductions in mortality of 20–30% after just 1 year of participation (Lavie & Milani, 2011). Specific reductions seen in lipids (e.g., total cholesterol, triglycerides, etc.) of 5–15%, indices of obesity of 2–5%, residual coronary stenosis of 30%, and recurrent cardiac events of 29% are all examples of individual factors that CR reduces and subsequently effect mortality (Lavie & Milani, 2011; P. D. Thompson et al., 2003). As is mentioned, these improvements are controlled by overall the overall CR program. This means that diet and medications have an important role to play. For instance, consumption of fatty fish (e.g., more polyunsaturated fat) can reduce mortality by 30%, while a reduction in sodium consumed can lead to blood pressure decreases of 5 mmHg that ultimately reduce mortality by 16% (Perk et al., 2007). Furthermore, the addition of proper pharmacotherapy can assist as well. The proper use of statins can reduce mortality by 30% due to a reduction in lipids, which, when elevated, are a risk factor for CVD (Afilalo et al., 2008).

Overall, CR helps cardiac patients live longer, especially when carried out to over 12 months post-event (Heran et al., 2011). Patients are not only living longer, but they are also living better. Quality of life in patients post-event that have participated in CR is better than control patients (Heran et al., 2011; Schopfer & Forman, 2016). This also means that pain, energy level, physical functional, well-being, general health, and mental health were also improved over the control group as well. The quality of life improvement has been seen in older adults as well, which bodes well for aging CR patients and the effectiveness of the program for them (Schopfer & Forman, 2016). Furthermore, patients participating in CR are exposed to fewer rehospitalizations, which suggest better overall health and wellness (Heran et al., 2011). This improved longevity and quality of life should mean that CR is the first option for any new or returning cardiac patient to return to health and their lives.

Key Research to Practice

Practice Recommendations

The preceding discussion regarding the efficacy of different CR modalities sets the tone for what should be currently practiced. Initially, usage of a rigorous referral program is essential for enrolling new cardiac patients into an effective program. Without effective referral into a program, the subsequent recommendations for practice cannot be utilized (Boyden et al., 2010; Grace et al., 2011). Generally speaking, CR should be approached through combined pharmacotherapy, exercise/physical activity, lifestyle modifications, and counseling (Table 18.1). Typical drugs administered for CR include antihypertensives, diuretics, and β-blockers but may also extend to immunosuppressants, anticoagulants, and infection prophylaxis depending on the condition (Tables 18.1 and 18.5) (Perk et al., 2007). The exercise recommendations for CR follow a similar prescription as the general population, with the caveat of extra supervision. Current practice dictates focus on both cardiorespiratory and resistance training. The former is aimed at achieving a volume greater than 150 minutes per week at a moderate intensity in a preferred mode of activity, while the latter is aimed at achieving 2–3 sessions per week across a variety of muscle groups, again using a preferred mode (Table 18.3) (Balady et al., 2007; Piepoli et al., 2010).

Among the most common lifestyle modifications include dietary changes, weight management, tobacco cessation, and diabetes management. Particular dietary changes include a focus on more polyunsaturated fats, fruits/vegetables, and whole grains while reducing intake of sodium, refined carbohydrates, and processed foods (Table 18.4) (Balady et al., 2007; Mozaffarian, 2016; Perk et al., 2007). The other mentioned lifestyle modifications tend to come as a by-product of pharmacotherapy, exercise, and diet modifications (Table 18.6), but they help improve patient outcomes as well. Lastly, patient counseling should be geared toward providing patient information to be successful in the previously mentioned components. Additionally, counseling should provide a way to overcome the psychosocial detriments of CVD including states of depression, anger, anxiety, or hostility or situations of social isolation, substance abuse, family/marital distress, or sexual dysfunction/adjustment (Balady et al., 2007; Leon et al., 2005; Perk et al., 2007). The overall effective implementation of these components should lead to improved patient outcomes for those engaging in CR.

Future Directions in Practice and Research

Despite the comprehensive nature of current CR standards, there is still room for the program to grow and expand. New pharmacotherapies for cardiac patients continue to be developed, which may open new avenues for treatment in the CR participant. For instance, patients with heart failure fall into two etiologies: reduced ejection fraction (HFrEF) and preserved ejection fraction (HFpEF). In the former, several modes of pharmacotherapy have been shown to not only improve the symptoms but also the survivability of these patients. However, in HFpEF, these same drugs only treat the symptoms (Braunwald, 2015). Thus, currently developing drugs should focus on a way to not only reduce symptoms in HFpEF patients, but also improve survivability. While current recommendations for exercise outline a fairly broad spectrum of activity, specific interventions may be better prescribed than others. For instance, research indicates that HIIT may be a suitable option for patients in CR programs (Guiraud et al., 2012; Hannan et al., 2018). However, HIIT has yet to be fully implemented in major recommendations around the world (Price et al., 2016). Subsequently, the lack of implementation of HIIT in CR underscores the necessity for optimizing exercise training modalities in CR between both cardiorespiratory and muscular fitness. This is especially important in this population given the limitations many patients face with exercise. Additionally, the continued demonstration of the negative effects of sedentary behavior on mortality and CVD risk factors poses additional problems (Ekelund et al., 2016; Kim et al., 2016). The continued investigation of non-exercise physical activity on CV health, particularly as it relates to CR, should be warranted as a means of further improving intervention outcomes in these patients. Perhaps the most important avenue of research that needs to be conducted involves improving referral rates in CR. Despite the fact that CR has been proven to be effective in a variety of populations, the barriers to referral remain an obstacle for many patients to fully realize the benefits CR provides. Thus, large-scale trials should be conducted investigating the effects of different forms of referral or combinations of these methods.

Conclusion

The breadth that CR covers gives the program an unparalleled method for improving cardiac patients' lives. Although on the surface, CR seems to be a straightforward program due to the simplicity of its parts, the additive effect of each component is what provides such tremendous improvement. Even if a patient decided to forego a certain portion of CR, it could still be said that the reduction in mortality and improvement in quality of life this patient would experience would be considerably better than the alternative. These improvements that are derived from a well-designed CR program in a variety of cardiac patient populations speak for themselves. Additionally, CR is greatly beneficial for the older population that is highly at risk for CVD, especially after an initial cardiac event. It is important to take these patients that may otherwise not live comfortably for what time they have left and give them the opportunity to live well for potentially longer. Unfortunately, CR is still not a perfect program and always has room to grow. It is important to know how much each individual component changes morbidity and mortality to understand what might be the most effective components of CR. Additionally, there may be a synergistic effect of individual components or there may be overlap in which the addition of a second intervention does not provide substantial improvement beyond the first alone. Knowing these answers might ensure the best possible design of a program for each patient. Overall, CR is an effective modality of therapy for young and old cardiac patients that helps improve prognosis and eventual survival.

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19 Exercise Rehabilitation for Older Breast Cancer Survivors

Mark J. Haykowsky, Rhys I. Beaudry, and Wesley J. Tucker

Overview

Breast cancer mortality rates have declined by 40% during the past 25 years as a result of advances in prevention, early detection, and treatment. Despite improved survival, breast cancer survivors have significantly higher cardiovascular disease (CVD) risk compared to age- and sex-matched noncancer controls. The increased CVD mortality is due, in part, to cardiovascular deconditioning associated with a sedentary lifestyle. Indeed, older breast cancer survivor's peak exercise oxygen uptake (peak VO_2) is nearly 20% lower than age-matched healthy controls. The aim of this chapter is to highlight the mechanisms responsible for the impaired peak VO_2 in older breast cancer survivors and discuss the role of exercise rehabilitation training to improve peak VO_2, muscle strength and functional outcomes, fatigue resistance, and quality of life.

Overall, breast cancer is the most commonly diagnosed malignancy and the second leading cause of cancer death among women in the United States (DeSantis, Ma, Goding Sauer, Newman, & Jemal, 2017). More than 80% of breast cancer cases are diagnosed in women who are ≥50 years (median age at the time of breast cancer diagnosis, 62 years) (DeSantis et al., 2017). As noted earlier, between 1989 and 2015, the overall breast cancer mortality rate decreased by nearly 40% as a result of advances in prevention, early detection, and treatment (DeSantis et al., 2017). Accordingly, breast cancer is evolving into a disease of older survivors who will encounter a new set of health-care challenges (Haykowsky, Scott, Hudson, & Denduluri, 2017). Specifically, breast cancer survivors have a significantly higher cardiovascular disease (CVD) risk, in particular cardiomyopathy and heart failure, compared to age- and sex-matched noncancer controls (Armenian et al., 2016). Moreover, Patnaik et al. and others have shown that CVD is the leading cause of death in older breast cancer survivors (Abdel-Qadir et al., 2017; Park et al., 2017; Patnaik, Byers, DiGuiseppi, Dabelea, & Denberg, 2011).

The increased CVD mortality is related, in part, to cardiovascular deconditioning associated with a sedentary lifestyle (Jones, Haykowsky, Swartz, Douglas, & Mackey, 2007). Indeed, breast cancer survivors' peak exercise oxygen uptake (peak VO_2) is 19% lower than age-matched noncancer controls (Haykowsky et al., 2016). Moreover, nearly one-third of survivors have a peak VO_2 below the minimal level required for full and independent living (Jones et al., 2012).

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Mechanisms of Exercise Intolerance: Role of Cardiac Function

Only a few studies have measured the acute hemodynamic responses during incremental to maximal cardiopulmonary exercise testing in breast cancer survivors; therefore, the mechanisms responsible for the decreased peak VO_2 are not well understood. Our group was the first to measure peak VO_2 and its determinants in breast cancer survivors and age- and sex-matched healthy subjects. The main finding was that peak exercise VO_2, cardiac output, and stroke volume were significantly lower by 19%, 11%, and 11%, respectively, in breast cancer survivors compared to healthy subjects. The lower cardiac output may be due to increased left ventricular afterload or decreased contractility. Specifically, we found that peak exercise systemic vascular resistance was 11% higher in breast cancer survivors compared to healthy subjects. Moreover, Koelwyn et al. reported that end-systolic elastance (a measure of left ventricular contractility) was significantly lower during upright cycle exercise (50% and 75% maximal workload) in breast cancer survivors versus healthy controls (Koelwyn et al., 2016).

Mechanisms of Exercise Intolerance: Role of Vascular and Skeletal Muscle Function

The reduced peak VO_2 may also be the result of noncardiac factors that result in decreased oxygen delivery to and/or utilization by the active muscles. Didier et al. measured forearm blood flow during submaximal handgrip exercise (20% maximal voluntary contraction) in 11 cancer survivors (breast cancer, n = 10) (Didier et al., 2017). The authors reported that forearm blood flow was 23% lower in cancer survivors versus controls (Didier et al., 2017). Several investigators have shown that central and peripheral pulse wave velocity, carotid compliance, distensibility, and brachial artery flow-mediated dilation are not significantly different between breast cancer survivors and healthy controls (Jones et al., 2007; Koelwyn et al., 2016). Thus, findings from the limited studies performed to date suggest that large conduit arterial endothelial function and arterial stiffness are not impaired in breast cancer survivors. Future studies are required to examine microvascular function in older breast cancer survivors.

Given that most of the oxygen consumed during exercise occurs in the working muscles, the decreased peak VO_2 may be due to a reduction in the amount or quality of skeletal muscle. Weinberg et al. recently reported that older (≥65 years) breast cancer survivors had significantly lower skeletal muscle area and increased fatty infiltration of skeletal muscle, relative to those who were <50 years of age (Weinberg et al., 2018). Furthermore, Toth and colleagues found significantly lower single muscle fiber cross-sectional area for both slow-twitch myosin heavy chain I and fast-twitch MHC IIA (−21% and −17%, respectively) in 19 cancer survivors (breast cancer, n = 6) versus healthy controls (Toth et al., 2016). In addition, the distance covered during a 6-min walk test was positively correlated with the myosin heavy chain I/IIA fiber ratio (Toth et al., 2016). Finally, O'Donnell et al. reported that peak VO_2 was related to leg strength in older breast cancer survivors (O'Donnell et al., 2016).

Improvement in Peak VO_2 with Exercise Training

Table 19.1 highlights the studies that examined the role of exercise training to improve peak VO_2, muscle strength, and functional outcomes in breast cancer survivors (≥55 years) undergoing, or who completed, adjuvant therapy. These studies consisted of aerobic training alone or combined with resistance training performed a median of 3 days/week for 43 min (range, 15–75 min), at an intensity between 50% and 80% of VO_{2peak} for 16 weeks (range, 6–52 weeks). As shown in Fig. 19.1, exercise training resulted in an average increase in measured peak VO_2 of 2.5 ml/kg/min (~11% increase) (Arem et al., 2016; Courneya et al.,

Table 19.1 Exercise training studies in older (>55 years old) breast cancer survivors assessing changes in cardiorespiratory fitness (VO_{2peak}), muscular strength and flexibility, fatigue, and quality of life

Study	Group (*n*)	Age (years)	Treatment	Ex mode	Ex frequency, duration, intensity, program length	Health outcomes/main findings
Kolden et al. (2002)	AET + RET (40)	55	Surgery, concurrent CT/RT/HT	Walk, cycle, weights (group based)	3 d/wk, 60 min, 40–70% VO_{2max} 16 wks	↑ estimated VO_{2max}, muscle strength and flexibility, QoL
Courneya et al. (2003)	AET (25)	59	Surgery, post CT/RT with or without HT	Cycle	3 d/wk., 15–35 min, VT (~70% VO_{2max}) 15 wks	↑ VO_{2peak}, peak power output, VT, QoL ↓ fatigue
	UC (28)	58				↔ VO_{2peak}, peak power output, VT, QoL
Schneider, Hsieh, Sprod, Carter, and Hayward (2007)	AET + RET (17)	55	Concurrent CT/RT	Walk, cycle, weights	2–3 d/wk, 40 min, 40–75% HRR 26 wks	↔ estimated VO_{2max}, FVC, FEV_1 (lung function) ↑ treadmill time ↓ fatigue, resting SBP
	AET + RET (96)	57	Post CT/RT			↑ estimated VO_{2max}, treadmill time, FVC, FEV_1 ↓ fatigue, resting SBP, DBP, HR
Hsieh et al. (2008)	AET + RET (22)	56	Post-surgery	Walk, cycle, weights	2–3 d/wk., 40 min, 40–75% HR_{max} 26 wks	↑ estimated VO_{2max}, treadmill time ↓ fatigue
	AET + RET (30)	56	Post-surgery + CT			
	AET + RET (17)	57	Post-surgery + RT			
	AET + RET (27)	63	Post-surgery + CT + RT			
Winters-Stone et al. (2011)	RET (52)	62	>1 yr. post RT/CT	Weights	3 d/wk, 45–60 min, 1–3 sets of 8–12 reps, 60–80% 1RM 52 wks	↔ BMD in spine, hip, osteocalcin ↑ lean mass in patients taking AIs
	Placebo (54)	62		Stretching	3 d/wk, 60 min 52 wks	↓ spine BMD ↑ osteocalcin

(continued)

Table 19.1 (continued)

Study	Group (*n*)	Age (years)	Treatment	Ex mode	Ex frequency, duration, intensity, program length	Health outcomes/main findings
Winters-Stone et al. (2012)[a]	RET (52)	62	>1 yr. post RT/CT	Weights	3 d/wk., 45–60 min, 1–3 sets of 8–12 reps, 60–80% 1RM 52 wks	↑ upper and lower body muscle strength ↔ SPPB, LLFDI (objective and subjective function)
	Placebo (54)	62		Stretching	3 d/wk, 60 min 52 wks	↔ upper and lower body muscle strength, SPPB, LLFDI (objective and subjective function)
Steindorf et al. (2014)	RET (77)	55	Concurrent RT/CT/HT	Weights	2 d/wk., 60 min, 3 sets of 8–12 reps, 60–80% 1RM, 12 wks	↑ QoL ↓ fatigue
	Placebo (78)	56		Stretching/Muscle relaxation	2 d/wk., 60 min, stretching/muscle relaxation,12 wks	↔ QoL, fatigue
Dolan et al. (2016)	AIT (12)	56	Post treatment surgery/CT/RT/HT	Treadmill walk	3 d/wk, 80–100% VO_{2peak}, 6 wks	↑ VO_{2peak}, muscle strength ↓ body weight, WHR, rest HR
	CMT (11)	56		Treadmill walk	3 d/wk, 55–70% VO_{2peak}, 6 wks	
	UC (10)	59				↔ VO_{2peak}, muscle strength, rest HR, body weight, WHR
Foley and Hasson (2016)	AET + RET (52)	60	Post treatment surgery/CT/RT/HT	Treadmill walk, weights	2 d/wk, 90 min, 70–85% HR_{max}, 12 wks	↑ muscle strength, functional capacity, flexibility
Di Blasio et al. (2017)	AET (23)	57	Post-surgery	Walking	3 d/wk, 45 min, 10–14 RPE (Borg 6–20 point scale), 12 wks	↑ estimated VO_{2max}, QoL, sleeping time

↑ increase, ↓ decrease, ↔ stays the same, *AET* aerobic exercise training, *AIs* aromatase inhibitors, *BMD* bone mineral density, *CT* chemotherapy, *DBP* diastolic blood pressure, FEV_1 forced expiration volume in 1 second, *FVC* forced vital capacity, *HR* heart rate, HR_{max} maximum heart rate, *HRR* heart rate reserve, *HT* hormone therapy, *LLFDI* late-life function and disability instrument, *QoL* quality of life, *reps* repetitions, *RET* resistance exercise training, *RPE* rating of perceived exertion, *RT* radiation therapy, *SBP* systolic blood pressure, *SPPB* short physical performance battery, *UC* usual care, VO_{2max} maximal oxygen uptake, VO_{2peak} peak oxygen uptake, *VT* ventilatory threshold, *WHR* waist-to-hip ratio, *1RM* one-repetition maximum

[a]Same cohort as Winters-Stone et al. (2011)

2003; Dolan et al., 2016, 2017) and a mean increase in estimated peak VO_2 of 4.8 ml/kg/min (~20% increase) (Di Blasio et al., 2017; Hsieh et al., 2008; Kolden et al., 2002; Schneider et al., 2007) (Fig. 19.2). The prognostic relevance of this improvement remains unknown in older breast cancer survivors; however, a 1 metabolic equivalent increase (equal to 3.5 ml O_2/kg/min) improvement in peak VO_2 is associated with a 17% reduction in all-cause mortality in healthy females (Gulati et al., 2003).

The magnitude of improvement in VO_2peak in older breast cancer survivors appears to be related to the volume of exercise performed and exercise adherence (Beaudry et al., 2015; McNeely et al., 2006). Specifically, we previously reported that the threshold level associated with a clinically significant increase in peak VO_2 was 600 intensity-minutes (equal to 10 weeks of exercise training performed for 90 min per week at 70% peak VO_2) (Beaudry et al., 2015; McNeely et al., 2006). Cancer therapy status may also impact the efficacy of exercise training for improvement of peak VO_2 with smaller improvements observed when exercise training is conducted during cytotoxic therapy (Jones et al., 2011). Poor exercise adherence is also an important contributor to an attenuated increase in peak VO_2 observed during chemotherapy or radiation treatment (Blanchard et al., 2008; Jones et al., 2011) as a result of fatigue, joint pain, and other adverse effects associated with anticancer therapy. This should not dissuade patients from meeting physical activity guidelines, as older breast cancer survivors who exercise during chemotherapy are less likely to experience further declines in peak $VO_{2,}$ relative to sedentary breast cancer survivors (Courneya et al., 2003; Jones et al., 2011; Schneider et al., 2007). Most importantly, breast cancer patients who exercise through chemotherapy experience fewer changes in therapy regimens, better treatment effectiveness, and improved survival (Courneya et al., 2003; Holmes, Chen, Feskanich, Kroenke, & Colditz, 2005; Jones et al., 2011; McNeely et al., 2006; Schneider et al., 2007).

Improvement in Peak VO_2 with Exercise Training: Role of Cardiac Function

Currently, the mechanisms responsible for the training-mediated increase in peak VO_2 are not well understood. Haykowsky et al. reported that 4 months of endurance exercise training did not significantly change peak exercise heart rate or peak VO_2 (Haykowsky, Mackey, Thompson, Jones, & Paterson, 2009). Also, left ventricular end-diastolic volume and end-systolic volume were significantly higher, while ejection fraction was significantly lower at rest and during peak dobutamine stress (Haykowsky et al., 2009). A later study by Jones and colleagues found that 12 weeks of endurance training significantly increased peak VO_2 and oxygen pulse, without altering resting left ventricular volumes, cardiac output, ejection fraction, or brachial artery flow-mediated dilation (Hornsby et al., 2014; Jones et al., 2013). Finally, Giallauria et al. reported that 1 year of exercise training significantly increased peak VO_2, peak exercise oxygen pulse and VO_2, and reactive hyperemia index with no significant change in the control group (Giallauria et al., 2016). The mechanisms responsible for the increased oxygen pulse were not studied; however, it may have been due to a greater peak exercise stroke volume and/or muscle oxygen extraction.

Improvement in Muscle Strength and Functional Outcomes with Exercise Training

Resistance exercise performed alone, or combined with aerobic training, improves upper and lower extremity muscle strength in older breast cancer survivors (Table 19.1) (Foley & Hasson, 2016; Kolden et al., 2002; Winters-Stone et al., 2012). The increased muscle strength may have beneficial functional outcomes with improvements in mobility, flexibility, and balance (Foley & Hasson, 2016; Kolden et al., 2002). Indeed, Foley and Hanson (2016) demonstrated that 12 weeks of aerobic and resistance training

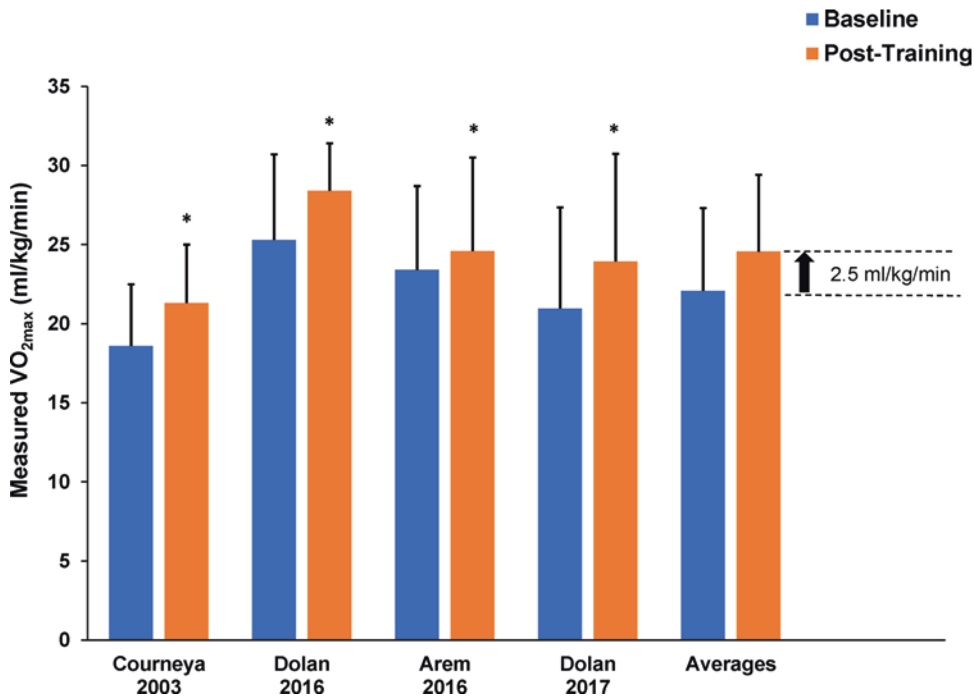

Fig. 19.1 Change in *measured* maximal oxygen uptake following exercise training in breast cancer survivors >55 years old

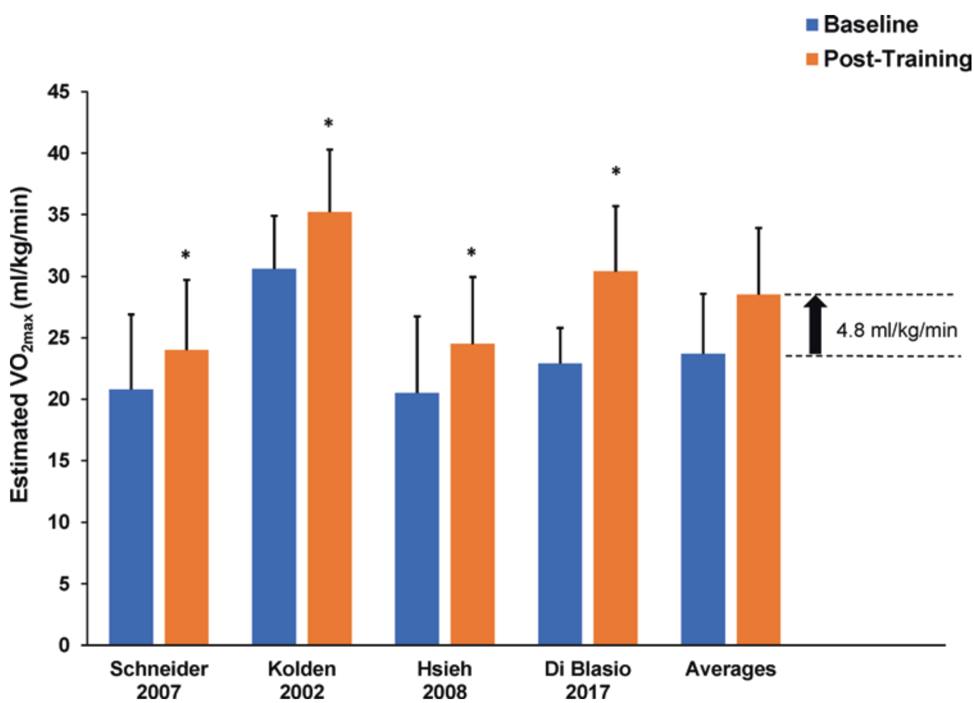

Fig. 19.2 Change in *estimated* maximal oxygen uptake following exercise training in breast cancer survivors >55 years old

increased leg and bench press one repetition maximum, timed up and go speed, and 6-min walk distance (functional mobility and aerobic endurance measures), back scratch distance (measure of upper extremity flexibility), and single-leg stance time (measure of balance) in older breast cancer survivors. In contrast, Winters-Stone et al. (Winters-Stone et al., 2012) found that increased leg and chest strength after 1 year of resistance did not improve short physical performance battery scores and physical function (as measured by the *Late-Life Function and Disability Instrument* and *36-Item Short-Form Health Survey*). However, women in the resistance exercise training group also showed a preservation of lumbar spine bone mineral density (+0.47%), compared to a marked reduction in controls (−2.1%). This may have important clinical implications, as the risk of spine and hip fracture increases by up to 55% after breast cancer diagnosis (Chen et al., 2009), and both fracture types are associated with high morbidity and mortality (Boonen & Singer, 2008; Morin et al., 2011).

In summary, resistance training alone, or combined with aerobic training, has favorable effects on muscular strength and bone mineral density that may contribute to improvements in physical function in older breast cancer survivors. Furthermore, the improved clinical and functional outcomes associated with exercise training may contribute to the 33% reduction in all-cause mortality observed with resistance exercise in male and female cancer survivors (Hardee et al., 2014).

Improvement in Quality of Life and Fatigue Resistance with Exercise Training

Fatigue is the most common and distressing symptom of cancer therapy, with prevalence rates as high as 96% reported following chemotherapy or radiotherapy (Hickok, Morrow, McDonald, & Bellg, 1996; Nail, Jones, Greene, Schipper, & Jensen, 1991). The presence of fatigue often leads to a decrease in daily physical activities which, in turn, leads to further deconditioning and decreased quality of life (Hsieh et al., 2008). Exercise training is an effective therapy to reduce fatigue levels and improve overall quality of life in older breast cancer survivors during or after completion of anticancer therapy (Table 19.1) (Courneya et al., 2003; Di Blasio et al., 2017; Dolan et al., 2018; Hsieh et al., 2008; Kolden et al., 2002; Schneider et al., 2007; Steindorf et al., 2014). Hsieh et al. (2008), using the *Piper Fatigue Scale* (a validated instrument to measure cancer-related fatigue), reported that 6 months of aerobic and resistance training significantly reduced behavioral, affective, sensory, cognitive, and overall fatigue scores in older breast cancer survivors undergoing various forms of clinical treatments. Similar findings have also been shown in breast cancer survivors when exercise training commences posttreatment (Schneider et al., 2007). Older breast cancer survivors who perform exercise training also report improvements in mood and physical and emotional symptoms of fatigue and reduced fatigue at work and during activities of daily living (Hsieh et al., 2008; Schneider et al., 2007). In addition, reductions in fatigue with exercise coincide with improvements in overall quality of life (Courneya et al., 2003; Dolan et al., 2018; Steindorf et al., 2014) and depression (Dolan et al., 2017).

Key Research to Practice Messages

Practice Recommendations

According to the 2010 American College of Sports Medicine (ACSM) Exercise Guidelines for Cancer Survivors Position Stand (Schmitz et al., 2010) and the scientific evidence provided in this chapter, it is recommended that breast cancer survivors engage in 150 min of moderate-intensity or 75 min of vigorous-intensity aerobic exercise each week, as this level of exercise has been associated with lower risks of all-cause and cancer-specific mortality, enhanced physical function and fitness, and improved self-reported quality of life among cancer survivors (Ballard-Barbash et al., 2012; Jones et al., 2011). In addition, given the plethora of additional health-related benefits provided by resistance exercise training outlined in this chapter, it is recommended that breast cancer survivors participate in resistance exercise training on at least 2 days each week if it is safe to do so (Schmitz et al., 2010). Exercise prescription guidelines for fitness and health professionals who intend to provide exercise training guidance and supervision to breast cancer survivors are provided.

Exercise prescription in breast cancer survivors should be highly individualized to meet the specific needs of each patient based on cancer diagnosis, treatment, and physical limitations. As such, fitness professionals and/or health professionals who work with breast cancer survivors are encouraged to obtain a detailed medical and cancer history record for each breast cancer survivor prior to starting any exercise program. Prior to each training session, fitness professionals should assess whether there have been any changes in medications, treatments, or physical limitations/symptoms since the last exercise training session that may warrant altering the exercise intervention. A common side effect of breast cancer treatment is lymphedema, which causes swelling in the arms and legs and can limit range of motion. Breast cancer survivors who present with lymphedema should wear compression sleeves during exercise to prevent further aggravation and assist with drainage (Schmitz et al., 2010). Changes in arm/shoulder symptoms or swelling should be closely monitored with cessation of upper body exercise if symptoms worsen.

Most exercise interventions in breast cancer survivors align with the aforementioned ACSM recommendations for cancer survivors (Schmitz et al., 2010) and consist of 40–60 min of supervised aerobic and resistance exercise on 2–4 days each week. Although each exercise session is individualized, a typical exercise session for breast cancer survivors includes a 10 min warm-up and 40 min of moderate-intensity aerobic and resistance exercises and concludes with a 10 min cooldown period. Aerobic exercise intensity is typically prescribed based on the results of a maximal exercise test performed on a treadmill or stationary bicycle. If this option is unavailable, an estimate of maximal heart rate (HR_{max}) can be obtained using the formula [$HR_{max} = 220 - \text{age}$] and used to prescribe training intensity. Exercise prescription using percentage of HR_{max} is the most accurate way of prescribing exercise intensity in breast cancer survivors (Scharhag-Rosenberger et al., 2015). The preferred mode of aerobic exercise is the mode that offers the greatest anticipated benefit for each individual with consideration of physical limitations. Options include outdoor or treadmill walking and upright or recumbent cycling. Resistance exercise training should consist of exercises that emphasize the major muscle groups and start off with a very low resistance and progressively increase the weight as tolerated. Most resistance programs include six or more exercises (chest press, lateral pull-down, seated row, leg press, leg extension, leg curl) with 1–3 sets of each exercise at a weight that can be lifted 8–12 times by the individual.

Future Directions in Practice and Research

As highlighted in this chapter, older breast cancer survivors have lower peak exercise VO_2 compared to age-matched noncancer controls (Haykowsky et al., 2016). However, there is a paucity of studies that measured the mechanisms responsible for this decline and their improvement with exercise rehabilitation training. Accordingly, future research should measure central (cardiac) and peripheral (vascular and skeletal muscle) determinants of VO_2 in order to tailor exercise interventions to optimally improve older breast cancer survivors' peak VO_2 and quality of life. The optimal mode (aerobic or resistance training alone or in combination) and intensity (moderate continuous versus high-intensity interval training or a combination of both) are also unknown. Finally, further studies need to examine whether training-mediated improvements in functional performance translate into improved survival in older breast cancer survivors.

Summary

Despite improved survival during the past 25 years, older breast cancer survivors have a significantly higher CVD risk compared to age- and sex-matched noncancer controls, a finding attributed, in part, to sedentary (cardiovascular) deconditioning during and following cancer treatment. Specifically, evidence to date suggests that the reduced peak VO_2 in older breast cancer survivors is the result of both central and peripheral abnormalities that result in decreased oxygen delivery and/or utilization by exercising muscle. Exercise training improves peak VO_2 by 11% in older breast cancer survivors. Furthermore, individuals who perform exercise training during chemotherapy also experience fewer changes in therapy regimens, better treatment effectiveness, and improved survival. Exercise training also increases muscle strength and preserves bone mineral density with subsequent improvements in functional outcomes (timed up and go and 6-min walk distance). Finally, older breast cancer survivors also report improvements in fatigue resistance and quality of life following exercise training.

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20 Rehabilitation After Brain Injuries

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Introduction

The focus of this chapter is rehabilitation after a brain injury. We will describe recovery after brain injury across the clinical context, the common characteristics observed after brain injury, core principles of rehabilitation across rehabilitation disciplines, and brain injury sequelae with long-term care concerns. However, as discussed in earlier chapters, brain injury is broadly defined but often divided into two primary categories: traumatic brain injury and acquired brain injury. Even so, the rehabilitative course, particularly for the range of acquired brain injury diagnoses (i.e., stroke, anoxia, tumor, and infection), is expansive and challenging to cover in a single chapter. Consequently, the scope of this chapter on rehabilitation will be limited to traumatic brain injury (TBI) and the most common acquired brain injury, namely, stroke or cerebrovascular accident (CVA). One may argue that even these two categories are too broad for the confines of a single chapter. After all, there are significant differences between TBI and CVA. Notably, the etiology, pathology, typical individual characteristics (i.e., age, ethnicity), and early medical management are expressly dissimilar. Furthermore, there is significant variation within the categories of TBI (severity, open vs. closed head injury, penetrating or non-penetrating) and CVA (ischemic vs. hemorrhagic, thrombolytic vs. embolic, blood vessel involvement) themselves. We concede these points and recognize the limitations of content depth and scope contained in this chapter. Nonetheless, persons with TBI and CVA typically experience similarities in the continuum of care recovery, share commonalities in symptom expression, and face parallels in long-term care issues. Further, current rehabilitation management is grounded in common foundation principles. Thus the scope of this chapter on rehabilitation after brain injuries will be limited to TBI and CVA. Where appropriate, we will compare and contrast the associated unique characteristics.

Context of Rehabilitation: The Continuum of Care

The continuum of care for persons with a brain injury includes emergency medical services, acute inpatient hospitalization, inpatient post-acute rehabilitation, skilled nursing, residential care, home health services, and outpatient rehabilitation including cognitive remediation and vocational programs. The extent of care depends

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on the severity of the brain injury and may include a combination of different levels of care. Multiple factors including severity of injury, resources, comorbidities, age, and support systems influence decision-making on best placements for care. While a person with a mild injury may transition from acute care to outpatient rehabilitation, a person with a moderate or severe injury may be seen across the continuum for an extensive period of time (Andelic et al., 2012; Doig et al., 2011; Jourdan et al., 2013).

Acute Care

Treatment begins in the emergency department and then acute care. During these phases of treatment, the medical team including the doctors; occupational, physical, and speech therapists; nurses; dieticians; and social workers will access and provide comprehensive care. Acute care hospitalization can range from a few days (for a mild injury) up to a few weeks for severe, medically complicated injuries. During the *acute care* phase of hospitalization, the medical staff address the critical medical needs, performs diagnostic tests, and medically stabilizes the patient for transfer. The healthcare team with the patient, family, and involved friends will confer on the next step of care. Factors considered in the transitioning from acute care to the next phase include medical complexities, severity of deficits in motor, cognitive, eating, swallowing, communication, and cognition. The following section will further define contexts of care.

Rehabilitation

Inpatient postacute rehabilitation focuses on providing intensive therapies for 3–6 h a day including occupational, physical, speech, and recreational therapy. The goal is for the person to achieve a high level of independence. A person must be able to tolerate the intensity of daily schedule. For persons unable to participate in daily intensive therapy of inpatient, postacute care can transition from acute care to subacute rehabilitation. In *subacute rehabilitation (skilled care)*, the focus is similar to postacute rehabilitation but does not require the person to participate at the intensity of postacute rehabilitation. Subacute rehabilitation is indicated when patients are unable to tolerate 3–6 h of therapy, are progressing slowly, and/or require a longer length of stay then in postacute rehabilitation. Often patients will transition from subacute to postacute rehabilitation or home as they recover. Further therapy may be provided in outpatient clinics.

Outpatient and Home Health

Outpatient therapy is provided at hospitals and clinics. During outpatient therapy, the patient will receive treatment from a range of therapies including occupational, physical, speech, recreation, and psychology. The focus of *outpatient therapy* is intensive therapies to achieve greater independence. Outpatient therapy does require the patient have transportation to the clinical site. Patients participating in outpatient treatment reside at home or in residential settings. If transportation is a problem, then the family and patient can choose to have treatment in the home, referred to as *home health*. In addition to the therapies provided in outpatient treatment, home health offers in-home nursing care, homemaker, and home health aides. Choosing between home health and outpatient treatment will depend on the specific needs of the patient and family.

Long-Term Care

For a person with a severe injury, a *long-term care hospital (LTCH)* may be recommended when transitioning from acute care. LTCH is recommended for persons who require continued care for daily needs such as bathing, dressing, eating, and grooming. LTCH's do provide some medical care but are primarily for meeting the daily care needs of the person. The patient in a LTCH will receive therapies and assistance with basic needs. Patients can transfer from an LTCH to other contexts as they continue recovery.

For patients with a severe brain injury, nursing care facility may be needed. *A nursing care facility* provides care for a person who does not need hospitalization but cannot be cared for at home by others. Persons with a severe brain injury may require placement in a nursing facility due to behavioral, cognitive, and/or motor problems. Nursing care facilities provide 24 h care from nursing aides and nurses. Nursing care facilities also provide physical, occupational, and speech therapies.

Community Reentry

In addition to hospital and clinical contexts, persons with brain injuries may require supportive living environments. Persons may transition to supported residential homes or apartments. *Supported residential homes and apartments* provide some level of supervision, but the person is generally independent in basic daily activities. Residential homes are often an option to foster independence. Residential homes may provide therapies, vocational training, and c*ommunity reentry programs.* Community reentry programs focus on intensive therapy for the purpose of greater independence in community living and vocational engagement. The schedule of day treatment programs often mimics typical workdays with designated schedules and responsibilities. As patients progress in the program, they may transition to vocational training. Vocational training programs for persons with brain injury can range from vocational exploration and training, supervised work environments, job coaching, and/or work with employers for modified work. *Vocational exploration and training* involves assessment of areas of interest and strengths along with training of specific skills including work behaviors. In addition to training programs, some programs offer s*upervised work environments* focusing on persons performing specific jobs often contracted with larger employers. *Job coaching* is another form of supervision provided by a person for the purpose of on-site job training. The job coach helps the person learn the job. For patients who are retired or no longer able to return to work, volunteer programs may be an option for community reintegration (Sander et al., 2010).

Transitioning from acute care through the continuum care requires communication between the healthcare team, the patient, family, and involved friends. While the healthcare team can help with educating the patient and others on options, ultimately the decisions must be based on the patient's needs, desires, and abilities. The team goal is optimal placement for continuing progress.

Characteristics of Brain Injury

In many ways, the real estate axiom of "location, location, location" is effective in determining impairments observed after a brain injury. For instance, in the event of a contusion or intracranial hemorrhage in the area of the primary motor cortex, a clinician would expect to see motor deficits on the contralateral side of the body. A clinician can reasonably maintain this expectation because different structures within the brain are tasked with specific functions. Some mechanisms of traumatic brain injuries (i.e., penetrating injury) and CVA cause focal areas of brain tissue damage with resultant focal deficits.

However, the reality of the aforementioned real estate axiom is limited in its application to brain injuries for at least two reasons. Firstly, all areas of the brain are profusely connected with other brain regions. This series of functionally integrated interconnections of brain regions is called "functional connectivity." Functional connectivity allows for simultaneous and synced activation of multiple brain regions to maximally perform human behaviors with vigilance and necessary attention. Consequently, an injury to one brain region will likely impact not only the immediate brain region but also its functional networks associated with another region (Andelic et al., 2010; Bercaw et al., 2011).

A second limitation to the real estate axiom, and one specific to TBI, is diffuse axonal injuries (DAI). A hallmark injury in TBI, DAI is a result of acceleration and deceleration resulting in widespread tissue damage within the brain. Because of the widespread brain tissue injury, the main symptom of DAI is lack of consciousness. DAI occurs in roughly half of all severe brain injuries and is thought to contribute to long-term issues among brain injury survivors (Carney et al., 2017; Corrigan et al., 2014; Hagen et al., 1972).

Motor Dysfunction After Brain Injury

Regardless of type of brain injury, typical impairments are made manifest. Among these include cognitive dysfunction, personality/behavioral changes, sensory deficits, and motor impairments. This section will focus primarily on impairments related to motor function.

Impairments of motor function are common after brain injury (Murphy & Carmine, 2012; Pattuwage et al., 2017). The severity of motor dysfunction tends to correlate with the severity of the brain injury. Table 20.1 lists commonly observed motor impairments.

Motor function is routinely assessed immediately after a brain injury and continually monitored during the recovery process. Initial assessment of motor function is performed by trained medical personal. In the case of acute stroke, initial clinical assessment of neurologic status is evaluated with the National Institutes of Health Stroke Scale (NIHSS). The NIHSS is a 15-item scale used to assess motor strength, eye movement as well as level of cognition, language, neglect, visual-field loss, dysarthria, and sensory loss. As a measure of stroke severity, the NIHSS is a reliable predictor of short- and long-term outcomes of people after stroke. In the case of TBI, severity of brain injury is assessed by the Glasgow Coma Scale (GCS). In order to categorize a TBI as mild, moderate, or severe, the GCS assesses brainstem and cerebrum function through eye, motor, and verbal responses.

Table 20.1 Common motor impairments after brain injury

Motor impairments may include any or all of the following:
Paralysis or paresis
Cranial nerve injury
Poor coordination
Abnormal reflexes
Abnormal muscle tone
Poor motor planning
Poor or reduced balance
Loss of bowel and bladder control

After initial assessment, motor function is reassessed periodically throughout the recovery process and across the continuum of care by trained rehabilitation personnel (i.e., physiatry, physical therapy, occupational therapy). During the rehabilitation process, motor

function is assessed in the context of health and disability using the International Classification of Functioning, Disability and Health (ICF) framework endorsed by the World Health Organization (WHO). Modeled on the biopsychosocial model of disability, the ICF framework allows for a multidimensional measure of functioning and disability interacting with environmental and personal contextual factors (see Fig. 20.1). In light of the reality that motor dysfunction after a brain injury rarely occurs in isolation, viewing motor function within the context of specific activities and participation allows for a more comprehensive view of how deficits in motor system impact the person with brain injury (Bernabeu et al., 2009). Suitable rehabilitation strategies to address motor dysfunction are then able to be developed and individualized to maximize potential outcomes for each patient with brain injury.

The contemporary approach to recovery of motor function is based on the theories of motor control and motor learning. Current clinical rehabilitation interventions are based upon the underlying assumptions associated with these theories. Motor control is a collection of ideas about the control of movement with associated assumptions of (1) normal movement stems from interaction of multiple body systems, (2) movement is designed around a goal, and (3) movement is constrained by the environment in which the task is completed. Motor learning is the process of using complex motor, cognitive, and sensory systems to

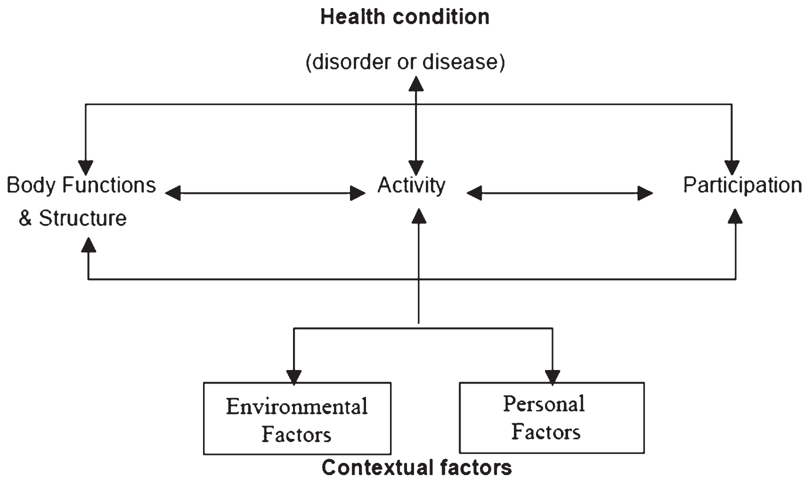

Fig. 20.1 International Classification of Functioning, Disability and Health (ICF) framework

develop effective strategies essential to solving functional tasks. This motor learning process requires practice and feedback. Application of motor control and motor learning theories is focused through a *task-oriented approach*. During a task-oriented approach, the rehabilitation clinician integrates the ICF model with examination of multiple body systems necessary to perform a behavioral goal (Brett et al., 2017; Turner-Stokes et al., 2015; Sandhaug et al., 2010). Strategies and interventions are then devised to assist the person to efficiently accomplish the behavioral goal through task-specific practice and appropriate feedback.

The two most well-described examples of contemporary rehabilitation interventions based on the theories of motor control and motor learning are body-weight support treadmill training (sometimes called locomotor training) and constraint-induced movement therapy. The most widely ascribed to approach to rehabilitation of walking after a stroke or TBI is body-weight-supported treadmill training (BWSTT). BWSTT is considered task oriented because of the following three principles: (1) the task is *challenging* enough to require new learning and engage attention, (2) the task is *progressive and able to be adapted* to the patient's capability and the environment, and (3) the task requires *active participation* by the person with stroke or TBI. The intervention of BWSTT allows for practice of walking in an environment where the therapists provide feedback to the person with stroke or TBI and suitably vary the task to promote motor relearning of walking. Ultimately, the task-specific intervention of walking will require a practice in a variety of environments to promote walking adaptability.

A second example of motor control/motor learning-based intervention is constraint-induced movement therapy (CIMT). CIMT is an intensive treatment to improve upper extremity function in people with hemiplegia from a stroke or TBI. Using a bimanual approach, CIMT seeks to prevent learned disuse of the affected arm and hand by promoting interlimb transfer of upper extremity gross and fine motor function from the less affected limb to the more affected limb. CIMT incorporates variable spatial and temporal constraints during functional task practice in order to require the person with stroke or TBI to problem-solve an effective solution for a behavioral goal (i.e., reaching and grasping a cup of water).

Cognitive

Cognitive Rehabilitation of Elderly Patients with TBI

Cognitive rehabilitation following a TBI in elderly adults presents with unique set of challenges and opportunities. Challenges arise from the inherent complexity of the injury including severity, location of the injury, and associated comorbidities. Additionally, varying degrees of rehabilitation efforts, social and family support systems add to the uncertain prognostic outlook following a brain injury. However, assets associated with older adults including life experiences, wisdom, and family support often assist during cognitive rehabilitation process.

Majority of older adults' cognitive training paradigms are similar to rehabilitative efforts in children and young adults (Goldstein, 2005). Although cognitive paradigms across ages may benefit from similar rehabilitative principles, older adult populations could benefit from additive/unique considerations. Therefore, the current section presents/discusses (a) neuroplasticity principles that guide cognitive rehabilitation, (b) behavioral approaches to cognitive rehabilitation, (c) fall prevention strategies, and (d) lifestyle and environmental factors to optimize functional outcomes following a brain injury.

Cognitive Rehabilitation/Remediation

Traditionally, cognitive rehabilitation efforts following a TBI adopt either a compensatory or a restorative approach. Compensatory approaches often train individuals in the use of external aids and/or environmental modification to compensate for the cognitive difficulties (e.g., calendars to remind an individual of performing a daily task). Task simplification or environmental modification to allow for task accomplishment may also be referred to as a compensation strategy. Restorative approaches refer to repair or strengthening an impaired cognitive process (e.g., strategies to improve memory) or a skill (e.g., cooking) (Park & Ingles, 2001; Sohlberg et al., 2000). As one can imagine, both approaches complement and may even facilitate each other. For example, improved memory using both strategies and a calendar could facilitate independence in cooking. That is, both compensatory and restorative strategies can cause neuroplasticity. Therefore, researchers are increasingly shying away from differentiating between compensator and restorative approaches. Focus is on mechanisms that cause the most change to facilitate neuroplasticity that is relevant to improving daily function and participation.

One such mechanism is top-down approach to rehabilitation. Top-down approach focuses on goal-oriented, internally driven, voluntary (not automatic) cognitive operations that both focus attention on task-relevant stimuli and ignore irrelevant distractions (Gazzaley et al., 2005). At a neural (brain level), top-down approaches engage in both the enhancement and suppression of brain activity depending on the relevance of the target goal (Buschmann et al.). Top-down approaches activate frontal networks in the brain, the area of the brain that is most vulnerable to a brain injury. Few examples of manualized treatment programs that adopt top-down rehabilitative approaches are:

- Goal management training (GMT). The GMT targets behavioral disorganization, which is commonly reported following a TBI. The program aims to improve goal-directed behavior through training in discrete stages of goal completion, including assessing a situation and directing attention toward relevant goals, selecting appropriate goals and partitioning these into subgoals, and monitoring progress toward the goal.
- Goal-oriented attention self-regulation training (GOALS) is a modification of GMT and takes into account attention, mindfulness, and problem-solving interventions through goal-based direction of behavior in daily life. The program focuses on incorporating strategies for reducing distractibility and emphasizing principles of applied mindfulness to redirect cognitive processes toward goal-relevant activities even when distracted.
  - Problem-solving training (PST) emphasizes problem-solving in everyday social contexts. Specifically, the treatment pro-

gram trains social problem-solving skills in the discrete steps of (1) problem definition and formulation (identifying the conditions and constraints of problematic situations and setting realistic goals), (2) generation of alternatives (brainstorming a range of possible solutions), (3) decision-making (examining potential consequences of options and selecting an optimal one, given the conditions and constraints of the problem), and (4) solution implementation and verification (enacting solutions, monitoring their effectiveness, and making modifications as necessary).

– Strategic memory advanced reasoning training (SMART) trains individuals in critical thinking skills including (*a*) strategic attention (inhibiting less relevant information), (*b*) integrated reasoning (abstracting concepts by combining preexisting knowledge with relevant facts), and (*c*) innovation (flexibly and fluently deriving multiple interpretations by interpreting the information from different perspectives).

Another avenue of cognitive rehabilitation that is gaining attention and is relevant in adult brain injury rehabilitation is building *cognitive reserve*: The theory of cognitive reserve states that an individual's experiences affect the efficiency of their neuronal (brain) network (ref). People who have had high levels of cognitive and physical activity during their life will be less susceptible to cognitive decline associated with normal aging and/or brain injury. Therefore, exploiting "building cognitive reserve" is a rehabilitative strategy to either compensate for cognitive deficits and/or a protective mechanism. Building on studies of environmental enrichment, proponents of cognitive reserve propose that a high level of education, an interesting occupation, and higher IQ are associated with increased brain connections (referred to as brain synaptic density) and brain cell growth (referred to as neurogenesis) (ref). Building cognitive reserve, following a brain injury, could include "new learning" as a protective strategy to mitigate cognitive deficits.

Lifestyle

Engagement and participation in daily life activities represent one's lifestyle. Activities, behaviors, roles, and responsibilities at home, work, and community affect ones thinking, mood, and daily function. All these lifestyle factors directly affect thinking and consequently have the potential to cause positive changes in the brain. In other words, our lifestyle can cause neuroplasticity. Some of the important lifestyle factors that promote brain health and can enhance cognitive rehabilitation efforts include:

(a) *Stress reduction*: Researchers have found that high stress levels impair learning and memory in both animals and humans. Strategies to reduce stress such as exercise (e.g., yoga, tai chi) may be beneficial (ref).
(b) *Maintaining good health*: It is said "what's good for your heart is good for your brain." Overall, good health promotes brain health. Physical exercise and healthy lifestyle promote neuroplasticity following a brain injury. Research is highlighting the association between physical activity and cognition by identifying the role of a specific growth factor that promotes neuroplasticity and structural changes in the brain following exercise. In other words, adding physical exercise to cognitive rehabilitation strategies could significantly enhance the benefit of cognitive rehabilitation.
(c) *Sleep*: Increasingly research is emphasizing the benefits of good night's sleep to maintain and improve physical and cognitive health (ref). Adequate sleep (7–9 h per night) aids in stress reduction, memory consolidation, and increased physical energy levels to engage in optimal daily functions.
(d) *Engagement in daily life activities*: Initiation, engagement, and participation in activities of daily living, as much as possible, promote healing and facilitate recovery. The use of compensatory tools including calendars, reminders, and adaptive tools and seeking help from others could aid in participation. Our brain's reward system is activated by successful participation and/or completion of a task, which subsequently motivates repeti-

tion of the task. Thus, total avoidance or non-participation in routine tasks could be detrimental to the recovery process.

(e) *Psychosocial activity*: As individuals age, their social network diminishes, and fewer family members or friends must endure a greater burden. Thus, rehabilitation efforts and support services are critical to both the TBI patient and their support network (Uomoto et al., 2008). Family and caregiving assistance is crucial for all individuals during rehabilitation but perhaps more so for older adults. Rehabilitation success is optimized with family involvement skills to problem-solve, communicate, fulfill role responsibilities, and behave appropriately. Caregivers and family members should be given long-term support therapy and education modules to teach them about transitioning events that their loved one might experience (Anderson et al., 2002). Additionally, caregivers should be a part of the planning process for future treatments and services (Dikmen et al., 2001).

Fall Prevention

The leading cause of TBI in older adults is a *fall*. Therefore, fall prevention is of paramount importance in the elderly with TBI. This is especially critical in patents with recent surgical interventions who may still be recuperating from postsurgical complications (Bouras et al., 2007; Rutland-Brown et al., 2006). Several fall prevention research studies examined cognitive and physical models that predict falls, and guide models have been created to correctly predict which individuals are susceptible to future falls and those in need of therapy to reduce the risk of future brain injuries (Felicetti, 2009; Medley, Thompson, & French, 2006).

Risk factors include (a) sensory motor limitations including balance and gait instability and reduced physical endurance and strength and (b) cognitive and psychosocial issues including depression, attentional deficits, executive dysfunctions, decreased self-awareness, impulsivity, and so on.

(a) *Physical exercise*: Engaging in physical exercise – either structured program guided by a professional.

(b) *Medication management*: Side effects of medication could result in changes in blood pressure. For example, tricyclic antidepressants that are commonly used in the treatment of posttraumatic headache may lead to complications in elderly patients due to anticholinergic side effects. Likewise, medications commonly used to treat muscle spasticity may lead to sedation. In fact, elderly patients with TBI should be presumed to be more sensitive to any centrally acting medication. In particular, physicians recommend cautious use of benzodiazepines and typical antipsychotics such as haloperidol that may slow recovery from TBI (ref). Use a notebook to organize information such as medical records, medication lists, and treatment recommendations. Prepare questions ahead of time, and ask professionals to record their answers in the notebook or use a voice recorder.

(c) *Home and near environmental changes:* Nearly half of all falls happen at home. Therefore declutter and organization are key to a safe home environment. Removal or reorganization of objects, furniture, clothing, and shoes that could cause a person to trip/slip is necessary. Simple tricks such as using double-sided tape to keep the rugs from slipping are advisable. Item placement within reach of the person (to avoid using step stools) cannot be emphasized enough to prevent a fall. Good supportive shoes, installing grab bars (tile and tub) and handrails (stairs), placement of nonstick mats in the bathtub, and showers are more examples of a strategic safe environment. Improved lighting in the home could help compensate for vision deficits.

(d) *Return to driving:* Return to driving is often a desired goal of persons with a TBI. The physical and cognitive deficits caused by the TBI can affect a person's safety when operating a vehicle. A brain injury cannot only affect a person's ability to physically operate the car but can affect the ability to perceive distance, maintain lane position, and attend to multiple visual and auditory stimuli, reaction time, navigating maps, and overall safety awareness and judgment. Prior to returning to driving, a person should speak with the physician and therapists and participate in a driving assessment administered by a trained driving evaluator. The local rehabilitation hospital and specifically the Department of Occupational Therapy can provide information on sites for getting an evaluation.

The Center for Disease Control's (CDC) National Center for Injury Prevention and Control also has informative resources and materials to prevent injuries and reduce disability, deaths, and costs associated with injuries. Call CDC toll-free at 1-800-CDC-INFO (1-800-232-4636), or visit www.cdc.gov/BrainInjuryInSeniors for more details.

Psychosocial

A brain injury is a major cause of long-term disability. Many persons never recover fully from the injury. Studies have shown that persons with brain injuries depend on family for support and caregiving. Persons with brain injury often experience personality changes and mood disorders. The term "neurobehavioral disability" has been used to describe the range of changes in personality and character (Wood, 2001). Families often identify changes in personality, mood, and character as stressors in relationships. These changes in the person put a strain on the family including jeopardizing close relationships and marriages. As roles change from partnerships to caregiving, the relationship can take on different dimensions of meeting each other's needs. In addition, loss of employment and continued medical expenses present additional stress. In a qualitative study, from the perspective of the person with a brain injury, critical factors included the support of family and friends, validation or an understanding of what had happened, and an understanding of what was different and why. They described an awareness that they were not the same but did not know how and why (Snell, Martin, Surgenor, Siegert, & Hay-Smith, 2018). Persons who did not experience social support, validation, and clear understanding of what was happening reported social isolation, low self-esteem, and feelings of confusion and failing.

Support for the patient and family can include participation in local brain injury support groups. Support groups can be found through the Brain Injury Association of America and by contacting your nearest rehabilitation center. Often local hospitals and rehabilitation centers sponsor support groups for TBI and for persons with stroke. Support groups are organizations of interested persons who come together to share their stories and discuss resources and ideas. Often support groups have guest speakers from the community who share valuable information. Support groups enable families, friends, and the patient realize that there are others with similar issues and concerns and they are not alone.

Principles of Rehabilitation

Neuroplasticity

Principles of Neural Plasticity

Animal and human research in the last two to three decades have provided a set of principles that cause neuroplasticity. Neuroplasticity refers to the brain's ability to change, following a behavior, environment, and/or a pharmacological agent. This change in the brain, especially during cognitive rehabilitation, is often presented as utilization, creation, or strengthening of pathways that were affected as a result of injury or creating of new pathways. One of the principles most commonly referred to is *Use it or Lose it***.** An individual's mastery or ease of performing a task, whether cognitive (e.g., math) or physical (e.g., walking), relies on familiarity and frequent use of the skill. Infrequent or nonuse of the task weakens it and may even extinguish. On the positive side, frequent use of the task/skill, even after a brain injury, causes positive changes that could potentially guide mastery and/or ease performance of the task. This principle is referred to as *Use it and Improve it.* Repetitive, task-specific training has been shown to be an effective rehabilitation strategy for cognitive and physical impairments. Repetition, with limited relevance and salience to a context, may not cause desired positive plasticity. Therefore, it is important to facilitate plasticity in an experiential context, also referred to as *specificity*. That is, the experience of repeating a skill should be relevant to a personally salient functional task (e.g., planning a day's schedule). Furthermore, *generalization* of the mastered skill to other contexts (e.g., planning an upcoming family event) provides an opportunity for repetition of the skill. *Repetition* is a key principle of neuroplasticity. Similar to physical exercises, cognitive changes are causes by repeated behaviors. Especially, repetition in multiple personally *salient functional contexts* is key to neuroplasticity. Recent imaging evidence is beginning to guide cognitive strategies that initiate activation of the desired brain networks. Specifically, the *intensity/complexity* of the skill plays an important role in the activation process. An example, in other words, a challenging task (within reasonable limits) may be more beneficial versus a simpler familiar task that can be accomplished with relative ease. Consider the following options while reading a newspaper article. An older adult with a brain injury could be asked to recognize the "who, what, when" facts versus being asked to "identify less relevant information and recognizing themes and deeper meaning" of the article. This latter approach is more effortful and draws upon thinking processes of reasoning and flexible thinking when compared to identifying the explicitly stated facts in the article.

"Best Practices"

Team Approach by Rehabilitation Professionals

Team approaches to healthcare are widely accepted as promoting improved outcomes for patients over "ad hoc" services without incurring additional healthcare costs (Lancet 2002; 360: 1280–86). Specific benefits to patients include an improved discharge destination from a hospital after stroke and greater return to social participation. Historically, a multidisciplinary team approach has been the predominant model. In this discipline-oriented team approach, professionals work parallel with clearly defined roles and hierarchical lines of authority. The physician is the team leader and communicates with each team member, but very little communication occurs between individual professionals. More recently, an interdisciplinary team approach is recommended as creating improved teamwork and enhanced team effectiveness benefitting patients. In the interdisciplinary team approach, rehabilitation professionals meet regularly to discuss and collaboratively set patient treatment goals and jointly carry out treatment plans (Prescott et al., 2018; Dean et al., 2016). The interdisciplinary team is comprised of healthcare professionals with diverse backgrounds (MD, RN, PT, OT, SLP, etc), function on the same hierarchical level, and communicate regularly and effectively.

Rehabilitation Contextualized for Real Life (Individualized Versus Group Approach)

Individuals are unique, and individuals with stroke or TBI are equally unique. While the mechanism of injury (i.e., occlusion of the middle cerebral artery) or the theoretically driven intervention (i.e., task-specific constraint-induced movement therapy) may be similar, the application to a specific person is necessarily unique. In part, this is due to the individual environmental and personal contextual factors as expressed by the ICF model. Each patient arrives to the hospital and rehabilitation setting with unique facilitators (i.e., ample family and caregiver support, financial resources, resilience) and barriers (i.e., multilevel home, history of depression, lack of insurance) that require individual attentiveness by the healthcare team to optimize outcome. Further, despite a similar mechanism of injury, each individual presents with unique differences in muscle strength, activity tolerance, sensation, perception, cognitive status, and ability to participate in functional activities and social roles. Consequently, tailored and individualized rehabilitation is recommended to improve physical function.

However, the benefits of socialization through group therapy are also appreciated as important in reestablishing social well-being, emotional stability, and mental health. In group therapy, individuals are able to interact and relate with peers experiencing similar challenges. Many rehabilitation centers attempt to incorporate both individualized therapy and group therapy. It is important for the rehabilitation professional to recommend and the person with stroke or TBI to participate in group settings after discharge from rehabilitation as a means of counteracting the social isolation so prevalent in people with chronic disabilities.

Case Study #1

History

Mr. J.S. is a 59-year-old male who sustained a traumatic brain injury from a motor vehicle crash 3 years ago. His friend and driver of the vehicle was killed. As an unrestrained passenger, J.S. was ejected from the vehicle and suffered a closed head injury with diffuse axonal injury, bilateral frontal and temporal contusions, and multiple right side fractures including an orbital fracture, radius fracture, and rib fractures. He was taken to a local level 1 trauma center where he received emergent medical care and diagnosed with a severe traumatic brain injury with a Glasgow Coma Scale score of 5. Medical care included evacuation of a cerebral hematoma, placement of an intraventricular catheter to monitor intracranial pressure, a month-long medically induced coma, and care from a team of neurosurgeons, neurologists, and nurses. J.S. spent an additional 4 weeks in the acute hospital before being transferred to an inpatient rehabilitation hospital in a minimally conscious state.

During inpatient rehabilitation, J.S. encountered a new team. This team was headed by a physical medicine and rehabilitation physician and consisted of physical therapy, occupational therapy, speech therapy, neuropsychology, recreational therapy, and nursing. During the initial weeks of inpatient rehabilitation, the focus of therapy for J.S. was on *Stimulation*, attempting to awaken and arouse his brain to the environment and people around him. As he progressed, the focus of therapy shifted to *Structure and Repetition* to help J.S. make sense of his environment and reduce his confusion. Throughout his 8-week stay in inpatient rehabilitation, J.S. demonstrated significant deficits of cognition, motor function, and behavior. Though his cognitive status improved, he remained with difficulty with short-term memory, challenges following multistep commands, limited insight into his deficits, and inattentiveness in unstructured busy environments. Though his motor function improved, he remained with mild hemiparesis of the left arm and leg, impaired coordination, muscle weakness, difficulty with motor planning, and imbalance.

J.S. was able to be discharged from inpatient rehabilitation to his home where he would receive 24-h supervision and assistance each day from his wife and youngest son. Additionally, J.S. continued his rehabilitation through a postacute day program specializing in rehabilitation for people with TBI.

Postacute Rehabilitation Intervention

For J.S., postacute rehabilitation consisted of daily therapy for 4 months in the postacute day program and intermittent weekly therapy in an outpatient rehabilitation clinic for 6 months. During this phase of recovery, the focus of rehabilitation was *Community Preparation* and returning to his pre-injury vocational, family, and social roles. Once again, there was a team of medical and allied health professionals to lead the rehabilitation process. However, the role of the caregiver grew increasingly important following discharge from inpatient rehabilitation.

Self-Management

Each of the therapeutic disciplines working with J.S. encouraged participation in self-management activities as he underwent rehabilitation. This was important for several reasons. First, despite the best efforts and intentions of his rehabilitation team, J.S. was likely going to have to manage chronic motor and cognitive conditions after formal rehabilitation concluded. Second, people with TBI (and resulting chronic conditions) are at greater risk of experiencing secondary health issues such as obesity, diabetes, and cardiovascular disease.

With assistance and encouragement from his wife and youngest son, J.S. engaged in several self-management strategies. J.S. created a weekly calendar and scheduled exercise 3 days/week, a routine sleep schedule allowing for 8 h of sleep per night, and three social activities (church, lunch with friends, and a brain injury support group meeting). He also used the calendar to manage his medication schedule.

Outcomes

Today, J.S. is 3 years post his TBI. He is independent with his mobility and activities of daily living. He is able to help with some household chores like laundry, cleaning, and mowing his lawn. Additionally, J.S. has resumed some of his hobbies such as playing guitar and card games. However, J.S. was not able to return to his job as an accountant for a local financial company nor able to manage the household budget (his wife now oversees the home finances). J.S. has been volunteering at his church and in the library of the neighborhood elementary school. His goal for the next year is to find employment.

One challenge to finding employment is that J.S. has not yet returned to driving. Beset by some posttraumatic emotional issues, returning to driving has been challenging. So, while J.S. no longer receives physical therapy, occupational therapy, or speech therapy, he visits a rehabilitation psychologist on a monthly basis. He also continues to follow up with his physical medicine and rehabilitation physician every 6 months.

Case Study #2

History

Ms. T. is a 74-year-old female, found unresponsive in her home by her spouse. She was treated in the emergency department and diagnosed with a right middle cerebral artery ischemic stroke. An ischemic stroke results when there is a blockage in an artery preventing the blood from getting to areas of the brain. A blockage in the right middle cerebral artery affects motor function of the left side of the body. The person may experience changes in vision, attention, judgment, and some quality of language (expressions of emotion).

She was transferred to the neuro intensive care unit (ICU). During the first few days, Mrs. T. was treated for medical stabilization, and physical and occupational therapists were consulted. Physical therapy provided intervention for positioning to prevent contractures, prevention of pressure sores, and range of motion to sustain joint mobility and sensory stimulation. Occupational therapy intervened by accessing the environment for the prevention of ICU psychosis. ICU psychosis can occur when patients are not experiencing normal sleep/wake cycles, are over- or underexposed to lighting, or lost rhythmic routine and schedule causing loss of sense of day and night. The occupational therapist establishes and monitors schedule and educates family and other healthcare team of healthy schedules and routines. This may result in scheduled visiting hours and careful administration of stimulation within the patient's room.

Acute Intervention

Once medically stable, Ms. T. is transferred to the hospital unit specializing in treatment of persons with neurological deficits. She is evaluated by physical, occupational, and speech therapy. A summary of the assessment is that Ms. T. has moderate paralysis on her left side with her arm more affected than her leg. She is able to perform some weight bearing on her leg and has minimal movement in her arm. She scored moderately impaired on assessment of judgment and visual field. Ms. T. has minimal awareness of her deficits. She is treated in therapy daily and is making slow but steady progress. A team meeting is scheduled with Ms. T's husband, daughter, and healthcare team. Because prior to her stroke, Ms. T was independent and active, it is recommended she be transferred to acute inpatient rehabilitation facility (IRF) for intensive therapy. Ms. T. is transferred to a local IRF and participates in intensive therapy.

Acute Rehabilitation Intervention

Upon admission Ms. T. undergoes intense evaluation by physical, occupational, and speech therapy. The physical therapist assesses Ms. T. mobility including moving in bed, sitting, standing, and transferring from bed to the chair. The occupational therapist assesses Ms. T's ability to perform basic hygiene (brushing teeth, combing hair), dressing self in street clothes, toileting, shower, and general cognition. The speech therapist assesses Ms. T's cognition and communication skills. Following the assessments, the team meets and determines that Ms. T would benefit from a minimum of 2 weeks of therapy. In physical therapy, Ms. T begins with relearning balance in sitting and standing and beginning some support walking. She benefits from a leg brace to support her affected leg. She progresses to using a quad cane. In occupational therapy, Ms. T is relearning how to perform daily activities using some one-handed techniques and some task training with her affected arm. Because she is right handed and her left hand is affected, the therapist focuses on the use of her left hand as the non-dominant hand. During teeth brushing, Ms. T is assisted in holding a tube of toothpaste and squeezing the tube. She learns hemi-dressing techniques including dressing the weaker arm and leg first. Initially, Ms. T had difficulty planning the steps to perform daily activities such as the sequence of applying toothpaste and then brushing. She also had difficulty planning her dressing due to visual processing of what were the armholes and the top and bottom of the shirt. The therapist used repetition of task in order for Ms. T to relearn. The therapist incorporated repetition in the dressing and hygiene. With 1 week, Ms. T was showing improvement to requiring minimum assistance in hygiene and dressing. She progressed in toileting to standby assistance and showered with minimum assistance. Speech found that Ms. T was able to communicate her needs with some labiality.

Ms. T, her therapists, and family work together in planning for discharge. Ms. T wants to return home and participate in the daily routines and activities important to her. She wants to be able to grocery shop, cook, and go out to eat, attend weekly bridge group, go to church, play computer card game, and communicate with her family via email and phone. The physical therapist works with Ms. T on car transfers, walking uneven surfaces, and alternative exercises to get 30 min of recommended aerobics daily. Ms. T is excited about incorporating WI bowling and a dance program as a form of exercise. The occupational therapist works with Ms. T on writing a shopping list, going to the hospital store to purchase some items, and cooking in the therapy kitchen. Ms. T demonstrates good problem-solving and judgment, asking for help when needed. The therapist determines she will initially need some assistance performing home chores. Ms. T is doing some computer gaming but is not satisfied with her slowed processing. She believes she needs to practice and play some more bridge before rejoining her bridge club.

Ms. T is scheduled for discharge after 18 days in rehabilitation. She and her family have been provided with resources on a local support, and she will be receiving home health nursing care and therapies following discharge. The therapists are recommending daily aerobic exercises, further task training with the use of left arm, participation in computer games, and return to desired routines.

Outcomes

Two years later, Ms. T and Mr. T have decided to move to a retirement community with independent and assisted living. The community has multiple amenities, desirable to the Ts. The community has dining rooms, bridge groups, golf teams (Mr. T), book clubs, trivia nights, and local trips to museums and activities. Ms. T continues to use a cane and gained some use of her left arm to assist in holding and stabilizing objects. She is playing bridge and recently joined a group organizing gift boxes for children in the local hospital. While she has some physical deficits and does need assistance at times, she has adapted to the new Ms. T.

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21 Medication Management in Older Adults: How to Avoid Opioid Abuse

R. Robinson, C. Noe, and S. Jones

Overview

Approximately 25–50% of elderly persons have chronic pain, and as many as 80% of nursing-home patients also have chronic pain (Helme & Gibson, 2001). Medication management for pain in these older adults is often challenging due to a number of factors, including the growing risk of opioid abuse. It is estimated that 11% of older women misuse prescription drugs and that prescription drug misuse among people over 50 years of age will grow to 2.7 million by 2020 (Simoni-Wastila & Yang, 2006; Weiner & Herr, 2002). Moreover, older patients have been prescribed more drugs with central nervous system action over the past decade. This dramatic growth of opioid use by older Americans has occurred, and, on top of that, polypharmacy has more than doubled (Maust et al., 2017). For example, in a study of elderly trauma patients, a surprising percentage (18%) of patients were positive for alcohol or drugs (Ekeh et al., 2014). Thus, polypharmacy is usually the norm among older adults.

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Opioid Use

In a study of chronic opioid use among patients having surgery, the age group with the highest prevalence of opioid use was in 50–59-year-old range at 11%; 8% of 60–69-year-olds were taking opioids; 7% of 70–79-year-olds and 6% of patients over 80 were taking opioids chronically (Jiang et al., 2017). Therefore, older adults are not exempt from the current prescription opioid epidemic. Also, physicians have been shown to be woefully inaccurate identifying high-risk patients using routine medical history and physical examination procedures. In a study of exclusively high-risk patients, physicians identified only 5% as high risk, and 20% of these high-risk patients were judged to be low risk (Brown et al., 2011). This naivety, plus the liberalization of laws such as the Intractable Pain Treatment Act, has created an environment for the prescription opioid epidemic. Indeed, in the 1990s, physicians began to be encouraged to prescribe opioids liberally for pain, and patients became "conditioned" to expect prescriptions for opioids on demand and for refills from different doctors.

Several of the ideas from the 1990s have now been discredited. It was thought that the results

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from short-term (12–16 weeks) studies of opioids in patients with chronic pain would be valid for chronic opioid therapy. It was also thought that the addiction rate in patients with chronic pain was low (1%). It was further believed that no "ceiling effect" for opioids was present, so doses could be increased as needed without concern for toxicity. Also, it was believed that, as tolerance to analgesic effects occurred, tolerance to respiratory depression would also occur and thereby protect patients from overdosing. Unfortunately, by 2012, 259 million prescriptions for opioids were written in the United States, with a population of 314 million people (Centers for Disease Control and Prevention, 2014). The United States has five times more patients on chronic opioid treatment per capita than Sweden, Israel, France, and many other industrialized countries (Humphreys, 2017; International Narcotics Control Board, 2016). Moreover, sales of prescription opioids in the United States nearly quadrupled from 1999 to 2014 (Centers for Disease Control and Prevention, 2011). The unintended consequence of the increase in opioid prescribing has been the parallel increases in opioid-related deaths and opioid dependence treatment (Sullivan & Howe, 2013). Nevertheless, there has not been an overall decrease in the amount of pain Americans report (Chang, Daubresse, Kruszewski, & Alexander, 2014; Daubresse et al., 2013). In fact, Americans may be paradoxically reporting more pain in order to receive medication for it. Additionally, evidence does not exist from long-term randomized placebo controlled trials to support long-term opioid treatment for analgesia nor functional improvement in patients with chronic pain (Chou et al., 2015). In fact, data exist that indicate opioids are associated with dose-dependent harms.

New Guidelines for Opioid Prescribing

In 2012, the *Physicians for Responsible Opioid Prescribing* called for limiting opioid treatment to only severe pain and to 90-day duration and for limiting doses to 100 mg MED. At the time, opioids had labeled indications for moderate and severe pain, and no limitation of dose or duration of treatment was in place. The 2016 CDC guidelines encourage limiting doses to 50 mg of morphine equivalents per day and encourage non-opioid treatment and discontinuation of opioids. These principles make sense considering that most chronic opioid therapy is initiated for the treatment of acute pain, but many patients continue opioids for a different problem (Callinan, Neuman, Lacy, Gabison, & Ashburn, 2017). Moreover, this study reported that over 50% of patients began opioids for acute pain, but many had no clear plan for discontinuing opioids. This has created the current prescription opioid epidemic, which has gone so far as to negatively impact the life expectancy in the United States (Dowell et al., 2017). For example, more than 165,000 deaths were attributed to prescription opioid overdoses between 1999 and 2014 (Centers for Disease Control and Prevention, 2016). Also, 1 out of 32 patients on high-dose opioids (200 MED) dies from an overdose (Kaplovitch et al., 2015).

Challenges Ahead

Thus, it is difficult to make the case for continuing at the current opioid consumption level. In fact, the case can be made for reducing opioid consumption in the United States by a large percentage. Several challenges exist to meet this goal, one of which is that 16 million Americans are on opioids for chronic pain (International Narcotics Control Board, 2016). Many of them are resistant to reducing their dose, and many of them will require treatment for substance use disorder. In 2012, 2.1 million Americans were estimated to be addicted to prescription opioids, and another half million were addicted to heroin (Substance Abuse and Mental Health Services Administration, 2013). An additional 2.5 million are estimated to have a substance use disorder, and these numbers are not counted as a part of the addicted population because they received a legal prescription for pain (Kolodny et al., 2015). So, without a doubt, a substantial percentage of patients who take opioids chronically need to get off opioids completely. Patients on high doses need to reduce their doses to lower their risk. Another challenge is managing new chronic pain patients without opioids. Only 19% of the public perceives opioids as a safety risk, while prescription opioid overdoses are a leading cause of death. Commercial air travel and severe weather are much less deadly but more worrisome to the public (Colorado Chapter American College of Emergency Physicians, 2017)!

Center for Disease Control (CDC) Guidelines

The Center for Disease Control's and Prevention opioid-prescribing guidelines have made a number of recommendations to assist physicians avoid problems with opioid prescribing for patients with chronic pain, as delineated below (Dowell, Haegerich, & Chou, 2016). Opioids are not a first-line therapy. Non-pharmacologic therapy and non-opioid pharmacologic therapy are preferred for chronic pain. Non-pharmacologic therapies and non-opioid medications include:

- Non-opioid medications such as acetaminophen, ibuprofen, or certain medications that are also used for depression or seizures
- Physical treatments (e.g., exercise therapy, weight loss)
- Behavioral treatment (e.g., cognitive behavioral therapy)
- Interventional treatments (e.g., injections)

Finally, clinicians should consider opioid therapy only if expected benefits for both pain and function are anticipated to outweigh risks to the patient. If opioids are used, they should be combined with non-pharmacologic therapy and non-opioid pharmacologic therapy, as appropriate (Dowell et al., 2016).

Acute Pain Management

Chronic pain after surgery begins with acute pain, and the management of acute pain may be very important to prevent chronic pain (Gilron & Kehlet, 2014). In fact, 22.5% of chronic pain is associated with surgery; 18.7% is related to trauma (Crombie, Davies, & Macrae, 1998). Thus, acute pain, particularly postoperative pain, is ideally treated with multimodal pain management for an opioid-sparing effect, perioperatively and postoperatively (Chou et al., 2016). Preoperative doses of oral acetaminophen, NSAID, gabapentinoids, and other drugs are commonly used for perioperative analgesia. Regional anesthesia and local anesthesia are being used more often, not only to reduce the anesthetic requirement but also to reduce postoperative pain. Intraoperative multimodal intravenous drugs include lidocaine, ketamine, and dexmedetomidine. Postoperative medications include acetaminophen, NSAIDS, regional analgesia, lidocaine, and ketamine. Opioids are left "in reserve as rescue drugs," except for predictably painful operations, such as complex spine surgery and thoracic surgery, where opioids are administered as a part of the anesthetic and postoperative pain treatment. Different patients report substantial variation in pain levels after the same operation, and risk factors for severe pain are not well understood (Gerbershagen et al., 2013). Moreover, treatments that have opioid-sparing effects are most attractive, because even small doses of opioids are associated with respiratory depression and ileus (Barletta, 2012).

Back Pain

This trend away from opioids is reflected in new guidelines for acute postoperative pain that advocate non-pharmacologic techniques, including transcutaneous electrical nerve stimulators and cognitive behavioral therapy techniques (Chou, et al., 2016). Also, reducing opioid doses in patients before surgery has been associated with improved outcomes (Nguyen, Sing, & Bozic, 2016). In addition, a recent guideline for non-pharmacological treatment of back pain endorses multiple alternatives to opioids, including (Chou et al., 2017):

- Tai chi
- Mindfulness-based stress reduction
- Yoga
- Exercise
- Psychological therapies
- Multidisciplinary rehabilitation
- Spinal manipulation
- Massage
- Acupuncture

Another guideline for noninvasive treatment of back pain endorses multiple non-opioid treatments for acute and subacute pain (Qaseem, Wilt, McLean, Forciea, & for the Clinical Guidelines Committee of the American College of, 2017):

- Superficial heat
- Massage
- Acupuncture
- Spinal manipulation
- NSAIDS
- Skeletal muscle relaxants

These guidelines go on to endorse additional non-opioid treatments for chronic back pain, including:

- Exercise
- Multidisciplinary rehabilitation
- Acupuncture
- Mindfulness-based stress reduction
- Yoga
- Motor control exercise
- Progressive relaxation
- Electromyography biofeedback
- Low-level laser operant therapy
- Cognitive behavioral therapy
- Spinal manipulation
- NSAID
- Tramadol
- Duloxetine

These guidelines reserve opioids for patients only if they are at low risk and are informed of the risks after failing non-opioid treatments.

Other Approaches/Considerations

Diet

Also, a plant-based diet may have an anti-inflammatory and analgesic effect (Kjeldsen-Kragh et al., 1991). The anti-inflammatory diet is based on fruits, vegetables, fish, tree nuts (almonds and walnuts) and garbanzo, dark beans, and whole grains. Pro-inflammatory foods include starches, meat, and dairy products.

Non-opioid Medications

Using proven non-opioid drugs for specific diagnoses is an important way to avoid overprescribing opioids. A growing body of literature exists for diagnosis-specific pharmacologic treatment for chronic and neuropathic pain. The number needed to treat (NNT) is a useful index to compare drug efficacy across different studies and to determine first-line drugs for specific diagnoses. The NNT is calculated from the inverse of the absolute risk reduction. The lower the number needed to treat, the more effective the treatment. A number needed to treat of four or less is generally considered a good treatment. A number needed to treat of four means one patient out of four has a good response to treatment. Diagnosis-specific tables with the NNT reported from multiple studies are listed in Table 21.1 (Finnerup et al., 2015; Finnerup, Sindrup, & Jensen, 2010).

Drug Combinations

Combinations of drugs are commonly used, but the data supporting this practice are currently somewhat limited. However, several studies are of importance, as noted below.

Table 21.1 Number needed to treat (NNT) for specific pain disorders

Painful peripheral neuropathy	
Amitriptyline	1.6, 3, 6.1, 50
Desipramine	2.2, 7.0
Maprotiline	11
Imipramine	2.4
Venlafaxine	4.1, 4.5
Duloxetine	2.2, 4.2, 4.8, 6.1, 30
Pregabalin	3.4, 3.9, 4.0, 4.2, 10.8, 20.2, −12.6, −26.7
Gabapentin	4.5, 7.0, 7.0, 12.5
The recommended first-line drugs for diabetic neuropathy are tricyclic antidepressants, duloxetine, or gabapentin. In patients over 65, tricyclic antidepressants are limited by anticholinergic and sedative side effects and fall risk. If tricyclic antidepressants are used, starting doses should be low, and titration should be slow to below 75 mg per day	
Postherpetic neuralgia	
Amitriptyline	1.6
Desipramine	1.9
Nortriptyline	4.0
Pregabalin	3.4, 4.0, 4.2, 5.6, 5.6
Gabapentin	3.4, 5.1, 6.0, 6.5, 9.0, 12.8
The recommended first-line drugs for postherpetic neuralgia are tricyclic antidepressants or gabapentin. Serotonin-norepinephrine reuptake inhibitor (SNRI) antidepressants have not been adequately studied	
Central poststroke pain	
Amitriptyline	1.7
Pregabalin	27.0
Peripheral nerve injury	
Amitriptyline	2.5
Pregabalin	8.3
Gabapentin	2.7, 24.5
Multiple sclerosis	
Amitriptyline	3.4
Duloxetine	15.1
Radiculitis	
Nortriptyline	18.6
Spinal cord injury pain	
Amitriptyline	4.4
Pregabalin	3.3, 7.0
Gabapentin	Infinity

- In a study of patients with fibromyalgia, duloxetine alone was better than pregabalin alone, and the combination was better, suggesting an additive analgesic effect (Gilron et al., 2016).
- In patients with diabetic neuropathy who failed single-drug therapy with either duloxetine or pregabalin, adding pregabalin to duloxetine improved allodynia. Increasing duloxetine alone improved paresthesias and dysesthesias. Adding duloxetine to pregabalin had a larger analgesic effect compared to increasing pregabalin (Bouhassira et al., 2014).
- Nortriptyline and gabapentin have additive analgesic effects for chronic pain (Gilron, Jensen, & Dickenson, 2013).
- For neuropathic pain, a review of an anticonvulsant plus an opioid showed an additive effect, and so a possible opioid-sparing effect may be present (Chaparro, Wiffen, Moore, & Gilron, 2012).
- However, the combination of tramadol and an antidepressant has been associated with serotonin syndrome, and high doses of this combination are discouraged (Lokesh, 2012).

Labeled Indications

Duloxetine and pregabalin have FDA-labeled indications for diabetic neuropathy and fibromyalgia. The gabapentinoids have labeled indications for postherpetic neuralgia. Duloxetine has a labeled indication for chronic musculoskeletal pain. Pregabalin has a labeled indication for spinal cord injury pain. Tricyclic antidepressants are older, generic drugs, and indications are limited to depression, but the data supporting their use remain significant for many chronic and neuropathic pain states.

Establish Goals for Pain and Function

Before starting opioid therapy for chronic pain, clinicians should establish treatment goals with all patients, including realistic goals for pain and function, and should consider how opioid therapy will be discontinued if benefits do not outweigh risks. Clinicians should continue opioid therapy only if there is clinically meaningful improvement in pain and function that outweighs risks to patient safety (Dowell et al., 2016).

Opioids and Function

Studies of opioid treatment of chronic pain are inconclusive about producing an improvement in function (Noble et al., 2010). Furthermore, in the workers' compensation population, early opioid prescribing is associated with increased vocational disability, and most patients who take opioids for 3 months continue to be on opioids 5 years later (Martin et al., 2011; Washington State Agency Medical Directors' Group, 2016). This creates a conflicting situation because some guidelines call for functional improvement to be documented in order for opioids to be continued (Washington State Department of Labor and Industries, 2013). Also, many elderly patients with chronic pain from, for example, spinal stenosis do not improve with time, treatment, or opioids. They are often palliative care patients, but not end-of-life care patients, so they are not within the "safe harbor" protection of hospice where opioids are prescribed without as much concern for addiction. It is not likely for these patients to improve functionally with opioids, and, perhaps, a lack of functional improvement should not be a reason to discontinue opioids in this group. However, the best treatment for functional improvement in patients with chronic pain is interdisciplinary pain management. Interdisciplinary pain management is an underutilized weapon against the prescription opioid epidemic and will be discussed at the end of this chapter.

Patient Education

Patients should be educated about the expectations for pain, recovery, and activity resumption with their pain diagnosis. Patients should be informed that opioids provide incremental amounts of analgesia, and they should be counselled to avoid increasing opioid doses in an effort to achieve complete pain relief. Patients with back pain should be informed that opioids have not been shown to be helpful for acute back pain and have been shown to be of limited benefit for chronic back pain (Abdel Shaheed, Maher, Williams, Day, & McLachlan, 2016). The best way to avoid problems with opioids is to not prescribe them for conditions, such as back pain and other conditions that opioids have not been shown to help to a degree that justifies the risk of treatment (Ballantyne, 2016). Education about the risks of chronic opioid treatment is also a good way to get feedback from patients about their attitude and potential risk for self-medicating.

"Saying no" to patients about a prescription for an opioid is uncomfortable, but, oftentimes, education about the evidence sends a message of caring to patients and their families and is helpful in maintaining a trusting doctor-patient relationship. Saying no at the appropriate time is easier than trying to say it later, after several missed opportunities or attempts. Most patients appreciate the information about the risks of chronic opioid therapy, and physicians should be wary of patients who dismiss information about the risks and argue for higher doses.

Long-Term Trials

The first long-term randomized trial of opioids showed no functional benefit with opioids, relative to non-opioid treatment (Krebs et al., 2018). Furthermore, pain was found to be significantly worse in the patients treated with opioids. The patient population in this particular study included patients with back pain and osteoarthritis of the hips and knees. Indeed, many patients who are treated with long-term opioid therapy have back pain and other musculoskeletal pain, so, fortunately, the results of this study are likely to lead to a significant change in the practice of prescribing opioids for chronic pain. Patients without substance use disorder may need to be "tapered off" opioids simply to avoid the risk of opioid treatment, because opioid treatment for chronic pain has not been shown to be effective.

It should also be noted that, while there is a lack of long-term randomized placebo controlled trials showing opioid analgesia, two randomized trials comparing opioid and naloxone combinations to opioid alone have been extended and show maintenance of analgesia. It seems reasonable that some selected patients may benefit from long-term opioid treatment (Sandner-Kiesling et al., 2010; Simpson et al., 2008; Vondrackova et al., 2008).

Blinded Opioid Infusions

It is not clear which patients with chronic pain are good candidates for opioid treatment. Blinded opioid infusions have been used to test opioid responsiveness (Portenoy, Foley, & Inturrisi, 1990; Racz, Heavner, & Noe, 1996). There are also some tools that can be used to document opioid responsiveness and justify opioid treatment for chronic pain conditions.

Adverse Effects

The common adverse effects include constipation, sedation, impaired judgment and reaction time, allergies, nausea, physical dependence, addiction, endocrine changes including low testosterone in men, and a potential opioid dependence in a fetus.

Dose and Overdose Risk

The risks of opioid treatment include a dose-dependent risk of overdose. Assuming a relative risk of 1 at doses from 1 to 19 MED, the relative risk increases to 1.5 at doses between 20 and 49 MED. This increases to 4 at doses between 50 and 99 MED. Over 99 MED, the risk is ninefold higher. One out of seven overdoses is fatal (Dunn et al., 2010). Additional risks include abuse, addiction, and diversion of drugs. In addition to these problems, several additional risks are present in older patients.

Risks in Older Adults

In adults over 65, overmedication may be a significant factor explaining the 2-year prevalence of falls, increasing from 28.2% in 1998 to 36.3% in 2010 (Cigolle et al., 2015). Also, a meta-analysis of studies of opioid-related fractures shows an 88% increase in risk of a fracture in patients taking opioids (Teng et al., 2015). Finally, the following should be considered:

- Sleep apnea is aggravated by opioids (Javaheri & Randerath, 2014).
- Pain processing and opioid sensitivity may be altered by opioids in patients with sleep apnea (Lam, Kunder, Wong, Doufas, & Chung, 2016).
- Other pulmonary problems place patients at higher risk with opioid treatment as well. Cognitive dysfunction and delirium can be worsened in cancer patients taking opioids (Lawlor, 2002).
- Patients in palliative care can experience sedation and sleep disturbance with opioids. Thinking processes and the ability to react can be altered. Cognitive and psychomotor impairment can follow. Myoclonus, hyperalgesia, and tolerance can also develop with opioids (Vella-Brincat & MacLeod, 2007).

- Chronic back pain has been associated with longer information processing times. Patients treated with opioids have been shown to have reduced or worsened spatial memory capacity, flexibility for concept change, and working memory (Schiltenwolf et al., 2014).
- Constipation is a significant side effect with opioids, and even small doses increase the risk of ileus. The resultant increase in hospital length of stay and the associated costs are large (Barletta, 2012).
- Chronic opioid therapy is relatively contraindicated in respiratory disease and narcolepsy.
- Renal insufficiency has been associated with accumulation of metabolites of opioids, such as morphine and meperidine. The best opioid to use in patients with renal failure is not clear, but several recommendations have been made.
- Codeine, morphine, and meperidine should be avoided. Alfentanil has been recommended for intravenous use. Tramadol, hydromorphone, and oxycodone have been recommended for oral administration (Conway, Fogarty, Nelson, & Doherty, 2006).
- Methadone and fentanyl have been recommended, but they are also the least dialyzable opioids (Dean, 2004).
- Tramadol at lower doses and longer dosing intervals has been advocated, along with fentanyl (Murtagh, chai, Donohoe, Edmonds, & Higginson, 2007).
- Opioids have also been associated with kidney disease (Barbosa-Leiker et al., 2016; Mallappallil, Sabu, Friedman, & Salifu, 2017).
- When starting opioid therapy for chronic pain, clinicians should prescribe immediate-release opioids instead of extended-release/long-acting (ER/LA) opioids (Dowell et al., 2016).
- Because no studies have shown superior analgesia with long-acting opioids and long-acting opioids are associated with a higher risk of overdose, long-acting opioids are contraindicated for opioid-naïve patients (Bohnert et al., 2011).
- This same argument can be extended to opioid-tolerant patients with chronic noncancer pain, because they have significant opioid consumption and overdose risk.

Use the Lowest Effective Dose

When opioids are started, clinicians should prescribe the lowest effective dosage. Clinicians should use caution when prescribing opioids at any dosage, carefully reassess evidence of individual benefits and risks when considering increasing dosage to ≥50 morphine milligram equivalents (MME)/day, and avoid increasing dosage to ≥90 MME/day or carefully justify a decision to titrate dosage to ≥90 MME/day (Dowell et al., 2016).

Dose and Risk of Substance Use Disorder

The relative risk of substance use disorder increases by a factor of 15 on low doses (<35 mg per day of morphine equivalents MED); relative to no opioid, by a factor of 29 on moderate doses (36–120 MED); and by a factor of 122 on high doses (>120 MED) (Edlund et al., 2014). Most studies are of doses below 100 MED, so patients on doses above 100 MED are not only at high risk for overdose, but they are also being treated with outlier doses. The "no ceiling dose" concept that was promulgated in the 1990s has now fallen out of favor. The exceptions to this principle are patients with cancer or burn patients who routinely require doses above 100 MED.

Labeled Indications for Opioids

- Labeled indications for several extended-release opioid products have been modified to limit use to patients with opioid tolerance.
- Intrathecal morphine indications have been modified to limit use to patients with severe enough pain to require intravenous opioid.
- Immediate-release, short-acting opioids are indicated for moderate-to-severe pain and are established treatments for cancer pain that does not respond to acetaminophen and NSAIDS with adjuvant drugs.

Prescribe Short Durations for Acute Pain

Long-term opioid use often begins with treatment of acute pain. When opioids are used for acute pain, clinicians should prescribe the lowest effective dose of immediate-release opioids and should prescribe no greater quantity than needed for the expected duration of pain severe enough to require opioids. Three days or less will often be sufficient; more than 7 days will rarely be needed (Dowell et al., 2016).

Duration of Initial Prescription and Risk of Long-Term Opioid Use

The risk for chronic use seems to increase after as early as 4–5 days of exposure. The risk for prolonged opioid use is correlated to the number of days of the initial prescription. For example, a 30-day initial prescription is associated with a 35% chance of remaining on opioids for 1 year and a 20% chance of remaining on opioids after 3 years (Shah, Hayes, & Martin, 2017). Also, patients often do not take as many pills as are prescribed following surgery, and the leftover pills are a potential source of misuse or diversion (Bartels et al., 2016; Hill, McMahon, Stucke, & Barth, 2017).

Evaluate Benefits and Harms Frequently

Clinicians should evaluate benefits and harms with patients within 1–4 weeks of starting opioid therapy for chronic pain or of dose escalation and should evaluate benefits and harms of continued therapy with patients every 3 months or more frequently. If benefits do not outweigh harms of continued opioid therapy, clinicians should optimize other therapies and work with patients to taper opioids to lower dosages or to taper and discontinue opioids (Dowell et al., 2016).

Ending Long-Term Opioid Treatment

Patients who do not experience significant analgesia with dose escalations should be tapered to the prior dose. Dose increases should be small and infrequent. Tapering off opioids is obviously easier from lower doses and after short durations of treatment. Other factors to consider are:

- Patients with intrathecal opioid pumps are particularly difficult to convert to non-opioid patients. They are often treated with non-FDA-approved intrathecal medications, such as hydromorphone, fentanyl, sufentanil, bupivacaine, and clonidine, and have spent thousands of dollars for the device and implantation surgery.
- Patients who are seeking a new prescribing doctor are frequently high risk, and should not be prescribed opioids on the first visit unless the prescribing physician has arranged for a transfer of care and the new prescribing physician has made a thorough evaluation. Patients who are in withdrawal, or who are at risk for withdrawal, should be referred to an emergency room at a hospital with a detoxification unit and addictionology program. Patients who are discovered to be diverting should not receive refills on opioids.
- Clinicians should consider having a conversation with the previous prescriber about aberrant behavior, diversion, overdose history, suicide attempts, emergency room visits for pain, reason for leaving the practice, diversion risk factors, criminal activity, and other important history.
- Before starting, and periodically during, continuation of opioid therapy, clinicians should evaluate risk factors for opioid-related harms. Clinicians should incorporate into the management plan strategies to mitigate risk, including considering offering naloxone when factors that increase risk for opioid overdose, such as history of overdose, history of substance use disorder, higher opioid dosages ($\geq$50 MME/day), or concurrent benzodiazepine use, are present (Dowell et al., 2016).

- Overdoses are more likely in patients with long-term opioid treatment with a coexisting substance use disorder (Bohnert et al., 2011). However, overdoses can also occur at low doses and after short durations of therapy (Fulton-Kehoe et al., 2013).
- Many high-risk chronic pain patients have depression or other major psychiatric problems and are at risk for suicide, as well as accidental overdose. Evaluating patients for psychiatric problems and effectively treating depression, in particular, can help not only pain but also lower risk related to opioid overdose whether it is intentional or accidental.
- The 2017 *Federation of State Medical Boards' Guidelines for the Chronic Use of Opioid Analgesics* includes new language for assessment documentation of:
  – One or more recognized medical indications and absence of psychosocial contraindications
  – Objective markers of disease or diagnostic markers as indicated.
  – Family history of alcohol or drug abuse
  – History of physical, emotional, or sexual abuse
  – Substance use disorder as defined by the DSM-5
  – Family history of mental health disorders
  – Screened for depression and other mental health disorders (Federation of State Medical Boards, 2017)
  – A history of an opioid overdose, opioid addiction, or current substance abuse should be considered contraindications for chronic opioid therapy. A family history of opioid addiction is a relative contraindication. Naloxone can be prescribed for use in the event of an overdose, and CPR training for family members has been advocated.
  – Information from family members can provide unique insight in to risk factors for diversion and abuse.

The Pain Medication Questionnaire

The Pain Medication Questionnaire (PMQ) is one of the several screening tools used to evaluate risk of opioid treatment and misuse. Elevated PMQ scores are correlated with a history of substance abuse, psychosocial distress, and poor functioning (Adams et al., 2004). The PMQ is reliable and valid and can identify dysfunctional thought and behavior that can negatively affect treatment (Dowling, Gatchel, Adams, Stowell, & Bernstein, 2007). The PMQ has also been shown to predict outcomes from an interdisciplinary pain management program (Holmes et al., 2006). Finally, the PMQ is helpful for monitoring progress in patients who are taking opioids (Passik, Kirsh, & Casper, 2008).

Review PDMP Data

Clinicians should review the patient's history of controlled substance prescriptions, using state prescription drug monitoring program (PDMP) data to determine whether the patient is receiving opioid dosages or dangerous combinations that put him or her at high risk for overdose. Clinicians should review PDMP data when starting opioid therapy for chronic pain and periodically during opioid therapy for chronic pain, ranging from every prescription to every 3 months (Dowell et al., 2016). Also:

- Patients who are prescribed opioids from multiple providers are at higher risk for overdose (Jena, Goldman, Weaver, & Karaca-Mandic, 2014).
- However, a significant percentage of overdoses occur even at low doses and after short durations of treatment; following guidelines may not prevent this from occurring (Fulton-Kehoe et al., 2013).
- Checking the electronic prescription record helps prevent overlapping prescribing and dangerous drug combinations that may not be reflected in an electronic medical record and may not be detected in urine drug screening.

- Among groups of patients with acute pain, cancer pain, chronic pain, and coexisting substance abuse, the overdose risk is highest in patients with coexisting substance abuse. Acute pain patients are the second highest-risk group, and the cancer pain patients are the lowest risk (Bohnert et al., 2011).

Diversion

Diversion is defined as the transfer of a controlled substance from a lawful to an unlawful channel of distribution or use. Prescription forgery, medication theft, or sales of a dispensed prescription are examples. Diversion risk factors include leftover medications, unlocked medication cabinets, teenagers in the home, friends or caregivers with histories of drug problems or drug dealing, etc. Local pharmacies and some police departments administer medication take-back programs.

Diversion also includes prescribing or dispensing without a legitimate medical purpose. “Doctor shopping” and obtaining prescriptions under false pretenses are particularly important diversion mechanisms for clinicians to avoid (Gilson, Ryan, Joranson, & Dahl, 2004). An analysis of electronic prescription records found 135,000 doctor shoppers with 32 prescriptions from 10 different prescribers. The doctor shoppers were 0.7% of the prescription purchasers, and they accounted for 1.9% of 4,285,000 prescriptions and 4% of the weight of opioid dispensed (Gilson et al., 2004). However, any cases with three prescribers, three pharmacies, out-of-pocket purchases, or overlapping prescriptions are all “red flags” for regulators that can be easily identified on electronic prescription records. Also, prescribers can be identified based on the amount they prescribe relative to their peers.

Use of Urine Drug Testing

When prescribing opioids for chronic pain, clinicians should use urine drug testing before starting opioid therapy and consider urine drug testing at least annually to assess for prescribed medications, as well as other controlled prescription drugs and illicit drugs (Dowell et al., 2016). Urine drug testing is adequate for most patients; however, serum drug testing should be considered for high-risk patients to avoid sample substitution, specimen tampering, and inaccurate testing. Screening tests for overdoses are not designed for chronic opioid therapy monitoring and are inadequate for monitoring patients on long-term opioid treatment.

Marijuana is controversial, depending on the jurisdiction. In states where marijuana laws have been liberalized, it may be accepted to prescribe opioids when a drug screen is positive for marijuana, as long as no diagnosis related to marijuana use is present. However, in states without new marijuana laws, marijuana is treated like any other Schedule I drug, and opioid prescribing is contraindicated (Gourlay, Heit, & Caplan, 2012; Passik, Heit, Pesce, Mikel, & Kirsh, 2013).

Avoid Concurrent Opioid and Benzodiazepine Prescribing

Clinicians should avoid prescribing opioid pain medication and benzodiazepines concurrently whenever possible (Dowell et al., 2016). The overdose risk is significantly higher with the combination of opioid and benzodiazepine, and patients on both drugs should be tapered off one or both of the drugs. Patients on benzodiazepines usually benefit from an evaluation for anxiety and/or depression and alternatives to treatment with benzodiazepine. Benzodiazepine tapers take much longer than opioid tapers, and withdrawal can be life-threatening and associated with seizures.

Offer Treatment for Opioid Use Disorder

Clinicians should offer or arrange evidence-based treatment (usually medication-assisted treatment with buprenorphine or methadone in combination with behavioral therapies) for patients with opioid use disorder (Dowell et al., 2016). The DSM 5 criteria for substance use disorder are a significant change because they allow for the diagnosis in the presence of pain.

Substance Use Disorder

A minimum of 2–3 criteria are required for a mild substance use disorder diagnosis, while 4–5 is moderate, and 6–7 is severe.

1. Taking the opioid in larger amounts and for longer than intended
2. Wanting to cut down or quit but not being able to do it
3. Spending a lot of time obtaining the opioid
4. Craving or a strong desire to use opioids
5. Repeatedly unable to carry out major obligations at work, school, or home due to opioid use
6. Continued use despite persistent or recurring social or interpersonal problems caused or made worse by opioid use
7. Stopping or reducing important social, occupational, or recreational activities due to opioid use
8. Recurrent use of opioids in physically hazardous situations
9. Consistent use of opioids despite acknowledgment of persistent or recurrent physical or psychological difficulties from using opioids
10. *Tolerance as defined by either a need for markedly increased amounts to achieve intoxication or desired effect or markedly diminished effect with continued use of the same amount. (Does not apply for diminished effect when used appropriately under medical supervision)
11. *Withdrawal manifesting as either characteristic syndrome or the substance is used to avoid withdrawal (does not apply when used appropriately under medical supervision)

*This criterion is not considered to be met for those individuals taking opioids solely under appropriate medical supervision (American Psychiatric Association, 2013). In one study, 91% of patients who overdosed were prescribed opioids again. A significant number of these patients overdose again (Larochelle, Liebschutz, Zhang, Ross-Degnan, & Wharam, 2016).

Clinical Opioid Withdrawal Scale

Recognizing opioid withdrawal is important. The Clinical Opioid Withdrawal Scale (COWS) is used for classifying opioid withdrawal. The COWS is presented in Table 21.2. It should also be noted that one of the problems with increased scrutiny of opioid prescribing is that prescribing physicians may be viewed as "abandoning patients." Physicians who are prescribing opioids should take ownership of their patient's predicament and discuss and initiate tapering opioid doses. Referring patients to another doctor with "just enough" opioid until their first visit with the new doctor just condones staying on an opioid, instead of getting off an opioid. If patients present themselves with a history of their prescribing physician being uncomfortable with continuing to prescribe, it should be considered that some aberrant behavior occurred and thus avoid prescribing until more information can be gathered.

Also, patients who change insurance or move often expect their new physician to simply continue their medication regimen. This is a good opportunity to change directions with regard to the management of chronic pain. Additionally, more physicians need to become certified to prescribe buprenorphine in order to handle the volume of patients who need to be converted to it. The capacity of addictionology programs is inadequate to handle the volume, and the insurance coverage for intensive addictionology programs is not available either.

Prescribing buprenorphine for pain is an option, but prescribing buprenorphine for addiction requires physicians to complete training and to obtain a DEA X waiver to legally prescribe buprenorphine for addiction. Off-label prescribing of buprenorphine/naloxone preparations is prohibited. The number of patients a physician may simultaneously treat under an X waiver is limited, and special records must be maintained (Jones, Campopiano, Baldwin, & McCance-Katz, 2015).

Table 21.2 The Clinical Opioid Withdrawal Scale (COWS); Wesson and Ling (2003)

Resting pulse rate: (record beats per minute)
Measured after patient is sitting or lying for 1 min
0 pulse rate 80 or below
1 pulse rate 81–100
2 pulse rate 101–120
4 pulse rate greater than 120
Sweating: *over past 1/2 h not accounted for by room temperature or patient activity*
0 no report of chills or flushing
1 subjective report of chills or flushing
2 flushed or observable moistness on face
3 beads of sweat on brow or face
4 sweat streaming off face
Restlessness *Observation during assessment*
0 able to sit still
1 reports difficulty sitting still but is able to do so
3 frequent shifting or extraneous movements of legs/arms
5 Unable to sit still for more than a few seconds
Pupil size
0 pupils pinned or normal size for room light
1 pupils possibly larger than normal for room light
2 pupils moderately dilated
5 pupils so dilated that only the rim of the iris is visible
Bone or Joint aches *If patient was having pain previously, only the additional component attributed to opiates withdrawal is scored*
0 not present
1 mild diffuse discomfort
2 patient reports severe diffuse aching of joints/muscles
4 patient is rubbing joints or muscles and is unable to sit still because of discomfort
Runny nose or tearing *Not accounted for by cold symptoms or allergies*
0 not present
1 nasal stuffiness or unusually moist eyes
2 nose running or tearing
4 nose constantly running or tears streaming down the cheeks
GI upset: *over last 1/2 h*
0 no GI symptoms
1 stomach cramps
2 nausea or loose stool
3 vomiting or diarrhea
5 Multiple episodes of diarrhea or vomiting
Tremor *Observation of outstretched hands*
0 no tremor
1 tremor can be felt, but not observed
2 slight tremor observable
4 gross tremor or muscle twitching
Yawning *Observation during assessment*
0 no yawning
1 yawning once or twice during assessment
2 yawning three or more times during assessment
4 yawning several times/minute

(continued)

Table 21.2 (continued)

Anxiety or Irritability
0 none
1 patient reports increasing irritability or anxiousness
2 patient obviously irritable anxious
4 patient so irritable or anxious that participation in the assessment is difficult
Gooseflesh skin
0 skin is smooth
3 piloerection of skin can be felt or hairs standing up on arms
5 prominent piloerection

Score: 5–12 = mild; 13–24 = moderate; 25–36 = moderately severe; more than 36 = severe withdrawal

New Technologies

The potential for new technologies to mitigate against the prescription opioid epidemic, while not compromising analgesia, is promising (Volkow & Collins, 2017). Intranasal naloxone, extended-release naltrexone, and abuse-resistant opioid preparations are available. Interventions to treat respiratory depression, including 5-hydroxytryptamine type 1A agonists, ampakines, and phrenic nerve stimulators and automatic naloxone injectors, are being developed. Several other drug classes are also being developed, including a long-lasting (6-month) buprenorphine implant, neurokinin-1 receptor antagonists, kappa-opioid antagonists, 5-HT$_{2C}$ receptor agonist, and α_{2A}-adrenergic receptor agonists. In addition, nonaddicting opioid analgesics are being developed. Vaccinations may soon emerge that prevent opioids from crossing the blood-brain barrier and produce antibodies to potent opioids. Finally, wearable biosensors may detect aberrant drug use and alert response teams in real time (Carreiro et al., 2015).

Summary: Opioids for Chronic Pain

Guidelines for opioid prescribing have been studied using an intervention to improve guideline adherence. The intervention group was associated with less opioid consumption, but the effect seen was limited to a discontinuance rate of 21.3%, versus 16.8% in the control group, and a 10% dose reduction in the patients who continued opioids (Liebschutz et al., 2017). This suggests that guidelines that establish best practices for continuing to prescribe opioids may not have the effects of dramatically reducing the doses and duration of therapy of opioid prescribed in this country. Relatedly, the 2017 guidelines from the Veterans Affairs and Department of Defense "recommend against initiation of long-term opioid therapy for chronic pain" (The Opioid Therapy for Chronic Pain Work Group, 2017). These guidelines go on to say: "For patients currently on long-term opioid therapy with evidence of untreated substance use disorder, we recommend close monitoring, including engagement in substance use disorder treatment, and discontinuation of opioid therapy for pain with appropriate tapering." Consideration should be given for legacy opioid patients to be tapered off opioids or at least to be tapered to doses below 50 mg per day of morphine equivalents. Patients who have had an overdose should be tapered off. Hospitalized patients may be tapered off in 7–10 days. Patients should be hospitalized for tapering if they are unstable or unmotivated. Patients who are reliable and motivated may be tapered off as an outpatient at a rate of 10% per week. Other factors to be considered are:

- New chronic pain patients should be managed without opioid, and evidence-based drugs should be used as analgesics.
- Headache, fibromyalgia, chronic low back pain, and abdominal pain do not respond well

to chronic opioid therapy. Inflammatory pain, in patients who cannot take anti-inflammatories, may be a niche for chronic opioid treatment. In the meantime, physicians should improve their skills with non-opioid analgesia and prescribe opioids only when it can clearly be defended.

Finally, the 2017 Federation of State Medical Boards Guidelines for the Chronic Use of Opioid Analgesics indicate that the new guidelines are "not intended for the treatment of acute pain, acute pain management in the perioperative setting, emergency care, cancer-related pain, palliative care, or end-of-life care." This is important new language that clarifies that the applicable population for restrictions is patients with chronic pain. Patients with cancer pain often require opioids for analgesia, and the next section will address this population.

Safe Opioid Management in Elderly Patients with Cancer-Associated Pain

More than one-half of all cancer patients are over the age of 65 (National Cancer Institute, 2017). For many reasons, elderly patients' cancer pain is often undertreated. One reason is that many older patients underreport pain to their providers because of fear that they will be viewed as a "bad patient." There are also many misconceptions about pain perception in the older population. Older adults often feel that pain is part of the "natural aging process" and should be endured (Fairchild, 2010). However, unrelieved pain in the older cancer pain population has many detrimental effects. Poorly treated pain is associated with increased depression rates in patients, lowers hope in these patients, and systematically can increase healthcare utilization and subsequently healthcare costs. Even highly trained healthcare professionals often have misconceptions regarding elderly patients' pain perception and older patients' ability to tolerate pain. Many providers fear the complications of opioids in the elderly patient population. Together, these many factors lead to undertreatment.

While many surveys have revealed less analgesic use among the elderly, suggesting lower pain prevalence in this population, there are no data to support that elderly patients display any physiologic changes in pain perception (Mercadeante & Arcuri, 2007). Elderly patients may, in fact, report pain less often due to stoicism or communication difficulties (delayed response, cognitive barriers, or language barriers in certain minority populations) (Gibson & Farrell, 2004).

Good symptom management is paramount for improving quality of life in elderly patients with cancer pain. To optimize pain control, providers need the necessary skills to appropriately manage analgesics, including opioid medications, and the ability to prevent opioid-associated side effects. Elderly patients often have more comorbidities than younger patients, which complicates treatment. Providers should also treat elderly patients based on their physiologic age, and not solely their chronological age. Because opioid medications continue to be the mainstay of appropriate pain treatment in the cancer pain population, providers must also understand the inherent risks of chronic opioid therapy, including aberrant usage and opioid misuse. The estimate of opioid addiction in the cancer pain population is 7.7% (Fairchild, 2010). Therefore, providers must be educated about these risks and know how to manage opioids safely in this patient population.

Pharmacologic Management of Cancer Pain in Elderly Patients

Analgesic drugs are divided into two main categories: non-opioid analgesics and opioids. Appropriate analgesic selection should be guided by the World Health Organization (WHO)'s three-step analgesic ladder. The WHO developed this ladder in 1986 in order to guide the treatment of cancer-related pain (World Health Organization, 1986).

Step I: Simple Non-opioid Analgesics +/− Adjuvant Analgesics

For mild pain, non-opioid analgesics should be instituted and are considered first-line therapy. One step to reduce opioid misuse is to optimize non-opioid therapies when appropriate. For pain that is considered mild, typically less than 4/10 in severity on the Likert scale, providers should follow the WHO analgesic guidelines and start with non-opioid analgesics. For example, paracetamol (acetaminophen) has analgesic properties, but no anti-inflammatory properties. The precise mechanism of action is still not entirely clear but appears to act centrally (central inhibition of prostaglandin synthesis). It is considered a relatively safe option in the elderly population due to minimal cognitive effects and unchanged elimination in the elderly. It can, though, cause liver and renal toxicity at high doses taken over extended periods of time. The maximal daily dosage should not exceed 4 g, but lower doses should be considered in elderly patients; 3 grams daily is typically considered a "safe" dosage in all patients over 150 lbs, but those patients with coexisting liver dysfunction, malnutrition, concomitant use of enzyme-inducing drugs, and chronic alcohol use may warrant lower maximum doses of 2 grams (O'Neil, Hanlon, & Marcum, 2012).

NSAIDs (nonsteroidal anti-inflammatory drugs) primarily act peripherally by reducing synthesis of prostaglandins. NSAIDs are effective analgesics alone and have shown synergistic analgesia when combined with opioid therapy. However, they have many potentially adverse effects, especially in the elderly patient population, including gastric effects, kidney effects, and coagulation effects. Elderly patients are at increased risk of developing toxicity from these drugs, and these drugs should therefore be used with caution in the elderly population, especially in those patients with multiple comorbidities (such as cancer patients). Although selective cox-2 inhibitors have less gastrointestinal effects, they have still been associated with increased risk of cardiovascular events, and therefore are also not a good long-term option in the elderly population. For these reasons, although NSAIDs are effective analgesics in cancer-associated pain, they should be used with caution in the elderly population. Elderly cancer patients treated with NSAIDs should be monitored closely for GI or renal effects, and these patients should be appropriately educated about the risks of NSAID therapy and aware of the signs of GI bleeding (O'Neil et al., 2012).

Step II: "Weak" Opioids for Moderate Cancer Pain or Low Doses of "Strong" Opioids

When pain severity exceeds 4/10 on a Likert scale, it is considered "moderate" but not severe in its intensity; providers should introduce "weak" opioids or lower doses of strong opioid medications to treat cancer-associated pain.

Codeine

Codeine is considered a "weak" opioid and can be helpful in mild to moderate cancer-associated pain. Less than 10% of codeine is metabolized to morphine through demethylation. However, most of the analgesic effect of codeine is dependent upon its conversion to morphine. Approximately 10% of patients are poor metabolizers due to genetic polymorphisms and thus derive very little analgesic benefit from codeine (Chen, Somogyi, Reynolds, & Bochner, 1991).

Tramadol

Tramadol has multiple mechanisms of action. It acts as a weak opioid (primary activity at the mu receptor) and also inhibits serotonin and norepinephrine reuptake. Tramadol is highly metabolized and excreted through the kidneys. Therefore, in patients with impaired hepatic or renal function, the dose should be appropriately reduced (typically by increasing the dosing interval). Tramadol lowers the seizure threshold and should be avoided in patients with a history of seizure disorder. The analgesic potency of tramadol is about 10% of that of morphine. Tramadol appears to have lower abuse potential and less constipation than stronger opioids (Grond & Sablotzki, 2004). Utilizing opioids with lower abuse potential is favored in those patients with higher risk factors for opioid misuse.

STEP III: Severe Cancer Pain – Strong Opioids

When cancer pain is severe and unresponsive to non-opioid and weak opioid medications, then the next "step" in the WHO analgesic ladder recommends institution of strong opioids.

Morphine

Morphine is available in many forms, including rectal, oral, sublingual, and parenteral. Due to its wide availability and long history of use, it can be considered the "gold standard" in pharmacologic management of severe cancer pain. Morphine is also frequently more affordable than other newer opioid formulations. Morphine is highly metabolized, primarily to two major metabolites: morphine-3-glucuronide (M3G) and morphine-6-glucuronide (M6G). Hepatic dysfunction does not significantly alter the effects of morphine due to high levels of hepatic glucuronidation, even in cases of significant hepatic disease. However, renal dysfunction significantly affects the excretion of morphine's active metabolites and can lead to drug toxicity. M6G crosses the blood-brain barrier and is a potent analgesic. M3G has no analgesic efficacy but actually antagonizes analgesia, and its buildup can lead to neurotoxic effects with symptoms such as myoclonus. Morphine and its metabolites are renally excreted, and thus administration of morphine to patients with significant renal dysfunction can lead to drug toxicity and adverse effects. Therefore, renal function must be carefully monitored in elderly patients who are being treated with morphine.

Hydromorphone

Hydromorphone is more potent than morphine. It is also metabolized in the liver to hydromorphone-3-glucuronide, which is then excreted through the kidneys. H3G, like M3G, is neurotoxic, and thus hydromorphone should also be utilized with caution in patients with renal dysfunction.

Oxycodone

Oxycodone is a semisynthetic opioid metabolized to noroxycodone and oxymorphone (a more potent metabolite). Recently, oxymorphone has also become available as an analgesic. Although oxycodone's metabolites are renally excreted, its pharmacokinetics are primarily independent of age and renal function, and thus it has emerged as a popular drug choice in the elderly population.

Fentanyl

Fentanyl is available in a transdermal application. The transdermal application is delivered as a skin depot of drug over a 72-h period. It is useful in those patients with continuous pain or in those with difficulty tolerating oral analgesics. Its primary metabolites are inactive and nontoxic and excreted in the urine. Therefore, fentanyl is often an option for elderly patients with severe cancer pain and renal dysfunction, when other opioids such as morphine or hydromorphone might be dangerous (Ahn et al., 2017). Although transdermal fentanyl can be abused, it is typically more difficult to abuse in comparison to other opioid formulations and thus is sometimes preferred in patients with higher risk for opioid misuse.

Buprenorphine

Buprenorphine is a unique opioid, with only partial agonist activity. More recent studies have shown it to be effective for the treatment of moderate and severe cancer pain. It is available in a transdermal application and is safe in even severe renal dysfunction, making it a feasible choice in those patients with renal impairment. It appears to have a "ceiling effect" on respiratory depression and, due to slow dissociation from the mu receptor, has lower abuse potential. Transdermal buprenorphine is an attractive option in patients at higher risk for opioid misuse (Ahn et al., 2017).

Opioid Dosing and Administration

Elderly patients are typically more sensitive to opioid-induced analgesia and its adverse effects. Therefore, opioids should be initiated at low doses and titrated slowly to response. Although this patient population typically requires lower doses than younger patients, opioid analgesics should be titrated based on individual response, and providers should not limit dose escalation due to fear of adverse effects. Providers should also initiate treatment with short-acting opioids to allow for easier titration. The doses should be escalated cautiously until the patient's opioid requirements are established. In the cancer pain population, it is preferred to transition opioid therapy to a long-acting formulation for constant, continuous pain. One successful strategy is to convert at least 50% of the patient's daily opioid requirements to a long-acting preparation and continue ~ 20% of the daily opioid dose in a short-acting preparation available every 2–4 h for any breakthrough pain episodes. Case example: An elderly patient with metastatic prostate cancer has well-controlled pain with morphine IR (immediate release), using 30 mg every 4 h, but having to use pretty consistently for pain control, averaging five times daily. His daily oral morphine equivalents are calculated at 150 mg. To improve basal analgesic control, the patient is converted to a sustained-release morphine, 60 mg twice daily (120 mg). For breakthrough pain, 20% of 150 mg is calculated at 30 mg dosing. He is prescribed morphine IR, 30 mg every 4 h as needed for breakthrough pain. This new regimen allows him to sleep throughout the night without having to awaken and take a pain reliever. He continues to utilize morphine IR for breakthrough pain episodes, but only averaging 1–2 doses daily as needed.

Because elderly patients are higher risk for experiencing adverse effects with opioid therapies, they should be monitored very closely during the opioid titration period. These patients should be seen on a regular basis to evaluate the efficacy but also potential complications of opioid therapy. Pharmacokinetic studies have evaluated opioids in the elderly population. There is a natural decline in all organ system function by the seventh to ninth decade of life. Due to multiple physiologic changes, one would expect a clear change in opioid pharmacokinetics in the elderly population. However, studies have failed to prove any pharmacokinetic differences after IV administration of fentanyl or morphine in elderly patients (Gupta, Krejcie, & Avram, 2011). Studies suggest that the most common reason for increased opioid sensitivity in the elderly population (especially morphine) is a decline in renal function leading to decreased clearance of morphine and its active metabolites (i.e., morphine-6-glucuronide; (Prostran et al., 2016)).

Pharmacodynamic studies reveal an age-related increase in sensitivity to opioid analgesics and their adverse effects, including respiratory depression. The EC50 (effect size concentration producing half the clinical effect) linearly decreases with age. Based on these models, an 80-year-old patient requires roughly 50% of the opioid dosing of a 40-year-old patient (Aubrun, Salvi, Coriat, & Riou, 2005; Chau, Walker, Pai, & Cho, 2008; Gupta & Avram, 2012). Practitioners should understand these pharmacokinetic and pharmacodynamic differences in the elderly cancer population and be prudent with management of opioid medications. However, when approaching severe pain in the elderly cancer population, one should be aggressive with opioid titration.

Managing Adverse Effects of Opioid Therapy in Older Cancer Patients

Although the precise incidence is unknown, numerous studies have shown that elderly patients are at increased risk of adverse drug reactions compared to younger patients (Gurwitz et al., 2003). Elderly patients are especially prone to adverse effects from opioid therapy (Swart, van der Zanden, Spies, de Rooij, & van Munster, 2017). Factors promoting such adverse effects in the elderly include physiologic changes, such as renal impairment, which is quite common in older patients. Many opioid metabolites are renally excreted, and active metabolites can build up, promoting toxicity. Higher prevalence of comorbid disease, such as heart failure and chronic liver disease, may also increase risk of drug accumulation in the elderly patient population. Also, elderly patients with pre-existing dementia are at increased risk for developing somnolence and cognitive dysfunction with opioids (Papaleontiou et al., 2010). The most common adverse effects associated with opioid therapy include nausea and vomiting, constipation, sedation, confusion, and rarely respiratory depression.

Nausea and Vomiting

Opioid-associated nausea and vomiting in the cancer population can be very difficult to treat and is often multifactorial in the setting of concurrent chemotherapy. Opioids can induce nausea and vomiting through multiple mechanisms, including enhanced vestibular sensitivity (symptoms may include vertigo and worsening nausea with motion), direct effects on the chemoreceptor trigger zone, and delayed gastric emptying (symptoms of early satiety and bloating) (Smith & Laufer, 2014). Elderly patients, in particular, seem to be at less risk for developing nausea from opioids. Nausea is often more prevalent at induction of opioid therapy, and most patients develop tolerance to this adverse effect rather quickly. Severe nausea should be treated with antiemetics. Specific antiemetics that have shown benefit in the treatment of opioid-associated nausea/vomiting include dopamine receptor antagonists, atypical antipsychotics, and 5-HT3 receptor antagonists.

Cognitive Dysfunction

Cognitive dysfunction is one of the most frequent psychiatric complications in advanced cancer patients receiving opioid analgesics. Although opioids contribute to adverse cognitive effects, anticholinergics are the major drug class responsible for confusion in older patients (Gloth, 2000). While opioids can contribute to delirium in older patients with cancer due to metabolic abnormalities, dehydration, sepsis, and other contributing drug effects, poorly controlled pain can also be a cause of agitation and cognitive impairment in older patients, especially those with baseline dementia. Low doses of opioids can actually lessen agitation in these situations (Manfredi et al., 2003).

Sedation

Sedation typically occurs when opioids are first introduced or during a rapid dose titration. Patients usually become tolerant to the sedating effects of opioid therapy (Dhingra, Ahmed, Shin, Scharaga, & Magun, 2015). However, if sedation persists, the dose should be reduced, with careful consideration of the patient's comfort level. Sedation is concerning for development of opioid-associated respiratory depression. One strategy is to combine the opioid with a coanalgesic to hopefully reduce opioid requirements or consideration of an opioid rotation. However, when sedation is refractory and opioids are necessary in cases of severe cancer pain, psychostimulants may provide some relief (Reissig & Rybarczyk, 2005). Specifically, dextroamphetamine, methylphenidate, donepezil, and modafinil have shown some benefit. However, especially in elderly patients with comorbid disease, these agents should be used with caution in settings of concurrent cardiac disease, hypertension, or seizures.

Constipation

Constipation continues to be the most common adverse effects of chronic opioid therapy. While patients develop tolerance to many of the other adverse effects of opioid therapy, there is no physiologic tolerance to the constipating effects of opioid therapy. Constipation results due to binding of mu receptors in the gastrointestinal tract, leading to slowed motility, increased resorption of fluids from the colon, and ultimately hard stools. Due to lower activities and functional constipation, elderly cancer patients are at even higher risk of developing significant opioid-associated constipation. A bowel regimen, including stool softeners and a stimulant laxative, should be initiated in these patients on opioid therapy. Increased fluid intake and ambulation should be encouraged. Newer agents for opioid-associated constipation include methylnaltrexone, which acts as a peripheral opioid antagonist. However, this medication should be used with caution, as it has been associated with bowel perforation (Nelson & Camilleri, 2016).

Respiratory Depression

Opioids can cause respiratory depression through action at the brain stem, reducing respiratory response to hypercapnia and hypoxia. Opioid-naïve patients are at highest risk of respiratory depression with initiation of opioids, usually due to initiation at a relatively high. In those patients who have developed tolerance, respiratory depression is usually rare (Mercadante, Ferrera, Villari, & Casuccio, 2006). Risk factors for fatal and nonfatal respiratory events with opioids form the basis of the Risk Index for Overdose or Serious Opioid-induced Respiratory Depression (RIOSORD). A version of the RIOSORD showed excellent (nearly 90%) predictive accuracy in a Veterans Administration case-control analysis of close to 9000 veteran patients. Strong predictors for opioid-induced respiratory depression include substance use disorder in previous 6 months (strongest predictor), bipolar disorder or schizophrenia, cerebrovascular disease, renal disease, heart failure, nonmalignant pancreatic disease, and concurrent benzodiazepine or antidepressant prescription. Many patients with active malignancy display depression and are often treated with concurrent antidepressants and often benzodiazepine therapy. Providers should understand the risk of opioid-related respiratory depression in these situations and monitor these patients closely.

Moderate predictors for opioid-related respiratory depression include recurrent headaches, chronic pulmonary disease, sleep apnea, and extended-release and long-acting opioid formulations of daily morphine equivalence dose of greater than 100 mg. While advanced age is not a strong predictor for opioid-associated respiratory events, older patients with cancer-related pain on opioid therapy are frequently maintained on high-dose opioid therapy (greater than 100 mg OME) and are often on long-acting opioid preparations. Both of these factors are associated with increased risk of an adverse respiratory event. For these reasons, these patients should be aware of the potential for developing opioid-associated respiratory depression and be educated on the signs of opioid overdose (i.e., slow respiratory rate, decreased responsiveness (Webster, 2017)). In an effort to reduce opioid-associated respiratory events and overdose, the CDC now recommends that providers consider prescription of naloxone to patients at higher risk of developing opioid-associated respiratory events (including patients with a history of overdose, history of substance use disorder, higher opioid dosages [≥50 MME/day], or concurrent benzodiazepine use) (Centers for Disease Control and Prevention, 2017). It should be recommended that older patients with cancer pain on high-dose opioid therapy receive prescription naloxone for possible opioid overdose.

Risk Mitigation

While the gold standard for moderate-to-severe pain related to active cancer is opioid therapy, providers must also recognize the risks of chronic opioid therapy in the older population and make efforts to reduce such risks. Methods to mitigate these risks include careful assessment and awareness of medication adherence. Even though opioids are often necessary in the treatment of cancer-associated pain, providers must also recognize that certain patients are at risk for opioid misuse and abuse and may need closer monitoring or, in some situations, even involvement of an addiction specialist. Factors associated with opioid misuse include those patients with noncancer pain, male sex, age younger than 65, personal history of opioid misuse, depression, family history of substance use disorders, current smoking, history of incarceration, and post-traumatic stress disorder (Bradford et al., 2012; Liebschutz et al., 2010).

Before prescribing chronic opioids for cancer pain, adherence monitoring may include use of a controlled substance agreement, review of data from prescription drug monitoring programs, periodic drug testing, and education. If the risk of opioid misuse is low and the pain is severe enough to warrant opioid therapy, the provider may safely prescribe opioids. However, if the risk of abuse is high, the provider should evaluate if the severity of the pain warrants opioid therapy despite such risk but also attempt to integrate reasonable alternatives. However, if the pain is severe and there are no other reasonable alternatives and the risk of abuse and/or diversion is moderate, a trial of opioids may be considered. Regardless of level of risk, non-opioid and non-pharmacologic therapies should always be considered and optimized as well. If opioids are continued, adherence monitoring should continue, with the frequency dictated by the level of risk. Unfortunately, in the setting of a national opioid crisis, elderly patients with cancer are potential targets for illicit solicitation of their opioid medications. Providers should be aware of the distinct possibility of diversion in the elderly cancer pain population and make an effort to identify such situations. Education about safe storage and disposal of opioid analgesics has been shown to improve safe patient practices. If patients on chronic opioid therapy for cancer-related pain display behaviors concerning for opioid misuse (multiple early refill requests, self-escalation, positive urine drug screens for illicit substances), then engagement from an addiction specialist should be considered to assist the provider in safely managing these patients (Bennett, Paice, & Wallace, 2017).

Clinical Practice Recommendations

Because we are in the midst of an "opioid crisis" in this country, practitioners should be cautious when prescribing an opioid. In fact, for acute pain, opioids should rarely be prescribed. There are also numerous side effects and cost addiction potential associated with opioids. Other drug and treatment modalities should first be considered, such as an interdisciplinary pain management program. For all patients especially the elderly, the World Health Organization's three-step analgesic ladder approach should be followed.

Older adults have historically been undertreated for pain, primarily because they underreport complaints of pain. Therefore, they should be carefully interviewed for the possible needs for treatment and then assessed for potential side effects and improvement once treatment is commenced.

Future Directions in Practice and Research

There is a dire need for the development of newer and safer drugs to replace opioids as the major method of treating chronic pain. This is especially true for older adults, who are at increased risk for experiencing adverse effects because of comorbid illnesses. Currently, newer technologies are being developed in order to mitigate against the prescription opioid epidemic while not compromising analgesic (e.g., Volkow & Collins, 2017). Several new drug classes are being developed, such as nonaddicting opioid analgesics. More are needed. Also, vaccinations may soon emerge in order to prevent opioids from crossing the blood-brain barrier, as well as to produce antibodies to potent opioids. Moreover, wearable biosensors may detect aberrant use and alert response teams in real time. Much more technology such as these is needed for the future!

Summary

Older patients with cancer-associated pain are at increased risk for undertreatment. Providers treating these patients' pain should understand the unique physiologic changes associated with aging that may affect safe medication management. Opioids are the mainstay of management of moderate-to-severe cancer-associated pain, and their prescription should be guided in part by the World Health Organization's three-step analgesic ladder. Providers should be aware of the many potential adverse effects associated with chronic opioid therapy in this patient population and be prepared to treat associated adverse drug effects. Furthermore, in the midst of a national opioid crisis, providers must also be prepared to recognize those patients at risk for opioid misuse and develop strategies for safe opioid management while also recognizing the potential for aberrant opioid usage.

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22 Non-pharmacological Management of Symptoms of Dementias and Their Prodromes

Sherri Hayden

The worldwide prevalence of dementia has exceeded historical predictions, having reached 46.8 million affected individuals in 2015 with these numbers expected to double in the subsequent 20 years to come. Furthermore, incidence rates of dementia significantly increase with advancing age. Approximately 2% of those affected are under the age of 65, with prevalence rates doubling every 5 years thereafter (Prince, Wimo, Guerchet, Ali, & Wu, 2015). There is also well-documented financial and social costs for the burgeoning population of Alzheimer's disease and other forms of dementia, with predicted estimates reaching $1 trillion in US dollars in 2018 (Wimo et al., 2017).

These neurodegenerative diseases are defined by their varying cognitive, psychological, and behavioral symptoms. The complexity in management of such issues is further confounded by the evolution of dementia symptoms inherent over the course of illness. Further challenges to effective management of the behavioral and psychological symptoms of dementia (BPSD) include the heterogeneity of these factors that span the course of illness. The psychological issues inherent in the prodromal phases, including preclinical dementia (PCD) and mild cognitive impairment (MCI), can encompass symptoms of depression as well as variants of anxiety (Caselli et al., 2018), which may evolve to grief. There are also challenges of adjusting to cognitive change in early-stage dementia. These issues are distinct from those faced in mid- to late-stage dementia (Cerejeira, Lagarto, & Mukaetova-Ladinska, 2012; Muller-Spahn, 2003), where behavioral issues such as agitation and noncompliance with care or increased risk of falls increases with the evolution of cognitive decline. Consequently, the form of assessment and the interventions required for BPSD must evolve across the disease course. Although pharmacological interventions may be effective in managing some of the cognitive, psychological, and behavioral symptoms of dementias and their prodromes, greater focus upon non-pharmacological interventions including psychological and behavioral is important in order to minimize the limitations and negative side effects experienced by utilizing only pharmacological treatments (Oliveira et al., 2015). This chapter will focus upon non-pharmacological interventions across the course of dementia from prodromes to late-stage illness.

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Psychological Factors of Dementia Prodromes

The prodromes of various forms of dementia, including preclinical dementia (PCD – prior to the presence of objective evidence for cognitive impairment) and mild cognitive impairment (MCI – objective evidence for cognitive impairment is present without meeting full diagnostic criteria for dementia) may present with distinct psychological issues that need to be distinguished from future disease progression. For example, symptoms of depressed mood and anxiety may be in response to emerging cognitive issues. A recent study of personality factors in PCD and MCI suggests an increase in neuroticism and decreasing openness along with subclinical indices of psychological factors including somatization, depression, anxiety, irritability, and aggression which were opined to be intrinsic to emerging disease as these issues were identified prior to the communication of change from PCD to MCI status (Caselli et al., 2018). These authors conclude that there may be a relationship between such psychological factors and prior findings of preclinical memory decline which precluded predicted diagnosis by 15–20 years.

Such findings affirm the need for comprehensive non-pharmacological approaches of care for this prodromal population. There is a growing public access to information about dementia and their risk factors, and although such information can certainly be of benefit, lack of regulation (e.g., online information) may place consumers accessing the information at risk for increased anxiety and/or misinterpretation of risk factors (Lawless, Augoustinos, & LeCouteur, 2017). Thus, it is important for clinicians addressing PCD and/or MCI populations to query perceptions of cognitive status and risk, as well as to provide evidenced-based psychoeducation in order to mitigate the emergence of anxiety or depression in anticipation of future dementia.

Regardless, in clinical practice, depression and anxiety are significant confounds to the clinical presentation of MCI populations. Although, historically, depression has been the focus of preclinical dementia care (McAllister, 1983), an emerging literature (Rozzini et al., 2009) supports the predominance of anxiety in this heterogeneous group. Anxiety is certainly known to be prevalent in aging populations with estimates of up to 15% of adults aged 60 and over experiencing symptoms meeting the criteria for anxiety disorder (Tampi & Tampi, 2014), with subclinical anxiety symptoms presenting in an additional 15–20%. Thus, it will also be important for clinicians to provide undiagnosed populations such as those with PCD or MCI who are presenting with concerns for cognitive change with information about the other possible contributing factors, including anxiety that may impact cognition, apart from the neurodegenerative process. Discussion of the cognitive impact of mood factors, as well as the normal course of aging upon cognition, must become a component of clinical care within the prodromes of dementia, along with any discussion of dementia risk factors.

Complicating diagnostic specificity within the prodromal phases of dementia is the relationship of anxiety in later life, which can be associated with some degree of cognitive impairment (Beaudreau & O'Hara, 2008). As the profile of cognitive performance is the criteria upon which diagnosis of most forms of dementia depends, it is critical to formally evaluate these psychological factors in conjunction with the formal assessment of cognitive function, which is more standard in the diagnostic process of dementia care. Ideally, this would take the form of a comprehensive neuropsychological evaluation including objective measurement of all aspects of cognition (e.g., overall intellect, attention, visual/verbal memory, visual-spatial skills, executive functions), as well as a full objective evaluation of mood and personality (e.g., symptoms of depression, anxiety, somatization, mood stability, personality traits). Such an objective assessment, in conjunction with a semi-structured clinical interview, provides greater specificity of cognitive deficits in the context of psychological factors.

One of the most clinically relevant distinctions in the evaluation of mood issues within prodromal populations is the differentiation of reactive anxiety from primary form of anxiety. Reactive anxiety is anxiety in response to or in anticipation of the consequence of measurable cognitive decline, whereas primary form of anxiety is anxiety that may be casually related to cognitive change. However, the paucity of formal research on anxiety within the PCD and MCI groups, as well as in dementia in general, remains a barrier to further understanding. Some studies suggest anxiety as a risk factor for conversion to dementia (Gulpers et al., 2016) and may represent the reactive anxiety group cited above, with anxiety emerging most often in response to specific cognitive change experienced by the affected individual. Other studies have not replicated this finding (Devier et al., 2009), suggesting a possible primary anxiety group contained within MCI populations, where the anxiety is contributing to perception of cognitive change rather than in reaction to objective cognitive decline. Such equivocal findings in the area of anxiety in PCD and MCI reflect the complexity of this psychological factor within this population, which may simply reflect a diversity of factors contributing to the presenting anxiety, such as intolerance of uncertainty (i.e., as experienced within the often prolonged diagnostic process), intolerance for change (i.e., as experienced with any change in cognition for MCI), or anticipatory worry (i.e., related to expected consequence of cognitive change and/or in anticipation of future disability related to dementia).

Appropriate identification and treatment of anxiety are required to improve diagnostic specificity in MCI, which may facilitate prediction of conversion to dementia. Cognitive behavioral therapy (CBT) has proven to be one of the most effective means of managing anxiety both for general and MCI populations. However, modifications to standard protocol approaches for such treatment may be required to accommodate objective cognitive compromise present in MCI groups. Such modifications would include the need for increased repetition of information and exercises conducted within this form of psychotherapy. Such treatment modifications would ideally be informed by the aforementioned comprehensive neuropsychological evaluation of cognitive strengths and weaknesses to ensure accurate compensatory strategies embedded within any form of psychological treatment are provided.

With such support, individuals within the MCI group may be better able to cope with the uncertainty of future diagnosis. In addition, stabilization of anxiety symptoms would aid more accurate cognitive evaluation for diagnostic purposes. Unfortunately, formalized anxiety treatment is not a common component in outpatient dementia clinics. However, integration of psychological treatment such as CBT interventions into the standard practice of dementia care would be more likely with further research into the efficacy of such forms of treatment with focus upon the potential for increased diagnostic specificity and perhaps prediction of conversion.

It is important to note that increased use of health-care resources and functional disability are inherent in anxiety populations, in general (Roy-Byrne, 1996). This would be no different for those in the prodromes of dementia, which only serve to increase health costs further in this area. In the dementia field where diagnostic uncertainty can remain for several years prior to meeting formal criteria, it is essential that health resources be more effectively utilized with individuals presenting with primary anxiety being treated through different care pathways such as via psychiatry or psychology resources rather than through neurology.

In addition to addressing the psychological issues noted above, the role of neurorehabilitation in mitigating cognitive issues has been a significant focus within the public domain for aging populations, including dementia and their prodromes. For PCD and MCI populations, computer "brain games" based upon theories of neuroplasticity are primarily involved. Neuroplasticity is a theory of generation of neural pathways through cognitive activities, thought to improve neurological resilience. Although there is evidence of the benefit of such programs on targeted cognitive skills, there is no consistent evidence of such skills being generalized to daily function (Sherman, Mauser, Nuno, & Sherzai, 2017). Therefore, in discussing these neurorehabilitation programs, which often have associated costs such as through websites or clinicians providing such programs, it is important to emphasize the lack of evidence for reversal of cognitive symptoms or disease. This informed approach to such intervention is critical to ensuring the engagement in such programs does not become predatory or misleading for this vulnerable population. Further research about the use of online tests and quality of online articles about Alzheimer's disease is warranted as there are ethical issues in the unregulated industry of neurorehabilitation of dementia (Robillard & Feng, 2016; Robillard et al., 2015). Ongoing formal review and psychoeducation are arranged within clinical populations.

Behavioral and Psychological Symptoms in Early-Stage Dementia

The psychological factors of early-stage dementia may include continuation of anxiety symptoms present within the PCD and MCI groups. However, following formal diagnosis, additional psychological factors such as grief, frustration, and anger may emerge and require distinct intervention and/or support. These resulting psychological factors are often in response to greater awareness of cognitive change and the consequent challenges of functional capacities during early-stage illness. In addition, for some individuals, fear regarding anticipated future decline (e.g., cognitive, functional) can result in excessive preoccupation and/or rumination, which in turn results in emotional discord or anxiety. Such issues frequently respond well to direct discussion regarding the nature of the fears and frustration within the context of an established clinical relationship. It is critical for health-care providers to have sufficient evidenced-based education and emotional support in addressing such concerns early and directly, should the affected individual express such forms of distress. This has been somewhat formalized in the concept of dementia care pathways, which provide frequent review and involvement of psychosocial interventions to mitigate distress inherent in the uncertainty of future care for affected individuals and their families (Samsi & Manthorpe, 2014).

Clearly then, it is critical for these early-stage dementia populations to have access to sufficient and individualized psychoeducation and support during the period of adjustment to diagnosis. Standard care for this stage of illness includes various forms of support groups for the individuals with early-stage dementia and their families (Logsdon, McCurry, & Teri, 2007), with literature reflecting evidence of improved quality of life and decreased family conflicts as a result of interventions. In many areas, such support groups are available through the Alzheimer Society which appear to be an effective means for provision of necessary psychoeducation and support required at this stage of illness. However, a proportion of this early-stage dementia group experience psychological distress of a degree that requires more directed treatment than can be provided in support group formats alone. Recent review of psychotherapeutic interventions in this group by Cheston and Ivanecka (2017) suggests the most effective is short-term group psychotherapy following diagnosis of dementia which affirms benefit for group psychological intervention formats for these early-stage dementia populations.

Nevertheless, there are certain affected individuals who are uncomfortable or unwilling to engage in the group format of psychosocial interventions, and this may place such individuals at risk for mood symptoms due to avoidance of support groups or group therapy formats. One recent Norwegian study of adapted CBT for individuals with early-stage dementia reflected benefit to everyday living and life satisfaction (Saubo, Misvaer, Tonga, Kvigne, & Ulsetin, 2017). Also, there is evidence of efficacy for CBT in early-stage dementia for such issues, which can be combined with cognitive rehabilitation techniques. Although the latter has not demonstrated significant impact on everyday activities of the participants, positive impact on life satisfaction was evident in one study (Kurz et al., 2012). Other forms of psychotherapeutic intervention, including validation therapy, reminiscence therapy, and supportive psychotherapy, have also demonstrated positive benefits although formal studies tend to be based upon small sample groups to date (Birtwell & Dubrow-Marshall, 2017; Gatz et al., 1998). Certainly, the area of efficacy of a variety of psychotherapeutic interventions with early-stage dementia requires further investigation.

In addition to various formats for intervention for psychological factors in early-stage dementia, this phase of dementia can result in behavioral issues consequent to evolving cognitive change. Consequently, it is critical for behavioral modification and cognitive adaptation techniques to be implemented with an understanding of the individual's cognitive profile including cognitive strengths and weaknesses which can be identified through formal neuropsychological assessment, as discussed earlier. These behavioral interventions may be further supported through the use of assistive devices for symptom management, which may be provided through occupational therapy service, with evidence in literature of demonstrated benefit for both patients and families (Gitlin et al., 2010).

Evolving Behavioral Issues in Mid- to Late-Stage Dementia

As dementia progresses, the affected individual's capacity for insight regarding the nature of their condition tends to fade, which often results in decreased identifiable psychological distress in response to disease symptoms. Less demand for psychotherapeutic interventions to address anxiety or grief responses is created, requiring a shift to management of the cognitive and behavioral issues, which are directly impacting the provision of care. However, the increase in objective cognitive impairment, in turn, increases risk for behavioral disturbance (see Fig. 22.1).

During these stages of dementia, psychoeducation for caregivers regarding cognitive factors that may be contributing to problem behaviors is critical in formulating specific behavioral interventions. For example, it would be helpful for caregivers to understand behaviors typical of the type of dementia experienced by the affected individuals. Behavioral observation of the affected individuals and of caregiver responses in conjunction with administration of cognitive screening measures (e.g., MMSE, 3MS, MoCA, Severe Impairment Battery) to those that remain accessible for such formalized testing may be explored. Such an approach allows for understanding of the context of behavioral challenges, including environmental triggers, which may be contributing to behavioral issues. In this context, it is critical to educate caregivers to distinguish affected individuals' behavioral responses to environment triggers and how they differ from the psychological issues that were previously present in response to grief, anxiety, or depression for earlier-stage illness. Examples of possible behavioral responses triggered by cognitive changes are provided below (see Table 22.1). With greater understanding of these triggers, individualized and appropriate behavioral interventions may be provided in nursing or caregiver settings.

At this stage of illness, there has also been demonstrated positive benefit on behavior in SOMC dementia populations from alternative non-pharmacological treatments including interventions such as art or music therapies (Svansdottir & Snaedal, 2006; Tucknott-Cohen & Ehresman, 2016). It is important to recognize, however, that once again, studies have been limited in this area. Also, for some forms of dementia such as some variants of frontal-temporal dementia, exposure to such interventions may result in increased behavioral disturbances due to overstimulation. Individualized review and treatment planning are essential in determining the outcome of such interventions.

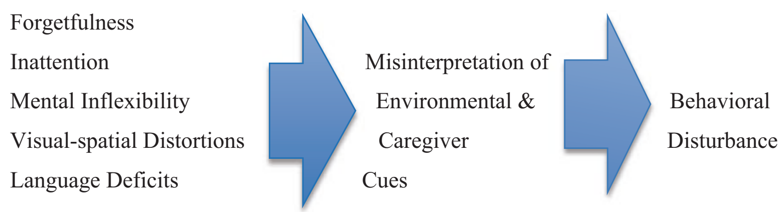

Fig. 22.1 Contributors to behavioral disturbance in dementia

Table 22.1 Behavioral issues and their cognitive triggers

Cognitive triggers	Behavioral responses
Difficulty expressing needs verbally	Frustration Aggression/agitation Depression Anxiety
Difficulty comprehending instructions	Rule noncompliance Problems following care direction Fear Suspiciousness
Problems with transitions/cognitive shifting	Agitation Withdrawal Transient confusion Sporadic forgetfulness
Forgetfulness	Rule noncompliance Repetitiveness Lack of continuity in activities of daily living
Attentional problems	Overstimulation Forgetfulness Poor persistence
Visual-perceptual problems	Fall risk Getting lost Misperception of visual cues

Family Issues in Dementia Care

There is well-documented evidence of increased risk for psychological issues in caregivers, which, in turn, can have negative impacts on care provided to the affected individuals. Meta-analysis of psychological interventions such as CBT with unpaid caregivers has found to have significant benefit for caregiver groups (Brodaty, Green, & Koschera, 2003; Kwon, Ahn, Kim, & Park, 2017). Furthermore, support groups for families and caregivers have demonstrated benefit as well although the benefit for these various psychological interventions tends to be domain specific, addressing only components of psychological needs inherent in caregiving (Sörensen & Conwell, 2011). The research identified a need to find at-risk caregivers with greater specificity, as well as a need for understanding biological and social contributors to the caregiving experience.

Clinicians must recognize the heterogeneity of caregiver responses to those affected by dementia in mid- to late-stage illness. The heterogeneity of responses results in additional challenges for the provision of appropriate and effective interventions. Of considerable importance is the provision of psychoeducation regarding the nature of symptoms experienced by their loved ones. An individualized approach based upon objective evidence of cognitive and/or behavioral issues reflected in objective testing, such as neuropsychological evaluation, cognitive screening, and behavioral measurement, would be most effective in increasing families' understanding of dementia symptoms, associated interventions, and their functional limitations. Providing evidenced-based education regarding dementia and behavioral challenges and clinician understanding of any misperceptions are essential.

Future Research and Practice Directions

Although this chapter certainly does not represent a comprehensive review of all non-pharmacological interventions for behavioral and psychological issues in dementia, the primary theme of this review suggests the need for coordinated plans for psychological care to be integrated into standard care practices for those with varying stages of dementias and their prodromes. Formal objective cognitive evaluation throughout the course of the disease, as long as accessibility for such testing remains, can take the form of comprehensive neuropsychological assessment in the prodromal and early stages of illness. As dementia progresses, formalized cognitive evaluation may be limited to screening tasks and/or behavioral observation. Regardless, information from mapping cognitive skills for affected individuals can inform non-pharmacological interventions such as CBT and support-based therapies. These therapies are aimed at decreasing emotional distress within the prodromal and early phases of dementia and providing the required behavioral interventions and cognitive compensatory strategies as the disease progresses.

To support such integration of services, there is a need for further exploration of the impact of anxiety or other mood/personality factors within the prodromal phases of dementia (PCD & MCI) to determine the relationship with future conversion to dementia. Greater specificity of subtypes of anxiety symptoms is also required in these groups. Additional research, including longitudinal methodologies into the efficacy of neuro- or cognitive rehabilitation programming for dementia and its prodromes, is required to ensure their appropriate use with this vulnerable population. Furthermore, ongoing investigation of ethical issues within this unregulated industry is required. Finally, longitudinal intervention studies to determine the impact of psychotherapeutic treatments (e.g., CBT, behavioral interventions, cognitive compensatory coaching) are required, both independent of and in combination with pharmacological treatments.

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23 Assessment of Competence in Older Adults

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Overview

Assessing mental competence is an issue of increasing significance in today's "age of aging." There are worldwide shifts in demographics as life expectancies increase (de Grey, 2015; He, Goodkind, & Kowal, 2016; Magnus, 2015; Nikolich-Zugich et al., 2016; Pardasani, 2018; Soliman & Hall, 2015). These shifts will likely parallel an increase in court challenges to testamentary competence due to increased wealth transfer accompanying the aging population (Peisah & Shulman, 2012). An enhanced emphasis on ethical and responsible professional practices surrounding fiduciary duty in the legal and health fields virtually ensures a greater focus on best practices in delivering mental competency exams in older adults. Indeed, changing demographics and increased societal pressures to cope with an aging population (Kincannon, He, & West, 2005; Magnus, 2015) have triggered a lively public, professional, and scientific debate on aging and associated challenges. These concerns include decisions surrounding the transfer of wealth via wills and estate planning; increased demands on caregivers, hospitals, and care facilities in working with people experiencing cognitive decline, as well as those with brain injury and chronic illnesses; increased longevity of persons with dementia; and a high proportion of elderly workers and professionals in the workforce. For instance, older adults (those over the age of 65) now account for 18.8% of workforce employees in the Unites States (Desilver, 2016). As a result, social and economic perspectives on retirement are changing, and proportionally older people, ranging from "blue collar" to professional status, are remaining in employment markets longer.

Together with higher rates of survival from serious injuries and illnesses with potential cognitive effects, such as traumatic brain injury and neurodegenerative and cerebrovascular diseases (Morley, 2017; Tsiouris, Patti, & Flory, 2014; Waljee, Greenfield, Dimick, & Birkmeyer, 2006; Zaloshnja, Miller, Langlois, & Selassie, 2008), we anticipate an increasing prevalence of cognitive and associated functional disability in the workforce and in the general population. As a consequence of these medical and social forces, an inevitable increase in concern has emerged regarding vulnerability of persons with cognitive decline to exploitation, an unsurprising growth in the need for care and support, escalating associated costs, and increased demands on health and

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legal systems (Darba, Kaskens, & Lacey, 2015; Holmerova, Hort, Rusina, Wimo, & Steffl, 2017; Swedish Council on Health Technology Assessment, 2008). With escalating demands for competency assessments, a lack of clear evidence-based guidelines and standards for these assessments has the potential for significant harm to older adults, their families, and the public. Strides have been made in providing guidelines for some competency assessments (American Bar Association Commission on Law and Aging & American Psychological Association, 2008; Spar & Garb, 1992). However, to date, evidence-validated practice standards that extend across the most common types of these evaluations are missing. Despite this absence (Sousa, Simoes, Firmino, & Peisah, 2014) and the high social, ethical, and philosophical implications of the absence of validated competency practice guidelines (Masand, Bouckoms, Fischel, Calabrese, & Stern, 1998), psychologists, physicians, nurses, and social workers are increasingly being called upon to conduct assessments of competence in a wide range of healthcare, legal, and work capacity contexts. Yet, competency evaluations are complex and challenging. Evaluated constructs across these assessment contexts are interchangeably used and variously defined and measured. Because these constructs involve a wide range of cognitive, affective, and physical capacities, they often require detailed, comprehensive, and focused assessment depending on the domain examined and may have far-reaching, life-changing, and even life-ending consequences for the person being evaluated (Marson, Hebert, & Solomon, 2011; Moberg & Gibney, 2005; Schultz & Greer, 2016; Sullivan, 2004a; Weinstock, Leong, & Silva, 2003; White & Lofwall, 2015). Finally, generating consensus-based practice guidelines might prove difficult given the lack of agreed-upon standards or procedures for competency assessments (Kocha, 2013), which likely reflects underlying conceptual and practical differences among competency domains.

Practical challenges abound when attempting to conduct comprehensive and valid competency assessments. First, competencies vary on an intraindividual basis. Individuals may not be able to competently perform one kind of task, but this does not necessarily imply that they are incapable of performing other tasks (Kontos, Querques, & Freudenreich, 2015; Soliman & Hall, 2015). For instance, an individual may not be competent to handle their finances, but may be sufficiently competent to make decisions with respect to his/her health (Weinstock et al., 2003). Even when attempting to assess a single specific competency domain, a person's capacities can still vary across relevant tasks, the context within which various competencies are being demanded, and the moment in time in which the skill set is assessed. Within the domain of legal decision-making capacity, for example, competency to sign a will, make medical decisions, or provide informed consent for research participation may involve levels and types of competence markedly different from competence to stand trial or testify in a forensic context (Schwartz & Mack, 2003).

Second, multiple assessment scales with differing psychometric properties may be treated as equivalent measures or otherwise unitized by the clinician. For example, screening measures of general cognitive functions, most notably the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975), are acknowledged as being relatively insensitive to subtle cognitive decline, yet their use accompanies many capacity assessments and may be disproportionately relied upon for conclusions surrounding the domains surveyed (e.g., attention, memory, orientation) (Billick, Perez, & Garakani, 2009; Guilmette & Krupp, 1999). Indeed, multiple objective measures may be needed to properly assess each of these areas of cognitive functioning. Third, a lack of agreement exists in the research literature regarding how some objective measures and interview processes might relate to real-life functioning (i.e., ecological validity), how to integrate assessment or clinical findings with respect to capacity to perform certain tasks, or which measures best discriminate between a competent or incompetent individual in a particular respect (Moberg & Gibney, 2005). Even with the use of multiple standardized cognitive measures, some may not properly capture an individual's real-world functional capacity. More recently, improved frameworks for competency assessment are beginning to be reported in aggregate form, including (1) findings and guidelines with respect to use of standardized assessment measures for decision-making ability and (2) findings from standardized assessments for advanced-care planning guidelines (McPherson & Koltai, 2018). Fourth, inconsistent assessment practices by health professionals (Moberg & Gibney, 2005; Sullivan, 2004a), within neuropsychology and across allied health professions, have likely arisen because of a dearth of ecologically valid standardized testing procedures. Differing assessment methods and situational criteria for competency assessments exist (Schwartz & Mack, 2003; Whiting, 2015). To boost fairness and objectivity of findings and provide measurable outcomes more amenable to proper post hoc analysis, competency assessments need (1) consistent application of clearly articulated conceptual frameworks when designing an assessment, (2) increased use of standardized procedures, and (3) development of valid and comprehensive assessment batteries. For example, the use of standardized tests that are better validated to detect subtle cognitive deficits in older adults (such as the Montreal Cognitive Assessment (MoCA)) (Nasreddine et al., 2005) can provide a model for other screening assessment tools. Moreover, educating expert professionals on how to properly construct and apply valid and fair competency assessment approaches will minimize inconsistent assessment practices that may have precarious validity, reliability, and fairness problems.

In an attempt to move the field of competency assessment forward, the present discussion will explore the critical factors involved in assessing competence in older adults; review the high-stakes nature of competency assessments; and propose an assessment framework for healthcare professionals tasked with determining if an older adult is capable of understanding a task or procedure, performing a job, or making a high-gravity decision. Further elaboration of the important factors surrounding best practices in competency assessments and future directions for assessment are also provided in later sections of this chapter.

A Definition of Competency and Its Functional Components

In simplest terms, *competency* is the mental and cognitive capability required to rationally execute a legally recognized act (Bisbing, 1998). Determining competency is a legal issue and typically decided by a judge in legal proceedings. *Capacity*, which is frequently conflated with *competency*, is best conceptualized as the underlying measurable skills that constitute the ability to perform a task *competently* or make decisions (Demakis 2012b). *Capacity*, in a more legalistic sense, refers to an individual's psychosocial abilities to form rational decisions and execute rational behaviors and the individual's ability to understand, appreciate, and manipulate information and form rational decisions. Assessment and decisions related to *capacity* are carried out by clinicians, whereas *competency* is rendered by a judge concerning an individual's legal status (McPherson & Koltai, 2018).

In the assessment literature, competency and capacity are frequently and conversely used (McPherson & Koltai, 2018), yet with different definitions and significant legal implications (Appelbaum, 2007). Neuropsychologists, in turn, often use competency in an undifferentiated way to decide a variety of capacities (Marson et al., 2011). However, differentiating the clinical and legal aspects of competency is particularly important when working with impaired older adults (Moberg & Gibney, 2005) wherein a clear understanding of the scope of the assessment being undertaken is a crucial component of constructing a valid and appropriate evaluation that may profoundly affect an older adult's independence and life (Demakis, 2012a, b). Moreover, decisional capacity is defined as an individual's ability to understand and comprehend treatment information, and to reason, and appreciate the consequences of decisions (American Bar Association Commission on Law and Aging & American Psychological Association, 2008). To this end, several types of associated capacity domains can be highlighted, including testamentary (legal and mental ability to make a will), driving, financial (administer one's estate, manage property, enter a contract, assign power of attorney, make donation), healthcare related (e.g., consenting to a procedure or treatment), mental healthcare related (e.g., level of contact with reality and potential risk to self and others), cognitive (low IQ and difficulty with intellectual and adaptive functioning in contrast to same age cohorts), issues of guardianship and trusteeship (determining the need to assign a guardian or trustee to act on behalf of another), and personal care and independence (Ciccone, 2003; McPherson & Koltai, 2018). Some of these domains are reviewed in detail in the present chapter, in order to highlight the crucial aspects of competency assessments with older adults.

Competency has also been variously defined in other legal or clinical contexts. Civil competency (as opposed to legal competency) involves an individual's capacity to perform a specific act (e.g., consent to a serious surgical procedure or to refuse treatment) or a set of activities such as handling financial affairs in the civil domain (Moberg & Gibney, 2005). Competency to sign a will, legal competence to make medical decisions, or to sign informed consent for a research project is therefore different from competency to stand trial or to testify in forensic contexts (Schwartz & Mack, 2003). It is important to emphasize that, in the context of forensic psychiatric assessments, as well as in consultation-liaison psychiatry, an adult is presumed to be competent unless adjudicated otherwise (Schwartz & Mack, 2003; White & Lofwall, 2015). Moreover, the list of competency domains can be expanded beyond assessment of a person's thinking capacity to include workplace functional capacity, or the ability to perform one's job, which can entail both cognitive and functional abilities. Workplace functional capacity, including fitness for duty, can include decisional capacity but also skill sets in performing specific physical tasks, as well as specific cognitive tasks (involving learning capacity, executive reasoning, judgment and decision-making, the ability to recall and apply expert knowledge base, insight, mental flexibility and adaptability). Deficits in work capacity do not only concern employers and profitability, but may also involve risks to the public and other employees and supervisees. This concern is particularly serious in the context of impact of aging on fitness for duty of safety-sensitive professionals, such as physicians, nurses, dentists, emergency respondents, and airline personnel. Figure 23.1 illustrates the relationship between capacity and competency.

Competency is, therefore, not a unitary construct, in which an individual is necessarily competent or not, "across the board." Competency may or may not cross multiple domains, and the capacity to perform one type of act or decision competently can be present in one domain but may not be present in another. For example, individuals may not be competent to make decisions about investments or their financial future, but fully capable of handling most activities of daily living involving basic calculations and other skills (e.g., preparing food, keeping good hygiene, cleaning their home, purchasing groceries, taking the bus). Even within domains, capacities may vary. A person may not be able to adequately make an informed decision about their psychotropic medications or accepting psychiatric hospitalization, but may be sufficiently

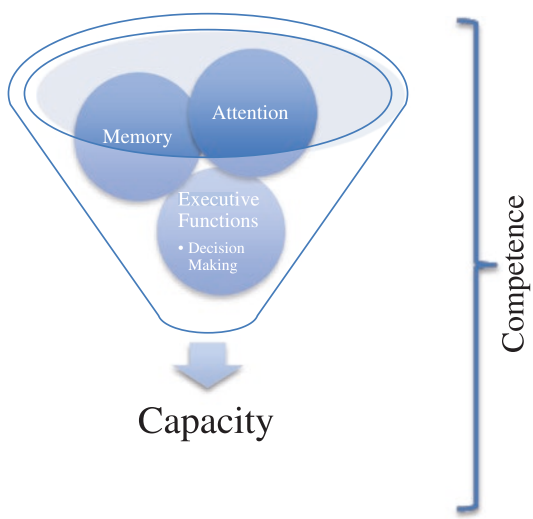

Fig. 23.1 The relationship between capacity and competency: cognitive factors

competent and have the capacity to decide whether to have their leg amputated for therapeutic purposes (Weinstock, et al., 2003). Comprehensive capacity assessments are typically the task of expert clinical neuropsychologists (Moberg & Gibney, 2005), using multimethod approaches, such as rating scales, interview, collateral data, cognitive tests, and review of records. Although neuropsychologists are uniquely prepared to conduct competency evaluations due to their expertise in neurocognitive assessment and psychopathology (Demakis, 2012a, b), a wide range of other healthcare professionals may be called upon to conduct these assessments, including occupational therapists, nurses, social workers, and physicians.

Clinical neuropsychologists and other practitioners conducting competency assessments with older adults must therefore assess a range of specific capacities to tap competence as comprehensively as possible (Ciccone, 2003). Of particular concern is executive functioning, but other cognitive abilities can also decline as individuals age (Persad, Jones, Ashton-Miller, Alexander, & Giordani, 2008). Alterations in competency can occur with or without dementia and in conjunction with, or exclusive of, metabolic or neuropsychiatric conditions (e.g., depression) (Alexopoulos, Kiosses, Murphy, & Heo, 2004; Lockwood, Alexopoulos, & van Gorp, 2002). The pioneering conceptual models of the capacity to consent to medical treatment have continued to inform the basic domains of functioning that must be examined in these assessments (Grisso & Applebaum, 1998). Typically, older adults who are the focus of assessment will need to demonstrate evidence that they are able to appreciate a situation and its consequences, manipulate information rationally, and make an informed decision leading to a rational outcome (being able to reason and weigh options). They must also appear to understand relevant information associated with a decision or action (Schwartz & Mack, 2003) and be able to communicate a decision or choice and/or carry out a task adequately (Ciccone, 2003; Marson et al., 2011).

Specific Factors of Concern for Older Adults in Competency Assessments

The assessment foci of competency appraisal, as outlined above, tend to become more complex when examining an older adult who is, or was previously functioning, at a particular level, but there is now concern that they are less capable in some respect. For example, as a professional or high achiever may demonstrate signs, they can no longer function at this level (Schultz & Greer, 2016) or suffer from psychiatric comorbidities such as mood or anxiety disorders, or substance use disorders, that vary in impact on functioning. High-achieving persons, including some older professionals, may possess a greater degree of cognitive reserves and coping abilities, and may be functioning quite well in some respects, and are thus better able to compensate or even conceal their difficulties when performing more complex duties or tasks. In the presence of subtle cognitive deficits, however, impaired professional judgment may not be immediately observable or otherwise easily detectable and thus could go unnoticed by the untrained eye. There can also be concerns related specifically to the effects of aging and health, and frail persons in particular are at greater risk for exploitation in various contexts (e.g., being at the margins of disqualification from further driving, yet convinced by a sales person to sign a lease on a new car for several years) or being subjected to undue influence from family members (e.g., with respect to control over their finances or disposition of assets). Competency assessments become even more complex when global cognitive decline is suspected, in the case of suspected dementia (Filakovic, Eric, Mihanovic, Glavina, & Molnar, 2011) or related disorders that can cause subtle cognitive impairment and functional deficits. Some deficits might be temporary or reversible, such as when being overmedicated or suffering from the effects of an infection. The variable or diverse nature of the older adult's functioning means that the attending assessor may have to examine and provide conclusions with respect to competency across a wide range of cognitive, emotional, and functional domains and in the context of diverse cultural and familial influences.

Competency Domains Relevant to Older Adults

What follows is a brief outline of some of the more important domains of competency assessment relevant to older adults, including mental health competency, cognitive competency, and other important functional competencies. In the initial planning assessment stages, it is crucial to establish what type of competency is being evaluated and ensure that all parties involved agree on what questions will be addressed. For instance, it can be difficult to differentiate what constitutes a mental health versus financial competency assessment when psychiatric conditions are added to the mix of concerns that center on cognitive functioning. Although the referring party may be concerned about the older adult's mental health, they may need the information to determine if the client is capable of signing a will or selling property. Ultimately, the purpose for requesting the assessment will need to be closely examined, and any confusion about one's role as examiner clarified in dialogue with the referring agent before starting the actual evaluation process (Purser & Rosenfeld, 2014). Concerns pertaining to competency in older adults often arise in the context of disease processes associated with aging that impact cognition, such as Alzheimer's disease, vascular dementia, and stroke, but may also include the impact of physical frailty, pain, and other disease processes (e.g., aphasia due to dementia or stroke), as well as severe mood or psychiatric disorders, and traumatic brain injury. In all of the competency assessment scenarios presented below, mental health examinations, including structured clinical interviews and the completion of questionnaire measures, intellectual assessment, and more advanced cognitive testing, are likely to be involved (Kutcher, Chehil, Cash, & Millar, 2005).

Mental Health Competency

The loss of capacity to make decisions for oneself and to control one's life is of particular importance to older adults and those who care for them. Frailty and declining health, changes in cognition with age or disease processes, vulnerabilities associated with poverty or low income, and the potential for exploitation at the hands of unscrupulous others can leave older adults exposed to distress and mental health problems that can rapidly overwhelm decisional capacity (Peisah & Shulman, 2012). Concern about potential abuse, lack of legal protection, and poor oversight of the guardianship process has resulted in legal and policy changes to protect the elderly and others who may lose their independence and the right to make decisions (Demakis, 2012a, b). A determination of mental health competency may become necessary when older adults are no longer able to care for themselves or their affairs, when they refuse help, and when there is a possibility of harm. Mental health competency issues often arise in the context of determining healthcare decision-making capacity, when concerns develop about personal care and independence capacity, or in the context of financial and testamentary capacity. In particular, such assessments are required if there is a safety concern or when competency needs to be demonstrated in a legal context, such as if someone wishes to contest a prior finding of mental incompetence or needs to complete a will preparation (Peisah & Shulman, 2012).

Common conceptualizations of mental health include both the presence of well-being and the absence of a mental disorder. The ability of an individual to make decisions independently, the capacity to demonstrate intact reality contact, and an absence of potential significant risk to self and others due to poor mental status, judgment, or capacity for self-care all contribute to mental health. Once competence is being investigated, impaired mental health can result in a range of potentially life-changing outcomes, ranging from nonintrusive intermittent supervision by family or other caregivers to commitment to a hospital or care facility against one's will and loss of independence and freedom to make decisions for oneself. In these latter scenarios, a judge or other appropriate legal panel may assign the affected elderly person to adult guardianship, wherein the Court assigns the guardian the duty and power to make decisions for a person who has been adjudicated incompetent (Demakis, 2012a, b).

A typical case scenario would involve an elderly person living in isolation or otherwise withdrawn from social contact, exhibiting increasingly depressed mood, and beginning to experience difficulties with self-care or fulfilling normal daily routines, such as cooking, shopping for food, and cleaning one's home. In such circumstances, it is common for family, friends, and neighbors to express concern to a social services agency. A social worker's visit may result in discovery of a home in chaos and an elderly individual who appears depressed, disengaged, and without the ability to express an adequate plan for addressing his/her needs. After contacting family, the decision may be made to have the elderly person attend the hospital for further mental health assessment and examination of the capacity to function independently and care for themselves.

Cognitive Competency

Thinking capacity is integral to everyday functioning and the ability to get by in the world independently. It includes tasks ranging from simple decision-making around dressing appropriately for the weather to complex tasks tapping the highest levels of executive functioning, such as planning for one's financial future or performing complex job tasks. Any competency assessment must therefore involve gauging the level of cognitive demands present within the domain being examined and selecting the appropriate level of cognitive and functional evaluation. Cognitive decline in older adults is often associated with decreased independent functioning (Plehn, Marcopulos, & McLain, 2004). Cognitive competency can be impacted by a history of intellectual or developmental disability, or neurodegenerative disorders, such as dementia and related disorders, mental health disorders, medical conditions, and medications. Difficulties with reasoning, judgment, and decision-making adversely affect independent functioning (Lezak, Howieson, Bigler, & Tranel, 2012; Strauss, Sherman, & Spreen, 2006). It is important, however, not to automatically equate disease processes, such as dementia, or psychiatric diagnosis, with cognitive incompetence. Given the progressive nature of illnesses such as dementia, individuals in the initial or prodromal stages of dementia or Alzheimer's disease may exhibit signs of mild cognitive impairment (MCI) (Dubois et al., 2014; McKhann et al., 2011; Scheltens et al., 2016) but may still be independent and able to carry on day-to-day activities. As the illness progresses, worsening of decision-making and self-care capacity typically occurs (Bertrand et al., 2017; Hegde & Ellajosyula, 2016). Alternately, an individual with a severe mental illness, such as schizophrenia, may have reduced capacity at one point in time, but, with treatment, this situation may change (Peisah & Shulman, 2012). Decline in cognitive functioning can lead to impairment in activities of daily living (ADLs) (Atienza-Martin et al., 2013; Willis, 1996), financial capacity, healthcare decision-making, testamentary capacity, or driving capacity. Also, as a disease progresses, the impact on caregivers (or knowledgeable proxy) and additional supports increases. Notably, included in the risks associated with worsening of decision-making capacity over time in individuals with dementia-like neurodegenerative illnesses is an increase in the potential for elder abuse (Dong, Simon, Rajan, & Evans, 2011). Additionally, individuals with compromised decision-making capacity often refer to others for decision-making (Kim & Kjervik, 2005), further adding to risks of abuse, neglect, or exploitation.

A cognitive capacity assessment will need to be a part of most financial, healthcare decision-making, testamentary, or personal care and independence competency evaluations. Such assessments require the measurement of several cognitive domains, including the ability to understand related concepts, memory functioning, verbal expressive language, the ability to articulate rational choices, and executive functioning (such as understanding concepts, logical reasoning, mental flexibility). There is significant overlap between cognitive and mental health competencies, wherein problems such as depression, anxiety, and weak reality contact can impinge on mental focus, memory, and the ability to initiate tasks, among other cognitive processes. The overlap can be evident on many tasks particularly sensitive to mental health effects, including computations, understanding transactions, planning or decision-making, and rendering judgment (Karlawish, 2008; Wang & Ennis, 1986). A typical case scenario associated with a potential cognitive competency assessment might involve an older adult presenting as increasingly disoriented in conversations, less able to process and retain information, and having trouble performing basic math operations (particularly surrounding purchases and financial transactions). Notably, acute illnesses, such as pneumonia or urinary tract infection, can lead to increased confusion and hospitalization. Healthcare staff and family may then request initial and follow-up testing to determine if the older adult's confusion will clear or if they are exhibiting signs of cognitive decline.

Health and Medical Decision-Making Competency

Health and medical decisions are among the most ethically sensitive and fraught areas in the medicolegal domain. Medical and healthcare staffs are often the first to raise such concerns, as they may be the first objective observers to spend time with an elderly patient. In seeking consent to perform a procedure, contact relatives, or set up services, the attending professionals may be concerned that the elderly patient does not fully comprehend the process involved in making these decisions. A wide range of medical conditions can potentially affect one's competence to give consent in these respects, including stroke, brain injury, dementia, and affective disorders, such as severe depression. Physical health conditions can also affect one's competence to give consent, including conditions such as brain tumor, metabolic dementia, Parkinson's disease, normal pressure hydrocephalus, liver or kidney disease, disruptions in hormonal functioning, infections, developmental disorders such as Down's syndrome, neuropsychiatric conditions (e.g., late-onset schizophrenia and other psychotic conditions involving hallucinations and delusions), as well as delirium, hypoxia, and toxic metal exposure. Appraisal of the patient's health and competence to consent for medical procedures or treatment can become crucial in maintaining a patient's care (Appelbaum, 2007) and possibly assist in determining additional treatment needs that could improve medical decision-making capacity or quality of life. Moreover, the capacity to make medical and other health decisions is closely related to the capacity for independent living and to one's cognitive capacity. Health decision-making involves patients being able to appreciate their circumstances and, in particular, their medical condition and important symptoms; to retain and understand information given to them (particularly by physicians and other healthcare professionals); recognizing the probability and importance of potential risks versus benefits involved in making a treatment decision; weighing potential costs and benefits of any alternative choices; the ability to communicate a choice; and being able to appreciate the probability that the identified treatment or care goal will in fact be achieved (Palmer, Savla, & Harmell, 2012).

A typical case scenario involving medical and health decisions might emerge from an older adult being admitted to a critical care unit for significant treatment such as surgery, followed by possible admission to long-term assisted living facility. On admission, the attending medical staff may notice that the patient exhibits confusion in conversation, putting into question the patient's ability to make reasoned medical decision. Given that medical staffs are ethically and legally required to obtain informed consent before proceeding, the family may be brought in to assist in understanding the elderly person's situation. A referral is then typically prepared for neurocognitive assessment, to assist in determining if the patient will be able to make a sound medical treatment decision or will require some form of adult guardianship.

Competency in Personal Care and Independent Living

Elemental to self-care is being able to function independently and perform common activities of daily living (ADLs), determined by individual's ability to safely live on their own or with some degree of assistance (Edemekong & Levy, 2018; Rockwood, 2007). Basic ADLs include the cognitive and motor skills needed to cope with tasks, such as eating, bathing, getting dressed, toileting, transferring and continence, and being able to recognize hazards and dangers at home and in the community (Everhart, Lehockey, Moran, & Highsmith, 2012). Depending on the individual's living context, the examiner may be concerned with issues beyond basic ADLs. Termed instrumental activities of daily living (IADL) (Graf, 2008), these include more advanced and difficult daily tasks, such as food preparation, housekeeping, laundry, shopping, ability to use a telephone, transportation, taking medication independently, and the ability to handle basic finances. The importance of assessing IADL capacity becomes manifest in contexts where the older adult must be wholly or mostly self-sufficient.

Being able to complete most basic and instrumental ADLs requires the capability to perform those identified specific tasks reasonably skillfully and reliably. Over the longer term, the fully independent client must be able to exhibit the ability to secure shelter, food, and clothing and maintain a safe and secure environment. Additional analysis of older adults' insight into their strengths and weaknesses, history of self-care, judgment and ability to make decisions about self- and medical care, and mental health status is often the focus of evaluation (American Bar Association Commission on Law and Aging & American Psychological Association, 2008), particularly when conducting long-term care planning. Thus, personal care and independent living assessments frequently involve assessment of financial and healthcare decision-making competencies.

Competency assessments focused on independence and daily living skills typically include direct appraisal or observational ratings from a reliable informant of ADLs, direct assessment of money management skills, querying if the older adult is able to know how and when to request medical treatment or emergency help, and inquiring about social and community functioning (Everhart et al., 2012). Poor performance on measures or observations of a single ADL task may or may not be an indication that a person is incapable of independent living. It is the cumulative effect of multiple deficits, rather than a specific impairment, that often renders an individual incompetent with respect to ADLs. There is a range of scales of independent living that can be employed for competency assessments; evidence shows that such scales may have better predictive value than indirect cognitive measures alone (Quickel & Demakis, 2013). However, decline in cognitive functioning is associated with a decrease in independent functioning (Plehn et al., 2004). An examiner must differentiate between the effects of cognitive decline and those that might be arising from a physical disability (Everhart et al., 2012). In the latter instance, individuals struggling with self-care may be able to retain their independence if they are provided with physical assistance or environmental adaptations. Notably, core basic personal care skills do not necessarily involve a significant higher-order cognitive capacity. Rather, most basic ADL skills are overlearned, procedural in nature, involve a low cognitive load, and are carried out rather automatically (unless physical disabilities restrict the individual). Indeed, personal care performance is relatively resilient to neurodegenerative processes and may not be readily evident early in an individual's path to cognitive decline. The completion of observational and/or self-information rating scales of ADL capacity is therefore recommended (American Bar Association Commission on Law and Aging & American Psychological Association, 2008). Additionally, although global measures of cognitive capacity are correlated with declines in ADL capacity, many specific neurocognitive measures are not. Specific assessment of visual-spatial skills which, in turn, is associated with tool use and thus being able to carry out many personal care tasks, and global screening measures, such as the Mini-Mental State Examination, may be of particular importance when assessing independent living capacity (Everhart et al., 2012).

A common case scenario associated with assessment of the capacity for independent living arising when the family becomes concerned about being able to care for an increasingly dependent elderly family member living on their own. The family may be visiting more frequently to check on their elderly family member and performing more tasks for them. They may become concerned because the elderly family member is losing weight. They may begin to question if their family member can properly care for him- or herself and start to wonder about options such as the timing of a move into the family home. If the family does not feel they can meet the needs of their elderly family member via the provision of nursing or home care assistance, they may also consider an assisted (semi-independent) living setting.

Financial Competency

Often included in the assessment of cognitive capacity of older adults is an examination of budgeting and money management skills. Competency with respect to money management and financial decision-making capacity is, however, an important domain in and of itself. Difficulties with managing finances can affect an elderly person's safety and security directly (Price, 2014). Poor financial capacity can have negative implications for the long-term health and well-being of an older adult, wherein they become vulnerable to abuse and exploitation by unscrupulous family and others. Financial competency is highly cognitively mediated (Marson, Triebel, & Knight, 2012), can be readily affected by a decline in attention and memory functioning (Widera, Steenpass, Marson, & Sudore, 2011), and is an early warning sign of vulnerability and loss of capacity. Deficits in financial capacity can affect the ability to enter into a contract (including those related to housing, securing loans, and other transactions), administer one's estate, manage property, make a will, act as a trustee for another, or assign power of attorney. In addition to being able to understand and perform basic math operations, financial capacity assessments require examination of the client's judgment and decision-making history, such as indications of poor financial judgment (e.g., excessive gambling, selling off assets, and distributing properties suddenly), and any warning signs of risk of exploitation by family members, including examining for any indications of undue family or other social pressures to release assets. Financial capacity involves both a performance aspect (completing financial tasks such as bill paying, making purchases) and a judgment aspect (e.g., being able to protect one's assets, long-term planning of spending). Cognitive skills associated with financial capacity are mathematics skills, visual-motor tracking, and executive reasoning. However, indirect cognitive measures cannot replace the ecological validity of directly testing mathematics skills (Marson et al., 2012). A common clinical scenario in this context often emerges when one spouse in a couple dies or is too disabled to assist or otherwise act as a counterbalance regarding asset allocation and spending.

Legal Decision-Making Capacity

Legal capacity is assumed unless proven otherwise in all adults regardless of physical or mental disability. A concerned or involved party almost always initiates examination of this capacity. It includes determining if the client has sufficient awareness of the exact nature and objectives of the court hearings or procedures. In the case of criminal procedures, the primary question before the evaluator and the Court is if the individual before the Court has sufficient fact-based knowledge of the given criminal procedure to allow the process to go forward. These aspects of legal decision-making are distinct from the "civil" capacities. Legal decision-making capacity extends to issues such as the capacity to retain legal counsel, to make a gift, to nominate a committee, to enter into a contract, or to marry (Kolva & Rosenfeld, 2012).

With respect to associated "civil" capacities, there is also testamentary capacity or the ability to decide on the disposition of one's property and possessions following death. Beyond the ability to make specific decisions about testamentary issues, legal decision-making capacity in other contexts also involves knowledge of possible outcomes of the court process and/or their own involvement in the proceedings, being able to communicate with a lawyer, take instruction, and express one's wishes to a lawyer and the Courts. Although there are specific measures designed to assess legal competency (Filakovic, et al., 2011; Kirshner, 2013; Whiting, 2015), no single measure is sufficient. Examination of implicated cognitive functions requires a broader assessment. As with civil competencies, legal decision-making competency may be influenced by severe psychiatric disorders, medical conditions associated with neurodegenerative and developmental disorders, and brain injury. Ultimately, the assessor must operationalize legal questions as psychosocial constructs amenable to objective evaluation (Peisah & Shulman, 2012). Legal decision-making capacity is addressed via assessment of cognitive functioning, including testing working memory, orientation, attention, and math skills, together with a clinical interview that might include specific questions tapping comprehension of the legal circumstance. With respect to testamentary capacity, it is essential that the older adult has comprehension of the basic details and processes associated with will preparation, an understanding the nature of a will, knowledge of one's property, knowledge of whom the will is directed at, and awareness of the plan to dispose of one's assets.

Situations involving concern about legal-decision-making and testamentary capacity are some of the more common contexts in which competence is examined in older persons. Typically, an elderly client attends a law office intending to prepare a will. They may have considerable assets to dispose of, or assets that are arranged in a complex manner, or there may be family tension and conflict surrounding the distribution of assets in the will. On intake, counsel may become concerned about whether or not the client fully understands the depth and breadth of their assets or perhaps is concerned about the undue influence of a particular family member with respect to the disposition of the assets. Indeed, once a relative who appears to be controlling or otherwise pressuring a client is excluded from the meetings, the client may appear uncertain about why they are there, be unwilling to express an independent opinion, or more evidently be confused when interviewed alone. In these scenarios, counsel may request an assessment of a client's cognitive functioning to determine if they have capacity to prepare and sign a will.

High-Gravity Decision-Making Capacity

With the proliferation of variously called "right to die," medical aid in dying (Schuklenk et al., 2011) or assisted suicide (Sperling, 2018), euthanasia legislations in Western countries (Gather & Vollmann, 2013), public concern, and ethical controversies have been growing with high gravity, because of irreversible health and life decisions made by the vulnerable elderly. The principle of the good of acting in a patient's best interest has been often in conflict with the good of respecting a patient's autonomy. Yet, both need to be balanced in high-gravity decision-making.

What does specifically need to be balanced? Notably, the definitions of well-being refer to risks and benefits of what is proposed. In high-gravity decision-making, the level of capacity required for legal competence rises with the extent to which the risks outweigh the benefits (Buchanan, 2004). Of concern, however, no allowance is often made for the fact that, in practice, there may be other means of obtaining the same benefit, for example, mental health treatment for a depressed patient seeking end-of-life or medically improved pain control for a patient with terminal cancer. Figure 23.2 illustrates the relationship between the gravity of the decision and capacity necessary for legal competence, using the balancing approach (Buchanan, 2004).

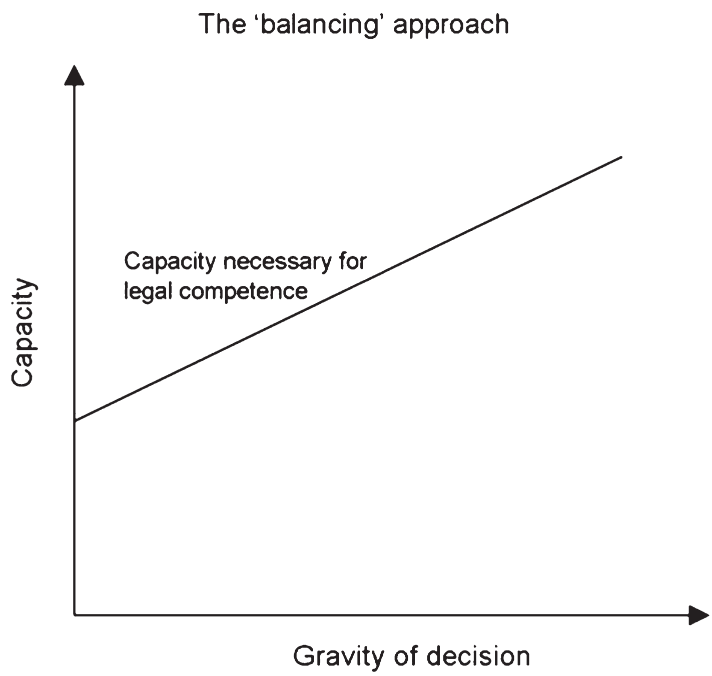

Fig. 23.2 The "balancing" approach: gravity of decision and capacity for legal competence

Conceptually, establishing reasonableness of risk in high-gravity decision-making scenarios is a complex task. It requires determination of five components: probability of harm; value given to harm; probability that the goal which necessitates risking harm will in fact be achieved; value attributed to this goal; and necessity of taking the risk, given alternative strategies, for example, treatment. Due to the complexity of the construct, measurement of high-gravity decision-making capacity translates into methodological complexity in capacity evaluations. The following underlying cognitive components need to be determined: patient's ability to retain information regarding decision; ability to weigh information and reach decision; consistency of current decision over time and with past decisions, wishes, and beliefs; ability to communicate choices in a reliable form; and ability to make decisions free of undue influence (Stewart, Peisah, & Draper, 2011). Some or all of these advanced cognitive processes may be compromised among the elderly by virtue of aging, neurodegenerative disorders, brain injury, mental health disorders, pain, and fatigue or medication side effects.

Research on predictors of physician-assisted suicide (PAS) emphasizes multiple implicated psychosocial factors that need to be given due consideration in competency evaluations. These factors include (1) depression, hopelessness, and suicidality; (2) anxiety; (3) interaction of depression with mild opioids; (4) low spiritual well-being; (5) low social support and thwarted belongingness; (6) low self-esteem; (7) perceived burdensomeness; and (8) financial consequences in case of depressed patients (Berghmans, Widdershoven, & Widdershoven-Heerding, 2013; Bulow et al., 2012; Gather & Vollmann, 2013; Jansen-van der Weide, Onwuteaka-Philipsen, & van der Wal, 2005; Johnson, Cramer, Conroy, & Gardner, 2014; Johnson, Cramer, Gardner, & Nobles, 2015; Macleod, 2012; Smith, Harvath, Goy, & Ganzini, 2015; Tucker, Buchanan, O'Keefe, & Wingate, 2014). Contrary to popular beliefs, suicidal ideation in the terminally ill is not directly related to pain intensity, but strongly related to depression (Levene & Parker, 2011). Severe pain may be predictive of PAS but primarily among patients with depression (Mystakidou et al., 2005). Indeed, depression is a key factor in assessment of competence, especially in high-gravity scenarios. Generally, the more advanced the terminal illness, the higher the prevalence of depression, which is known to be associated with pessimistic bias (Mystakidou et al., 2005) affecting cognition. Research shows that depressed individuals are compromised by imprecision in prediction of undesirable events (Strunk, Lopez, & DeRubeis, 2006), which is apt to adversely affect their competency to make health and life decisions. Notably, improvement in depression decreases a desire for hastened death (Rodin et al., 2007).

As discussed in this chapter, dementia especially adversely affects legal competency, via difficulties with reasoning, judgment and decision-making, and worsening of decision-making capacity over time (Okonkwo, Griffith, Copeland, et al., 2008). To complicate matters, research stipulates that patients with dementia receive less pain control than individuals with terminal cancer. Moreover, others often make decisions for them. Yet, according to a 2017 survey of 306 caregivers in Quebec, Canada, a significant percentage of caregivers desire hastened death for people with dementia (Bravo et al., 2017). These factors set the stage for challenges in validity, reliability, and fairness in assessments of competency for high-gravity decision-making among this highly vulnerable population. Instability of PAS requests constitutes another area of controversy in high-gravity decision-making among the elderly. Research on the terminally ill showed that about half of the patients who considered PAS changed their minds. Importantly, patients with depressive symptoms were more likely to change their minds within months (Emanuel, Fairclough, & Emanuel, 2000), whereas older depressed patients frequently rejected their decision 6 months later (Blank, Robison, Prigerson, & Schwartz, 2001). Other correlates of decision instability included male gender, higher suffering, poorer health, and lower support (Blank et al., 2001). The decision instability problem challenges existing healthcare practices of single PAS decisional capacity evaluation and/or repeated evaluation within days or weeks of hospitalization. Evaluators of PAS decisional capacity need to be aware of the fact that the irreversibility and terminality of the decision, in the context of potential external pressures and multiple other factors contributing to decision instability, may undermine the principle of "informed" consent. What is at stake does alter the level of capacity necessary for legal competence.

Yet, the high-gravity, irreversible decisions expected from the elderly are affected by multiple psychosocial factors that make capacity evaluation a dubious process with multiple built-in psychometric limitations. The context of decision-making plays an especially significant role, including (1) timing, recency of illness or diagnosis, present symptoms, or mental state on a given day; (2) who provides information and how and what information is given; (3) availability of family, medical, spiritual, and social support; and (4) external pressures from family, healthcare providers, and society. It is thus important for evaluators to assess not only cognitive ability and mental health but also the impact of contextual factors known to affect decisional capacity. The elderly patient may consent to PAS, but there may exist therapies that can be offered but are costly or difficult to access; medical diagnosis and prognosis may be inaccurate; or subtle coercion of the family or healthcare team may be present. Patients may also react to trauma or loss, lack social support, and feel like a burden.

From a practical competency assessment perspective, to be deemed competent for high-gravity decision-making, the elderly patient must show evidence of ability to discern a "choice" and reasonable outcome of choices, ability to base choices on rational reasons, together with ability to understand and actual understanding of choices and circumstances. Yet, no consensus-based or empirically supported guidelines have been developed for assessment of high-gravity decisional capacity, especially for PAS, despite irreversibility and life-death nature of such decisions. Various jurisdictions around the world used disparate approaches, measurement instruments, and professional qualifications of assessors. The psychometric properties of such instruments are often poorly known, and the potential assessor's bias is a concern. One promising, standardized capacity instrument is the Capacity to Consent to Treatment Instrument (CCTI) (Marson & Hebert, 2008) that targets four treatment consent domains: expressing choice, reasoning, understanding, and making a reasonable choice. Research shows that in cases of mild cognitive impairment, measures of short-term memory predict three of these four standards, followed by executive functions (Okonkwo, Griffith, Belue, et al., 2008). The CCTI uses two specialized vignettes (neoplasm and cardiovascular disease), each associated with two treatment alternatives and their risks and benefits. Studies found that patients with mild cognitive impairment demonstrate significant impairments on measures of decision capacity (Okonkwo et al., 2007), which are worsening during conversion to Alzheimer's disease (Okonkwo, Griffith, Copeland, et al., 2008). With respect to brain tumor, although patients may show minimal disability, they demonstrate impairments on measures of medical treatment decisional capacity (Martin, Gerstenecker, Nabors, Marson, & Triebel, 2015). Notably, consent-to-treatment instruments have not been specifically developed to assess high-gravity decisional capacity, such as for PAS, but they represent a future direction in which construction of such instruments could proceed.

In brief, the higher the gravity of decisional capacity determination, the higher the legal and measurement standards that are expected to be employed. Yet, current standardized methodologies for high-gravity decision competency assessment are challenged by many limitations. They include a reliance on single methods often developed without appropriate investigation of validity, reliability, and fairness and insufficient recognition of contextual psychosocial factors affecting the vulnerable elderly and inherent instability of decisions. In addition, limited training is provided to professional healthcare assessors in this complex and evolving field of practice, where personal biases of evaluators are of concern. This situation places the elderly, especially those with dementia, depression, and terminal illness, at risk for irreversible, and yet erroneous, biased, or otherwise inadequate competency determinations. Importantly, to improve assessment objectivity, "what if" hypothetical clinical thinking needs to be employed in PAS and other high-gravity decisions: what if effective intervention, treatment, or supports can be provided which can change the rationale for the person's decisions? Other de-biasing methods also need to be systematically deployed in evaluations: a multimethod approach; use of valid, reliable, and fair instruments; avoiding haste and simplification; exploration of alternative hypotheses; recognition of complexity and context; and familiarity with current research, methods, and best practice guidelines in the field.

A Model for Constructing Competency Assessments for the Elderly

The increased emphasis in forensic psychological and psychiatric evaluations of competence in the elderly has placed pressure on the field of psychosocial assessment to develop improved approaches to conceptualizing, designing, and implementing reliable, valid, and practical competency evaluations (Sullivan, 2012). Operationalizing the relationship between an area of competency and its underlying capacities is one of the most challenging conceptual issues in forensic assessment. In essence, the assessor must determine which mental capacities are needed to make which competent decision and find the best measures or analysis to assess each of the key capacities. To perform this task, the assessing healthcare professional has to have a working understanding of the legal underpinnings of the area of competence being assessed, practice ethics, and human cognition, test design, and interview methods (Demakis, 2012a, b; Kolva & Rosenfeld, 2012) [e.g., using the Competency and Incompetency Assessment Testing and Ranking Inventory (SICIATRI) for psycho-oncology patients (Akechi et al., 2015)]. Critical to this process is identifying the implicated psychosocial functions to be measured and then matching these to valid psychometric tools and/or aspects of the clinical and collateral interviews. The approach outlined here is presented as a practical conceptual guide to the key areas to consider when tackling a competency assessment.

Prior to commencing an assessment, it is expected that the clinician will delineate the specifics of their intended approach, including determining the scope of the investigation, the core cognitive, affective, and psychosocial domains that need to be assessed, identifying the key variables that must be examined in each domain, and selecting the appropriate measures and interview approaches (clinical and/or semi-structured interviews) for the evaluation. Although the evaluation approach is informed by backgrounds in psychosocial and neurocognitive assessment, experts in other fields in mental health and medicine may have the requisite training and expertise to approach these assessments. However, training in cognitive assessment is likely a must-have skill for any evaluator working in this area.

The present approach is based on the Grisso model of assessing legal capacity (Grisso, 1986) and the expansion of that model by the American Bar Association Handbook for Psychologists on *Assessment of Older Adults with Diminished Capacity* (American Bar Association Commission on Law and Aging & American Psychological Association, 2008), with additional modifications based on clinical experience in neuropsychological and capacity assessments with older adults. The development of a customized, systematic, and valid assessment framework is essential because (1) the areas of human capacity being assessed are diverse, may overlap in a particular assessment, and defy a cookie-cutter approach; (2) capacity assessments present unique challenges when working with older adults, such as the need to work around physical limitations or the need to observe functional behaviors in real-world contexts; and (3) the gravity of the concerns necessitates a comprehensive assessment employing logical and ecologically valid approaches with the best chance of making a reasonable and clinically sound decision that addresses the legal question being asked.

Step 1. Establishing the Capacity Assessment Framework

The attached figure depicts the balancing act that the assessor must engage in when conducting capacity assessments. The assessor is expected to consider functional elements, prior diagnoses, the cognitive underpinnings essential to forming a reasonable opinion, and evaluation of the impact of psychiatric or affective conditions or neurological conditions on capacity. These factors must be balanced (Purser & Rosenfeld, 2014) against a client's values and preferences about life and these types of decisions, against considerations of the level of risk behind a decision to allow or not allow to proceed with an activity, and against considerations of what steps can be taken to enhance a client's capacity should they fall short in some way.

In determining the scope of inquiry surrounding a competency evaluation, prior to commencing the assessment process, the attending clinician must gain clarity with regard to any important limitations or boundaries on the investigation. Thus, the assessor must become familiar with the legal standard being adjudicated in the specific referral regarding civil capacity, via a client's lawyer, or a private referral (often via family member), or a medical or social service organization. Due to the differing legal and psychological conceptualizations of competence and capacity, particular attention must be paid to the legal standard being examined as compared to the clinical factors (detailed below) available to the clinician. The attending clinician must also develop a clinically sound approach for mapping their findings onto the expected legal concepts and be aware of the limitations of their examination in this regard. Consultation with a legal expert may be necessary in order to gain a comprehensive understanding of the standard in operation. When possible, and particularly in the instance of a referral from a lawyer or from a healthcare organization, a clear written referral (letter of instruction), outlining the referral questions that are to be addressed in the assessment, should be provided.

Step 2: Determining What Type of Competency Is Being Measured

Once the clinician has outlined the core considerations of a competency assessment, the next step is operationalizing the assessment procedures. Cognitive and behavioral variables are the most readily operationalized aspect of competency assessment. Key variables are detailed below and include comprehension, information processing, decision-making, and communication skills. The assessor must decide how to measure or otherwise assess these core aspects of the area of competency under examination. The appropriate standardized cognitive assessment tools are best suited to test relevant aspects of the dominant cognitive functions underlying information processing and decision-making in particular, but do not, in and of themselves, provide a complete answer with respect to competency. When combined with a comprehensive interview (and collateral interview when possible) and review of the relevant background information, a more complete picture of the client's competence in a particular area of functioning in a given psychosocial context can be developed. From a practical perspective, various competencies outlined here can be divided by the level of cognitive demands placed on the individual and the associated underlying capacities or skills. In this model, when approaching a competency assessment, it is important to first determine which of these two major types best captures the type of assessment likely to be involved: Type 1, Basic, or Type 2, Complex. Each is defined by the level of skills being evaluated and ranges from the simplest daily tasks (e.g., dressing oneself) to the most complex (e.g., performing brain surgery) of human capacities.

Type 1: Basic Competency Assessments are those focused primarily on evaluating how an individual performs various basic activities of daily living, work skills that are primarily physical or task oriented and procedural or overlearned in nature, and activities that do not require extensive executive-level cognitive processing. Some examples of Type 1, Basic Competencies include the following:

- Occupational functioning centered on the ability to perform simple, routine, repetitive, or otherwise restricted tasks that do not involve independent judgment
- Management of financial affairs centered on understanding the daily uses of money and basic budgeting (financial capacity)
- Basic independent living skills
- Health and daily activities of self-care

Type 2: Complex Competency Assessments are those focused on evaluating an individual's ability to arrive at decisions that involve complex or multifaceted information processing and/or ability to perform sophisticated or higher-order occupational or other functions that are either less reliant on specific skills or that involve primarily the application of intellect, executive reasoning, and judgment. Examples of Type 2, Complex Cognitive Competencies include the following:

- Ability to live independently and make non-routine decisions
- Ability to instruct counsel in legal proceedings
- Testamentary or legal capacity including wills, contracts, and important purchases
- Medical treatment decisions including health-care and end-of-life instructions
- Workplace functioning involving professional or complex technical skills. This can include concern about loss of competency or fitness for duty in a professional or other highly skilled person because of compromised cognitive capacity or motor, sensory, or physical impairment.

To differentiate Basic vs. Complex Cognitive Competency, it may be helpful for the clinician to ask the following questions: (1) Does the competency involve principally performing routine tasks?; (2) Does it involve complex decision-making or judgment?; (3) Is the person being evaluated responsible for the health, welfare, or supervision of others?; and (4) Is a skill tested directly or via measurement of an underlying cognitive capacity in order to determine if the individual is competent to perform a (typically more complex) task or essential duty?

Step 3: Operationalizing the Assessment Procedures

Once it had been determined if the assessment involves Basic or Complex Competency, the next step is to operationalize the key components of the competency involved. The American Bar Association guidelines (American Bar Association Commission on Law and Aging & American Psychological Association, 2008) recommend the examination of three core elements encompassing the principal facets of an individual's functioning – the cognitive underpinnings associated with this area of competency, the individual's psychiatric and emotional status, and their everyday functioning. It is further recommended that the assessor break down the targeted element into its smallest meaningful components by determining which cognitive and/or behavioral skills are needed to perform an associated action or task and listing the associated cognitive abilities. Within the everyday functioning domain, assessment of the older adult's ability to perform the specific task in question must be undertaken. This task can range from examining their ability to perform ADLs and IADLs, through examining their actual job performance, to examining the cognitive components of decision-making. The inclusion of a functional component differentiates capacity evaluations from neuropsychological assessment. Notably, measuring ADL/IADL performance is the principal component of independent living assessments in the elderly. There is a range of readily available published measures that operationalize these tasks through collateral and self-report or direct observation (e.g., the Direct Assessment of Functional Status (DAFS)) (Loewenstein et al., 1989).

In determining work capacity, particularly in Basic Competency assessments, a typical breakdown of the specific employment skills could first include conducting a formal job or task analysis (Kirwan & Ainsworth, 1992). At its simplest level, such analysis consists of a preparation of a list of specific task completion behaviors, followed by having the individual being evaluated, their work supervisor or a person with depth of experience, rate both the importance and the frequency of each task. Job Analysis Worksheets are readily available online. Slightly more complex task analysis involves listing the various competencies involved in a job, rating their importance, determining when each competency is needed for effective job performance, and, finally, adding a distinguishing value scale (distinguishing superior from merely acceptable or minimal competence). Task analysis is more comprehensive, but value scales in particular could be important in determining what level of competency an individual is capable of achieving or maintaining. When possible, interviewing the employer/supervisor and obtaining a formal description of the job requirements can be helpful. Administering previously developed skill tests specific to the individual's job or industry designed can be informative as well (Kirwan & Ainsworth, 1992). Regardless of the task complexity, it is recommended that the assessor develop or select a rating list of targeted everyday functioning daily living tasks or job duties and either interview the client regarding their task performance; observe the client during the completion of the listed tasks; or interview their employer, family members, and/or any care-team members with detailed knowledge of their capacity therein. When examining Complex Competencies and Basic Competencies, underlying cognitive skills must also be assessed, rather than relying solely on directly testing a skill. The use of a task-analysis approach will help the assessor select standardized measures of cognitive functioning that are analogues to the various key skills under evaluation. Evaluating underlying cognitive functions is critical because some capacities, such as consenting to a medical procedure or preparing a will, are highly cognitively mediated (Marson, Chatterjee, Ingram, & Harrell, 1996). Cognitive impairments affecting one's capacity to function in a given domain can have a direct effect on crucial areas of functioning related to competence – not just with respect to the ability to perform a specific task, but also with respect to insight and awareness of one's ability to perform certain tasks and attendant judgment surrounding when it is appropriate to act. Moreover, some capacities are highly complex and involve psychological and behavioral components that intermix with cognitive determinants in a less clear manner, and these will need to be "teased apart." For instance, mental health problems, such as depression, and motivational factors, including low effort, and possible exaggeration or malingering (to gain services, fulfill a "sick" role or otherwise attention-seeking) can impact functioning independent of one's cognitive capacity and need to be surveyed. Consideration of the cognitive underpinnings that could potentially affect a client's functional capacity is essential and must therefore be thoroughly delineated. The first step in this regard is to identify the core cognitive domains that the evaluator believes underpin the competency being assessed. Those domains are readily familiar to neuropsychologists, occupational therapists, and other professionals experienced in assessing cognitive functioning and include (1) sensorimotor activity, (2) speed of processing, (3) attention/concentration, (4) working memory, (5) short-term memory, (6) long-term memory, (7) receptive language and expressive language, (8) arithmetic, (9) verbal reasoning, (10) visual-spatial reasoning, (11) visuo-constructional reasoning and ability, and (12) executive functioning.

While specific measures of cognitive functioning will not be comprehensively reviewed here, the Wechsler Adult Intelligence Scales and Memory Scales, and the MMSE, are among the most commonly employed tests by neuropsychologists in competency assessments (see Sullivan, K, Neuropsychological Assessment of Mental Capacity, Neuropsychology Review, Vol. 14, No. 3, September 2004 for a review of relevant cognitive measures), although the MMSE may not be sufficiently sensitive in many competency assessment contexts. Once key cognitive abilities are identified, methods for assessing these abilities will need to be determined. For competency concerns related to intellectual capacity to make decisions and to make competent decisions about one's own welfare, core cognitive functional capacities include (1) comprehension of the task or tasks under consideration (e.g., "what decision do I have to make or what do I have to do?"), (2) ability to process relevant information (e.g., ability to attend to, process, and comprehend what is being asked of them, ability to focus on and complete a task or decision, and ability to adjust their performance in the face of feedback from the environment), (3) ability to take what was learned and use it to exert decision-making capacity (e.g., choosing the appropriate thing to do) and/or execute the behaviors needed to complete a task, and (4) capacity to communicate their decision to important others and/or to perform the relevant task (Kolva & Rosenfeld, 2012; Sullivan, 2004b). As well, some competencies include skills in numeracy, reading comprehension, the capacity to understand social situations and exhibit social judgment, and being able to exert impulse and emotional control. For instance, the capacity to retain information can be assessed with a verbal or visual memory measure, numeracy or reading comprehension with standardized academic tests, and the use of tests of executive reasoning for measuring logical reasoning capacity. Evaluating skills related to social judgment and self-control may be more difficult to assess using standardized measures, and interview and collateral information may have to be relied on.

An evaluation of elderly high-functioning professionals, especially those in safety-sensitive occupations, is a separate aspect of complex competency worthy of brief mention here. When examining in this context, three important factors need to be considered: (1) the professional's level of training (and if they are still capable of relearning or learning additional needed skills); (2) their level of professional experience; and, just as important, (3) their capacity to exert professional judgment within their practice area. With respect to issues of judgment or decision-making, the use of standardized measures of executive functioning can provide objective means of assessment, both directly and via their skills in deductive, categorical, and conceptual reasoning. Noteworthy though is that the ecological validity here plays a crucial role, which needs to be taken into consideration. In addition to measures of cognitive functioning, competency assessment involves a comprehensive clinical interview, observational data, collateral information on adaptive functioning, and measures of mental health and personality functioning. Particular to mental health-related issues, there exist specific psychiatric, affective, and personality factors that can diminish capacity, mainly those that impact thinking directly (such as psychosis and the development of false beliefs, cognitive slowing associated with depression, and anxiety and its relationship to impulsivity and lowered frustration tolerance) (Everhart et al., 2012; Grisso & Appelbaum, 1995). However, it is important to emphasize that psychiatric disorders do not necessarily result in diminished capacity across the board. Persons with clinical depression may still very well be able to make rational decisions about their lives. In contrast, acute psychosis can impair an individual's capacity to make decisions or perform tasks. Providing treatment recommendations, as well as prognosis and time estimate for recovery, is critical for the adjudicator of the proceedings or in assisting other professionals in determining if a person remains competent in the domain being examined. Emotional, behavioral, and personality factors that need to be assessed include clinical levels of depression, anxiety, bipolar disorder, obsessive tendencies, psychosis and attendant disorganized thinking, hallucinations, and delusions, the capacity for insight and self-monitoring, as well as behaviors such as impulsivity and noncompliance. The use of semi-structured or otherwise comprehensive clinical diagnostic interviews and personality tests with built-in measures of response validity and consistency is recommended for comprehensive competency assessments. The examiner must next review the previous medical and mental health diagnoses assigned to an individual, if any. The degree to which the individual's disorders, any medication effects, and physical restrictions could potentially impact their ability to perform during the assessment must be considered at this point. In doing so, it is particularly important to determine if the diagnosed conditions are progressive (e.g., Alzheimer's disease), stable (e.g., developmental intellectual disability), or potentially reversible (e.g., delirium, depression, etc.), as this differentiation will have an impact on the nature of the conclusions and recommendations.

Step 4: Integration of Subjective and Contextual Factors

Clinical judgment involves the clinician's capacity to weigh important cognitive and psychological data and identify the most salient and relevant factors in an assessment, in this instance, with respect to those affecting competency. However, as an important component of the "balancing act" of clinical judgment, standardized test data and objective information need to be balanced against the individual's values, preferences, risks of the situation, and prognosis for improvement. In the end, the assessor must balance these diverse and varied considerations and arrive at a yes/no decision with respect to an individual's competency. These cognitive and affective factors must therefore be weighed against more subjective influences and factors and context. An individual's values and preferences are impacted by factors such as race, culture, ethnicity, gender, sexual orientation, and religion and thus inform and guide behavior, judgment, and emotional responses (American Bar Association Commission on Law and Aging & American Psychological Association, 2008). Values and preferences are the underlying sets of beliefs and approaches to the world that guide personal decisions, and can be informative in determining past preferences (Wood & O'Bryan, 2012), and can be at odds with the norms, expectations, and demands of family and society. Even people with diminished functioning may have deeply held core personal, cultural, or religious values around lifestyle, personal preferences, and life and death matters that must be accounted for and respected. Furthermore, it is important for the assessor not to allow their own values to be the basis for deciding another's capacity to make a decision about their well-being (particularly with respect to end-of-life decisions and with respect to unconventional lifestyle choices). Risk of physical harm to oneself or others, social isolation, home safety, financial loss or risk of exploitation, and vulnerability at the hands of family or others must also be assessed and judged. This is the "interactive" piece of the assessment (Grisso, 1986; Grisso, Borum, Edens, Moye, & Otto, 2003), governing the transactional elements of the parties with a vested interest in the outcome of the assessment. The level of risk of harm and, in particular, the level of risk associated with a decision or behavior in a given situation must be examined closely. This evaluation ultimately determines the gravity of the matter under consideration and the need for thoroughness in the investigation; it also helps account for any available external supports, as well as the possible need for supervision required to mitigate this risk (American Bar Association Commission on Law and Aging & American Psychological Association, 2008).

Finally, the provision of recommendations that could potentially enhance an individual's functioning is a further essential component to most competency assessments. For instance, possible medical treatments, the use of tools and practical steps (e.g., using reminders, obtaining hearing exams and hearing aids), psychoeducational support, and direct clinical treatment (counseling, physiotherapy, occupational therapy) should all be outlined, with an attendant prognosis for improvement and a realistic timeline. This information can influence whether or not the adjudicator in a matter needs to revisit a decision on competency in a reasonable time frame. This information points to the potentially variable nature of capacity depending on circumstance and an individual's health and well-being and may directly affect a client's plan of care (American Bar Association Commission on Law and Aging & American Psychological Association, 2008).

Step 5. Selecting Assessment Tools and Techniques

Most standardized assessments use a range of techniques to examine the areas of functioning under consideration. A variety of test batteries available to trained experts in cognitive assessment can readily cover most core aspects of cognitive functioning, including the Wechsler Adult Intelligence Scale (WAIS-IV) and Wechsler Memory Scale (WMS-IV), the Delis-Kaplan Executive Functioning System (D-KEFS), and the Neuropsychological Assessment Battery (NAB). The administration of a test of effort and/or response validity is recommended, to detect inconsistent or unlikely response patterns associated with misrepresenting psychopathology or low effort occurring for reasons other than impairment (e.g., the Test of Memory Malingering (TOMM); Structured Inventory of Malingered Symptomatology (SIMS)). It is important to emphasize, however, that routine cognitive assessment tools will not necessarily directly test the functional skills involved, particularly for ADLs (Everhart et al., 2012). More important than the use of a specific test or battery is the assessor's ability to generate valid findings with respect to the area of functioning under examination, in which each test administered contributes to the accuracy of the overall findings. This way, one can ensure that all relevant areas of cognition are adequately tested, and consistency of assessment practices across clients is enhanced. With respect to identifying the various key functional elements underlying a particular capacity domain, these include at a minimum, for most individuals being examined, their level of ability to perform ADLs (e.g., grooming, dressing, or toileting) and IADLs (e.g., managing money, health decisions, functioning in the community and at home). ADLs and IADLS are most closely associated with basic capacity. Testing functional skills can also include measuring the ability to perform simple work tasks or avocational pursuits and even basic communication skills. The evaluator must directly assess these skills and abilities and, in doing so, examine both general cognitive skills involved (such as intellect) and the client's capacity to exhibit the actual skills involved.

For functional elements, the use of a standardized assessment tool is recommended, with a range of tools available for assessing ADLs and financial skills in particular (see Everhart et al., 2012 for a review); also the Direct Assessment of Functional Status (DAFS) (Karagiozis, Gray, Sacco, Shapiro, & Kawas, 1998), the validated Independent Living Scales (ILS) (Quickel & Demakis, 2013), and the Vineland Adaptive Behavior Scales, 3rd edition (Vineland-3), among others, can be employed. Finally, the assessor may be able to select a measure specifically designed to assess competency in a particular area of functioning. For legal competency, in particular, and for competency assessments generally, no single measure is sufficient. All evaluations must additionally include clinical interviews and standardized testing, obtaining collateral information from relatives and/or friends or coworkers, and a review of available medical, mental health, educational, and vocational background information. A range of well-established specific measures in the field can be deployed to help assess legal competency. They may prove helpful in not only directly assessing capacity in this respect but also in structuring the evaluation. For example, the MacArthur Competence Assessment Tool – Criminal Adjudication (MacCAT-CA) (Hoge et al., 1997; Otto et al., 1998) is in fairly wide use in the USA, with the Fitness Interview Test (FIT-R) (Roesch & McLachlan, 2008; Roesch, Zapf, & Eaves, 2006) in use in Canada (where adjudicative fitness is defined differently than in the USA). Mental health questionnaires are widely used in the assessment field and include both comprehensive (e.g., the Personality Assessment Inventory (PAI)) and disorder-specific measures (Patient Health Questionnaire (PHQ-9) (Kroenke, Spitzer, & Williams, 2001), Geriatric Depression Scale (GDS-30) (Yesavage et al., 1982), and Geriatric Depression Scale for the Informant (GDS-IF) (Brown & Schinka, 2005)). Structured clinical interviews for major mental health disorders include the Structured Clinical Interview for DSM-5 (SCID-5) and provide a comprehensive forensic diagnostic evaluation. With respect to financial capacity, the Prior Financial Capacity Form (PFCF) and the Current Financial Capacity Form (CFCF) have been cited in the research literature as potentially valid and useful (Marroni, Radaelli, Silva Filho, & Portuguez, 2017), as has the Financial Capacity Instrument (FCI), particularly for persons with Alzheimer's disease (Marson et al., 2000).

Practice Recommendations

This chapter was an attempt to delineate some key ingredients of comprehensive competency assessment and to propose a framework for conceptualizing an approach to the evaluation process. Existing guidelines, such as those outlined in the ABA Handbook for Psychologists (American Bar Association Commission on Law and Aging & American Psychological Association, 2008), are an important step forward in establishing best practice guidelines for competency assessments. With the ascendency of ethical and professional concerns surrounding the legal and institutional treatment of the elderly, the increased advocacy efforts to ensure due process, and the emergence of legal and health practitioners' standards surrounding informed consent and ethical practices, there has been an inexorable social movement toward self-determination by the elderly. Thus, crucial is the establishment of a nascent comprehensive and systematic approach to competency assessment that will increasingly allow for outcome studies to be conducted. In particular, ensuring that examiners understand the legal standards for competency within a particular jurisdiction, and what the assessor is being asked to deliver by way of a capacity assessment, become the first steps in responsibly accounting for the potentially serious and irreversible implications of competency assessments for the older adults. A careful examination of the scope of the assessment ensures that not only cognitive functioning and psychopathology are assessed but that the entire context in which the assessment is being conducted be examined as well. Cultural, familial, and lifestyle factors must therefore be properly examined and accounted for. This investigation extends past the expressed wishes of family members to include a close examination of any possible effects of undue influence from family and/or others on the elderly client.

Moreover, providing a clear, concise analysis of the relationship among the assessed factors and the area of competency being examined is the most fundamental responsibility of the assessor, so that the consumer of the report, typically judge or other trier of fact, has an understanding of the assessor's rationale for arriving at the conclusions presented. This clarity makes evidence-based critical analysis by the consumer of the report findings easier. The assessor is also responsible for outlining any important limitations on their findings arising from restrictions on the scope of the assessment, problems in completing the examination, limited sources of information, or special extenuating circumstances. The examiner must not just merely mention these limitations, but also provide an estimate of how severely they impact the certainty of any conclusions arrived at. Importantly, the assessment opinion needs to be de-biased as shown in the high-gravity decision-making section of this chapter.

Future Directions in Practice and Research

In developing valid, reliable, and fair measures of competency, the main focus of research efforts needs to be on determining what factors the assessment should measure and developing the best and most appropriate methodology for doing so. In the course of improved understanding of what is being measured in competency assessments, it will be important to develop evidence-based external validity criteria and then gather data on how these evaluations are being performed, for comparison purposes. It is unlikely that a single standardized assessment battery capable of covering all forms of competence will be developed in the foreseeable future. Studies will need to focus on developing guidelines for assessing diverse capacities and, in particular, criteria for evaluating elderly persons with specific pathologies, such as severe psychosis or traumatic brain injury. Persons suffering from progressive neurocognitive disorders may also differ with respect to the course of their disease, with early- and late-onset groups presenting with different paths in terms of changes in their capacities. Additionally, the impact of other specific factors, such as pain, fatigue, medication, and substance use, the course of an illness or pathology in other respects, the potential for recovery in the future, and other changes in health status on competency in the elderly will need to be better understood. Further understanding of familial, cultural, and other contextual factors and work on cross-cultural definitions of competency and capacity will be helpful. With respect to public policy, researchers and public health officials will need to synthesize research findings in terms that foster a high degree of concordance among pertinent ethical considerations, legal standards for competency, and what capacity instruments are capable of measuring.

Finally, we note the importance of research into the development of mandatory competency evaluations for older workers in public safety positions (such as first responders, medical and other public health occupations, engineering, and legal professions, as well as further work on driving and flying licensing for the general public). The effect of loss of certification or licensing on the older adult's mental health and the potential for rehabilitation and/or support to return the older adult to their job or social role represent some potential future research directions emerging from the current social and medical-legal trends in competency assessment.

Discussion and Conclusions

Competency evaluations are "high stakes." The higher the stakes of assessment, the higher the methodological and legal standards that are expected to be deployed. Inadequate or incorrect competency determinations may produce serious, irreversible, or unknown outcomes for vulnerable elderly individuals, especially those with depression, dementia, chronic pain, terminal illness, and other disabilities. Having a mental health or medical diagnosis does not imply reduced competency, and the autonomy and independence of the older adult requires appropriate support and recognition. Competency is domain-specific, understood in temporal, situational, and psychosocial contexts, and not a trait. Consequently, assessment of psychosocial attributes pertinent to a given competency needs to be balanced with the assessment of context. Competency is often unstable and requires repeated assessment over extended periods of time, including accounting for social, economic, family, and institutional pressures.

A multimethod approach to competency evaluation is recommended, using evidence-supported, valid, reliable, and fair instruments, while avoiding haste and oversimplification. It should rely on current research, instrument development, and best practice guidelines. Further research and best practice advances in the area of competency assessment are essential to address current gaps and challenges, especially given the complexities and potential harm and risks associated with such assessments. Increased efforts at training and educating assessors are particularly important to avoid harm to vulnerable older adults.

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Management of End-of-Life Issues

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Janice Kishi Chow, M. Heather McKay, and Noralyn Davel Pickens

Overview

Dying and death may not be frequent topics among rehabilitation professionals, whose work typically focuses on goals of functional recovery. However, a paradigm shift from "traditional" rehabilitative approaches to a broader vision of each rehabilitation professional's role in end-of-life management (inclusive of hospice and palliative care) is needed to meet the needs of clients with life-threatening or terminal illnesses (Kanach, Brown, & Campbell, 2014). Shifting the way rehabilitation services are utilized as the end-of-life approaches can allow dignity and comfort for the person with a life-threatening or terminal illness, empower and enhance the quality of life for these clients and their families, provide a positive impact on hospice and palliative care programs, and offer meaningful experiences for therapy practitioners (Barawid, Covarrubias, Tribuzio, & Liao, 2015; Case, Blackwell, & Sprong, 2016; Pollens, 2012). (Note: when the terms "family" or "families" are used in this chapter, they refer to all loved ones identified by the client as family).

Professional associations define the roles of rehabilitation professionals (i.e., occupational, physical, speech therapy, and rehabilitation counseling) as part of the interdisciplinary team in hospice and palliative care (American Occupational Therapy Association, 2016; American Physical Therapy Association, 2012; American Speech-Language-Hearing Association, n.d.; Commission on Rehabilitation Counselor Certification, 2017b). The integration of therapy in its various forms in hospice and palliative care settings is a growing trend in end-of-life care. Such an integration taps into each rehabilitation profession's positive approach to dying and death while providing diverse professional value for clients living life to the fullest with dignity and respect (Jeyaraman, Kathiresan, & Gopalsamy, 2010). Many hospice and palliative care (HPC) organizations are increasingly aware that therapy practitioners are well equipped to meet the needs of, and maximize quality of life for, clients with life-threatening or terminal illnesses and their families.

Still, opportunities exist to further clarify the purpose of rehabilitation services with this population and focus the practice approach within the scope of each discipline. Regardless of medical prognosis or setting, rehabilitation professionals can continue to advocate for improved access to health services for these clients. This chapter will

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provide an overview of chronic illness patterns, what to expect with a practice in end-of-life care, and describe rehabilitation services at this stage of life. By increasing awareness of an array of factors that constitute the complex and dynamic situation of clients who are simultaneously living and dying, rehabilitation professionals can help improve the quality of life for patients and their families. It should be noted that Chap. 1 of this handbook provides a more comprehensive overview of chronic illnesses.

Dying

Trajectories

Chronic illness affects 45% of Americans and accounts for two-thirds of all deaths in the Unites States (National Association of Chronic Disease Directors, 2016). Understanding patterns of prevalent chronic illnesses and how needs are shaped by the illnesses processes assists clinicians in developing appropriate interventions and supports meaningful living until death. In a seminal study, Lunney, Lynn, Foley, Lipson, and Guralnik (2003) interviewed 4190 US patients and caregivers before death and identified 3 general patterns of decline, or dying trajectories, for patients with cancer, organ failure, and frailty. Subsequent studies continue to validate these findings (Bostwick et al., 2017; Kendall et al., 2015; Lloyd, Kendall, Starr, & Murray, 2016; Morin et al., 2017). Understanding these dying trajectories, as detailed in this chapter, the clinician can better address the needs of people living with incurable illness and improve care.

Cancer

Clients with cancer often remain quite functional until the last 5–6 months, with a rapid decline in the few months to weeks prior to death (Lunney et al., 2003). In addition to physical symptoms, clients frequently experience psychosocial distress. Murray et al. (2007) observed psychosocial and spiritual trajectories with lung cancer, with marked transitions at the time of diagnosis, discharge after treatment, disease progression, and entrance into the terminal stage. People with cancer also often have a higher sensitivity to disgust than people without cancer, which may result in self-disgust, avoidance, depression, and anxiety (Azlan, Overton, Simpson, & Powell, 2017; Reynolds, Bissett, Porter, & Consedine, 2016). They often maintain an accounting of when their illness began, mark transitions around anticancer treatments, and maintain hope along with fear of dying (Kendall et al., 2015). Common goals are to die at home, be free of pain, not be a burden on others, and say goodbye to important people in their lives (Khan, Gomes, & Higginson, 2014). Given the complexity of physical and psychosocial needs throughout the illness process, it is imperative that palliative care is integrated early, in conjunction with oncological treatments.

Although considered the more predictable among the three dying trajectories, recent research has shown the cancer trajectory may vary based on the type of cancer. In a longitudinal mixed-method study of ten women with breast cancer, Reed and Corner (2015) observed one pattern similar to the cancer trajectory identified by Lunney et al. (2003), with a long period of high functioning, while a second pattern had a short duration with gradual functional decline with acute episodes of illness progression (uncontrolled symptoms and little symptom respite). A third pattern spanned 2–5 years, with oscillating function similar to the organ failure trajectory. Although the cancer trajectory gives a generalized pattern of decline, rehabilitation professionals need to be sensitive to the unique aspects of a client's type of cancer.

Organ Failure

The organ failure trajectory includes diagnoses such as lung diseases and heart failure. Pattern of decline is gradual with periods of acute exacerbations over 6–24 months and significant decline in the last 3 months (Lunney et al., 2003). Clients typically do not regain function previous to exacerbation, and death is often due to an acute event. Clients and family caregivers may struggle to pinpoint the start of the disease process and speak openly about death, focusing instead on "beating the odds" (Kendall et al., 2015). Clinicians frequently see transitions in the illness process, marked by exacerbations, while clients do not see exacerbations as part of decline and wait until the physician tells them that they are dying. Unfortunately, given the difficulty in prognosticating and the desire to maintain a client's hope, physicians have been found to defer end-of-life conversations even in the last year of life (Houben, Spruit, Schols, Wouters, & Janssen, 2015). Due to this lack of preparation, a client's death upon an acute event often feels sudden. Therapeutic interventions need to maximize independence with adaptive strategies and assistive devices (Cooper & Kite, 2015); however, psychosocial support is needed to help clients begin end-of-life conversations and prepare for death (Lowey, Norton, Quinn, & Quill, 2013).

Frailty

Clients who do not have organ failure or cancer often develop dementia or generalized frailty of multiple body systems (Lunney et al., 2003). The pattern of decline is less predictable and can vary over 6–8 years. Transitions are not as marked as with cancer and organ failure, making prognostication difficult. Dementia is characterized by cognitive and functional decline. Frailty is defined by weakness, weight loss, fatigue, and slowed activity. Common client fears include experiencing cognitive decline, burdening others, and being institutionalized (Lloyd et al., 2016). Therapeutic interventions need to help clients adapt to cognitive and physical decline; maintain a sense of self and social relationships; establish community networks; and integrate palliative care early to support clients, families, and caregivers throughout this long process (Lloyd et al., 2016).

Although dying is unique to the individual, dying trajectories articulate patterns for cancer, organ failure, and frailty and provide a framework for rehabilitation interventions. Rehabilitation professionals can play a vital role in the healthcare needs of people living with terminal illness. With such knowledge, the rehabilitation team can be sensitive to how the illness process may shape a client's needs, be alert to deviations from typical patterns, integrate appropriate and client-centered interventions, and facilitate quality of life at the end of life.

Active Dying

The active dying phase includes the last days to hours of life (Hui et al., 2014): the client becomes withdrawn and less responsive yet may have energetic surges and restlessness (Hospice Foundation of America [HFA], 2011). Observed changes may include minimal to no oral intake, cold and mottled (purplish) distal extremities, weakened pulse, and decreased urine output (HFA, 2011; Lacey, 2015). Breathing may be rapid, shallow, and labored (Harlos, 2010). Fluids may accumulate in the pharynx, causing a cracking sound in the chest, commonly referred to as "death rattle" (Lacey, 2015). In the last minutes to hours, Cheyne-Stokes breathing may be observed, with periods of rapid, shallow breaths (agonal breathing) separated by periods of no breathing (apnea) for 1–3 min (Harlos, 2010). After breathing stops, the heartbeat will cease several minutes later (Harlos, 2010). Death is confirmed upon unresponsiveness to voice or touch, fixed and dilated pupils, and cessation of cardiac and respiratory function (Morrow, 2014).

Hospice and Palliative Care

Terminology around end-of-life care can be confusing for clients and rehabilitation professionals leading to questions about where, when, and how rehabilitation professionals can best work with clients approaching the end of life. *End-of-life care* is a term that encompasses both palliative care and hospice that can be provided in the final stage of life. A general palliative approach to care and a certified hospice program are closely related. Both types of care are centered around achieving the best possible quality of life for patients and their families. According to the National Hospice and Palliative Care Organization [NHPCO] (2015), palliative care is a total approach to care. This approach improves the quality of life for patients and their families facing the problems of life-threatening illness through the prevention and relief of suffering by means of early identification, assessment, and treatment of symptoms (i.e., pain or other physical, psychosocial, or spiritual concerns). A client's choice whether to elect palliative care or hospice is often a question of timing. Palliative care differs from hospice as it can be administered at any point in the illness process, regardless of prognosis (World Health Organization, 2016). For instance, for a client with a neurodegenerative illness that has no cure, the care of the individual can be considered palliative from the time of diagnosis. From the first encounter with the client, the rehabilitation professional is providing palliative care. Additionally, palliative care may be delivered in combination with curative interventions, as in the case of many people with cancer in early stages of the illness.

Hospice care also focuses on comprehensive symptomatic relief and maximizing quality of life for clients and families. Hospice care differs from palliative care in that it is reserved for the terminal stage of the person's condition (Baxter et al., 2014). A person receiving palliative care and curative treatments simultaneously may transition to hospice when curative measures are no longer desired or appropriate (American Occupational Therapy Association, 2016). The National Hospice and Palliative Care Organization [NHPCO] (2013) describes the hospice philosophy in *Standards of Practice for Hospice Programs* as follows:

> Hospice provides support and care for persons in the last phases of an incurable disease so that they may live as fully and as comfortable as possible. Hospice recognizes that the dying process is a part of the normal process of living and focuses on enhancing the quality of remaining life. Hospice affirms life and neither hastens nor postpones death. Hospice exists in the hope and belief that through appropriate care, and the promotion of a caring community sensitive to their needs, that individuals and their families may be free to attain a degree of satisfaction in preparation for death. Hospice recognizes that human growth and development can be a lifelong process. Hospice seeks to preserve and promote the inherent potential for growth within individuals and families during the last phase of life. Thus, hospice is not a place but an environment and philosophy of care that can be delivered wherever the person lives for as long as the person is eligible according to hospice eligibility guidelines. (NHPCO, 2013)

Ethics

The term end of life refers to a developmental progression in a person's life in which people live their lives through a "time-left" lens (Papalia, Feldman, & Martorell, 2015). This is a helpful view for rehabilitation professionals to understand when working with people in end-of-life care. People may be in relatively good health, with an acute or chronic condition for which they are receiving rehabilitation; however, for some, the condition may be a reminder of one's mortality. While experts in end-of-life planning and care address the psychosocial and spiritual needs of clients, rehabilitation professionals have a role in preparing for declining health through education on energy conservation, environmental modification, and self-management routines.

Ethical principles guide professional practice yet often have conflicting intentions, thus creating ethical dilemmas for the rehabilitation team. Ethical issues around end-of-life care for rehabilitation professionals often begin with analyzing the issues through classic principle-based ethics (Beauchamp & Childress, 2014) of autonomy (self-determination), beneficence (act in best interest of others), nonmaleficence (do no harm), and justice (fairness and equality). Virtue-based ethics provide a lens into the character and intent of people, rather than courses of action, and are strongly related to values and standards of professional conduct (Pozgar, 2016). Values such as fidelity, honesty, discernment, and respect are expectations of healthcare environments. Yet, ethical issues arise at the end of life in which these values are challenges and principles may be in conflict.

Autonomy is key to a "good death" (McCaffrey, Bradley, Ratcliffe, & Currow, 2016). Rehabilitation professionals who use a client-centered, client-directed approach to therapies help foster client-control of care. A typical dilemma in care occurs when clients who are facing their deaths opt to engage in behavior that puts them at risk in the view of the healthcare team. Something as simple as a client's desire to leave the care facility to see a child's school event, though she is highly susceptible to infection, can pose such a dilemma. In this situation, ethics of autonomy and nonmaleficence compete and raise value-based questions around respect, freedom, and compassion. More complex dilemmas involve a disabled client desiring assisted suicide. Does the right to choose include the decision to live or die – and with what supports? While rehabilitation professionals may not be directly involved in these decisions, the intimacy of the professional-client relationship often provides an outlet for clients to share their thoughts and feelings about end-of-life matters.

Rehabilitation professionals typically function in a beneficent manner – doing good for the client. However, "paternalism" can be beneficently broadly applied. Rehabilitation professionals often believe they know what "is right" for their clients, thus enacting in a beneficent but paternal manner. This impedes true autonomy in decision-making. Fully informing clients of care options, benefits, and risks – including what may be futile or misdirected energy – reduces the risk of paternalism. Rehabilitation professionals who work specifically in end-of-life care recognize the dual nature of helping clients live their lives while preparing for death (AOTA, 2016). While rehabilitation for improvement of health may be futile, therapies that maintain strength and endurance, or provide comfort, are quality-of-life enhancing.

Cultural and Religious Considerations

Autonomy, along with other "principle-based" ethics, is a broadly Western idea. For example, self-determination is culturally relevant as demonstrated by the ways that age, family systems, and ethnic differences affect decision-making and planning. Cultural beliefs, traditions, and values add complexities to end-of-life care (Case et al., 2016). To be fully present to their clients, rehabilitation professionals must reflect on their own values and be self-aware of potential biases (i.e., Western ideology of "independence first").

A cultural lens fosters a sensitive and empathic approach to care. Lack of training for rehabilitation professionals in end-of-life care is one of the several causes of cultural insensitivity. Nursing and medical training programs have developed discipline-specific curricula for end-of-life care, which helps the professional address the complex needs of the palliative or hospice client and family (Boucher, 2016). The same is needed for rehabilitation professionals.

Providing culturally relevant opportunities and sensitive care is important, not only in all rehabilitation phases but especially near the end of life. The cultural issues faced in end-of-life care are diverse, requiring sensitivity to understand the intricate needs of culture-sharing groups. For example, family traditional foods may be considered in specialized diets. Enabling participation in spiritual activities reflective of personal beliefs and values may be incorporated into treatment plans. Barriers to accessing quality end-of-life care for Latinos are often related to language barriers, family values around care provision, and religious beliefs – such as the focus on miracles (Cruz-Oliver & Sanchez-Reilly, 2016). Additionally, historical violations and resulting distrust of the medical establishment, as well as preference for aggressive care, have been found to hinder early involvement with hospice and palliative care for many African-Americans (LoPresti, Dement, & Gold, 2016; Williams & Harvey, 2013).

Concept of Rehabilitation in End-of-Life Care

The basic tenets of palliative care and hospice are well suited to rehabilitation approaches when interdisciplinary teams shift the priority from recovery to minimizing or slowing disability while maximizing the quality of life for patients and families (Javier & Montagnini, 2011). The concept of a palliative approach to rehabilitation in end-of-life care corresponds with the following hospice values:

- Acceptance of death as a natural part of life
- Client and family centeredness
- Considering the entire family as the unit of care
- Caregiver education
- Holistic, evidence-based interdisciplinary care
- Compensatory strategies for symptom relief
- Environmental modification and adaptation
- Temporal context of support that extends to bereaved caregivers beyond the death of a loved one

Articulating how one's discipline aligns with these foundations for palliative care and hospice philosophy allows rehabilitation professionals to employ their full scope of practice in end-of-life care.

To assure the alignment of rehabilitation services with comprehensive end-of-life care, clinicians should consider specific areas of focus in hospice – such as pain and symptom control, quality of life, diagnostic honesty, and follow-up bereavement care for the survivors. For example, clients with incurable cancer benefit from an interdisciplinary, multi-model, personalized treatment plan to address pain management, in addition to medical and pharmacological interventions (LaPointe, 2012). In this case, therapies may be used for cancer-related pain prevention and management. Specifically, occupational therapists can help clients continue or resume usual roles despite cancer-related pain, as well as engage in occupation (meaningful activities) for a diversion from the pain experience (Hoffman, 2017; LaPointe, 2012). Occupational therapists' role in this context encompasses active listening, education, prevention, problem solving, and provision of experiential learning (LaPointe, 2012). To strengthen the support for therapy in end-of-life care, Javier and Montagnini (2011) compiled a list of studies documenting the benefits of rehabilitation in patients with advanced cancer and cardiac and lung diseases. Included in the evidence was a 6-week structured physical exercise program which demonstrated improvements in physical performance, fatigue, and quality of life in 34 hospice and palliative care cancer patients (Oldervoll et al., 2006).

Role of Rehabilitation Services in End-of-Life Care

The purpose of rehabilitation services in hospice is stated in the Hospice Medicare Benefit: "Physical therapy, occupational therapy, and speech-language pathology services may be provided for purposes of symptom control or to enable the individual to maintain activities of daily living and basic functional skills" (Centers for Medicare and Medicaid Services, 2015, Chapter 9, Section 40.1.8). Rehabilitation services are included in addition to the hospice core services (physician services, nursing services, medical social services, and counseling) and must be provided by the hospice agency, either directly or under arrangements, to meet the needs of the patient/family (Chapter 9, Section 40.5). The Centers for Medicare and Medicaid Services (2016) ensures that coverage for rehabilitation services is based on the need for skilled service and *not* based on the client's diagnosis or the potential for improvement. The Medicare Benefit Policy Manual explains, "Skilled therapy may be needed, and improvement in a patient's condition may occur, even where a chronic or terminal condition exists. For example, a terminally ill patient may begin to exhibit self-care, mobility, and safety dependence requiring skilled therapy services. The fact that full or partial recovery is not possible does not necessarily mean that skilled therapy is not needed to improve the patient's condition […]. The deciding factors are always whether the services are considered "reasonable, effective treatments for the [client's] condition and require the skills of a [rehabilitation professional], or whether they can be safely and effectively carried out by unskilled personnel without the supervision of qualified professionals" (Chapter 15, Sections 220, 230;

Centers for Medicare and Medicaid Services, 2013). Knowing these laws and regulations, rehabilitation professionals may appropriately promote and expand access to therapy services by ensuring that other health professionals are aware of the value of rehabilitation services for clients with expected physical decline. Any member of the hospice team, including the client or family, may identify the need for therapy with a referral initiated at any point during hospice care. A closer look at each discipline's role is helpful to understand the provision of comprehensive end-of-life care.

Occupational Therapy

Occupational therapy's distinct value in hospice is to improve quality of life for clients and their families through engagement in occupations in the end-of-life care environment (AOTA, 2016). In a critical historical analysis of the role of occupational therapy in end-of-life care, Russell and Bahle-Lampe (2016) traced the roots of occupational therapy in hospice. Over the past 30 years, a broad range of research exploring the nature of occupations, clients, families, and hospice team members emphasized the contribution of occupation to dying a good death. The authors' synthesis of the research expands the view of occupation, as experienced at the end of life, beyond basic activities of daily living to include more dynamic occupations which support personally meaningful roles for clients and families. For instance, the chosen occupations of a dying person or their family members may be familiar and routine, such as sharing a final family meal or attending the regular meeting of one's social club. Likewise, occupations during this time may be tied specifically to leaving a legacy, such as crafting meaningful gifts or archiving personal stories for friends and family. A family caregiver may wish to re-engage in her own desired occupation to re-energize and regain balance during a difficult period of caregiving. In all these cases, participation in meaningful activities facilitates clients and families coping with losses and creating connections to life (Hammill, Bye, & Cook, 2014). Occupational therapy practitioners employ a wide variety of interventions to enable clients' chosen occupations, ranging from rehabilitating physical impairments to adapting tasks or environment (Benthall & Holmes, 2011). Occupational therapy practitioners recognize the dual value of occupation for this population as providing a means of self-expression and engagement while also serving as a vehicle by which clients and families find peace with the dying process and prepare for death (AOTA, 2016).

Upon referral for services, the occupational therapist conducts an initial evaluation to determine the client's occupational history and experiences, meaningful roles, interests, values, and reasons for seeking occupational therapy services. During the initial evaluation, the client's priorities and concerns related to participation in chosen occupations determine which specific assessments are most relevant to the client's participation. Based on the client's priorities and concerns, with information gathered from a variety of sources, the occupational therapist analyzes the client's current participation in the context to identify demands of the activity, specific problems, or potential challenges, as well as supports and barriers present in the environment. For instance, participation in meaningful daily occupations may be challenging for the client near the end of life because of physical pain; motor, sensory, or cognitive declines; or emotional distress. The demands of the activity, as it was previously engaged in, may become overwhelming for the client now and need to be modified. Occupational therapy practitioners consider environmental and contextual factors (e.g., accessibility of objects or places in the environment, caregiver training, social contacts available to prevent isolation), as well as personal factors (e.g., decreased endurance, increased anxiety) that may limit a client's abilities and satisfaction when engaging in desired occupations (AOTA, 2016).

Occupational therapy's role in hospice extends beyond direct patient care. Because of occupational therapy practitioners' training with group activities and knowledge of coping mechanisms and stress reduction, these practitioners can lead groups of hospice employees to promote healthy ways to cope with their roles' inherent daily stress and emotional challenges. The same applies to the occupational therapist's potential role in supporting family members and caregivers through the process of bereavement (Russell & Bahle-Lampe, 2016).

Physical Therapy

Physical therapists are equally integral and often underutilized members of the hospice and palliative care teams. While it is common for hospice and palliative care facilities to contract or employ physical therapists, relatively few clients in these settings receive physical therapy services, and utilization is inconsistent across settings (Drouin, Martin, Onowu, Berg, & Zuellig, 2009). In 2012, the American Physical Therapy Association updated and clarified the role of physical therapy practitioners in hospice and palliative care and included concepts relevant to continuity of care, ensuring access to physical therapy regardless of prognosis, the importance of an interdisciplinary approach, enhancing education for practitioners and students, and pursuing appropriate coverage and payment for physical therapy services (American Physical Therapy Association, 2012). Since then, a growing body of research points to the benefits of physical therapy interventions in optimizing function and improving quality of life for clients with life-threatening illnesses (Wilson, Stiller, Doherty, & Thompson, 2017). In a systematic review of physical therapy in hospice and palliative care settings published in the *American Journal of Hospice & Palliative Medicine*, authors reported improvements in a variety of client functional outcomes and symptoms including, but not limited to, pain, mobility, activities of daily living, endurance, mood, fatigue, lymphedema, and quality of life (Putt et al., 2015). Additionally, when clients receive physical therapy in hospice, families report increased confidence in their caregiving role and personal safety (Drouin et al., 2009).

Toward the goal of promoting the benefits of physical therapy in this practice area, Wilson et al. (2017) developed a conceptual framework depicting a physical therapist's role within hospice and palliative care and factors that differentiate it from traditional physical therapy practice. Fundamental to the authors' model is an evolution in the physical therapist's approach beyond "traditional rehabilitation," as priorities shift from rehabilitative care to palliative and support interventions. As priorities shift in end-of-life care, the expertise of the physical therapist may be needed to maximize function or slow the physical decline for a patient as the disease progresses. Physical therapists, influenced by a myriad of personal and environmental factors, decrease their emphasis on rehabilitative direct care activities and gradually balance with a concurrently increased emphasis on comfort, listening, compassion, and supportive care. According to the model, the physical therapist's direct care role with clients and families is threefold: client management; family/caregiver support; and advocacy for the client/family. The physical therapist's work with clients and families addresses culture, religion, preferences, expectations, safety, and prevention (while providing comfort and pain control, caregiver education regarding injury prevention, safe handling and positioning, and safe activities of daily living). In advocating for clients, physical therapists are concerned with the optimal utilization of visits and resources, obtaining durable medical equipment for declining function, connecting clients with other community support and ensuring proper payment through documentation and functional outcome measures (Wilson et al., 2017).

Beyond direct care for clients and families, there are other important dimensions of the physical therapist's role. For instance, the physical therapist assumes role responsibilities as a member of the interdisciplinary team. This aspect of the physical therapist's role further reflects the shift in treatment emphasis on a single client, typical of traditional rehabilitation, to the family/interdisciplinary team focus near the end of life. On the interdisciplinary team, the physical therapist provides consultation and education such as screenings, information during rounds, safe handling and movement, ergonomics, evaluation and programming to prevent workplace injuries, and education for colleagues on the role of physical therapy. Additionally, supportive care for the bereaved family may be a supplementary role for the physical therapist as a member of the palliative care or hospice team (Wilson et al., 2017).

Speech Therapy

Speech language pathologists are another important part of the healthcare team during the end of life. Given that most deaths now occur in medical or skilled nursing settings, it is common for a speech language pathologist to be faced with the issues of dying and death (Stead & McDonnell, 2015). Thus, it is essential that speech language pathologists are "well informed on the scope of practice, ethical boundaries, counseling skills and the physical processes associated with dying" (Stead & McDonnell, 2015, p. 12). They must hold a deep understanding of the emotional and psychosocial issues being faced by the client and family while respecting the client's and family's wishes and culture. Speech language pathologists typically contribute to the client's overall quality of life at the end of life by focusing on swallowing and communication (ASHA, n.d.). The speech language pathologist may work with the client and caregiver(s) to develop compensatory strategies to enable the patient to continue eating orally for as long as possible, suggest modified food consistencies that decrease the risk of aspiration, or recommend alternative nutrition methods. The speech language pathologist also can play an important part of facilitating meaningful communication at the end of life by helping to develop alternative communication strategies that allow the client to express wants and needs and maintain social relationships (ASHA, n.d.).

In addition to developing swallowing and communication strategies, speech language pathologists also serve in a consultative role, by communicating with other healthcare professionals regarding the patient's care and quality of life and collaborating with the family while educating them and gathering information regarding the client's preferences (Pollens, 2012). As with any healthcare provider working in end-of-life care, a speech language pathologist will be a part of the conversations regarding advance directives. Specific treatments addressed in advanced directives that fall under the scope of practice of the speech language pathologist include nutrition and hydration, tracheostomies, and ventilation (Stead & McDonnell, 2015).

Given a speech language pathologist's expertise in communication and the increased amount of time spent with clients, the speech language pathologist may understand client's desires and wishes better than the physician (Stead & McDonnell, 2015). Thus, speech language pathologists have much to offer when determining a client's plan of care near the end of life (ASHA, n.d.).

Rehabilitation Counseling

Rehabilitation counselors come from a broad range of clinical backgrounds, with credentials such as social work, psychology, nursing, and some therapies. The Certified Rehabilitation Counselor credential demonstrates advanced training and examination in the service of people with disabilities. The rehabilitation counseling scope of practice includes individual and group counseling, case management, and assessment and procurement of needed resources. Their training includes developing an understanding of medical and psychosocial aspects of conditions and personal and institutional culture issues (Commission on Rehabilitation Counselor Certification [CRCC], 2017a, 2017b).

The code of ethics for rehabilitation counselors specifically addresses the needs of terminally ill clients by seeking to help clients (1) obtain high-quality end-of-life care for their physical, emotional, social, and spiritual needs; (2) exercise the highest degree of self-determination possible; (3) be given every opportunity possible to engage in informed decision-making regarding their end-of-life care; and (4) receive complete and adequate assessment regarding their ability to make competent, rational decisions on their own behalf from mental health professionals who are experienced in end-of-life care practice (CRCC, 2017a, 2017b, p. 8).

Rehabilitation counselors may have a twofold approach in working with clients facing death: first, through a case management lens to assist with legal and social aspects of preparing for death, and second, through a counseling relationship (Case, Blackwell, & Sprong, 2016). The CRCC supports counselors referring spiritual and ethical issues for pastoral, rabbinical, or monastic counseling on topics such as pursuing suicide. However, the counseling role focuses not only on the social/physical transition of finances, goodbyes, and legacy but also the inner transition of preparation for death. For many people with disabilities, loss has occurred many times over. Rehabilitation counselors account for that prior preparation of sorts, in transition to death (Case et al., 2016).

Caregivers at the End of Life

As older adults near the end of life, caregiving demands increase and caregiving networks expand (Ornstein, Kelley, Bollens-Lund, & Wolff, 2017). In 2011, the nation's 900,000 older adults in their last year of life were assisted by 2.3 million caregivers. The vast majority of end-of-life care was provided by approximately 2 million unpaid family caregivers. An estimated 260,000 paid caregivers joined those families to cover the need, an expense most often incurred by clients and families. Compared with other older adults, those who were at the end of life received almost twice as many hours of help per week from all those involved in their care. Of the 2 million family caregivers serving as the primary source of support for a dying loved one, 30% were themselves aged 65 and older, and many of these older caregivers (15%) reported significant health issues of their own.

Caregiver Burden

Although many family caregivers report a positive view of their role, end-of-life caregiving entails considerable emotional, social, and physical costs for the family (Stajduhar, 2013). Contributing to the risk of health deterioration and decreased quality of life for caregivers is the challenge of "juggling" the usual life stressors (care for other family members, finances, maintaining positions at work/school, social obligations) with the role of caregiving (Pickens, O'Reilly, & Sharp, 2010). Not knowing how or when to implement care strategies/techniques can compound the stress and leave caregivers feeling frustrated and helpless facing an uncertain future (Stajduhar, 2013). Some of the most commonly noted stressors for end-of-life caregivers include:

- Disruption in normal life
- Uncertainty of waiting for death
- Helplessness and vulnerability
- Grief of successive losses
- Psychological distress (often higher than the dying person's)
- Social isolation
- Fatigue
- Sleep deprivation
- Lack of adequate nutrition
- Missed medical appointments
- Financial strain
- Relocations
- Relationship difficulties

Rehabilitation team members can provide important, perhaps even life-sustaining, support for family members who are caring for a loved one at the end of life. The development of a collaborative relationship with the client and family enables the rehabilitation team to include family/informal caregivers in care planning and education – an approach which considers family caregivers as full-fledged clients in their own right. By understanding the perspectives of caregivers and applying concepts of health and wellness with family and paid caregivers, rehabilitation professionals can address the needs of all involved in the care of a dying loved one (Forbat, McManus, & Haraldsdottir, 2012; Pickens et al., 2010). For example, when family caregivers know how to provide care in the best way and have timely information to guide end-of-life decisions, the benefits are improved quality of life for family caregivers as well as clients. Other beneficial interventions for caregivers and clients alike include:

- Creating advanced directives and advanced care plans (Wilson, 2016)
- Connecting with resources, such as nighttime or daytime respite services (Stajduhar, 2013)
- Training in safe patient handling for injury prevention (Wilson et al., 2017)
- Minimizing institutional barriers to care (Wilson et al., 2017)
- Designing programs to increase family caregivers' realistic or "grounded hope" (Feldman & Kravetz, 2014)
- Ensuring patients and families have choices where end-of-life care is provided (Stajduhar, 2013)
- Incorporating familiar, preferred activities or family rituals into the new normal (Pickens et al., 2010)
- Facilitating life review and storytelling (Akard et al., 2015; Pickens & Long, 2016)
- Coaching self-management techniques (Pickens & Long, 2016)
- Educating in energy conservation (Pickens & Long, 2016)
- Educating in durable medical equipment use (Pickens & Long, 2016)
- Providing environmental modifications (Pickens & Long, 2016)

Helping Family Caregivers

Rehabilitation professionals in this practice area use individual assessment data of the family to facilitate conversations about the caregiver's needs, priorities, and solutions. Assessing and addressing family caregivers' needs in a systematic way – versus relying on informal, undocumented discussions – reduces the risk that caregivers' needs go unseen, yields positive results for families, and provides an evidence base for the ongoing development of services for these valuable team members (Aoun et al., 2015). Clinically effective instruments are recommended to assess family caregivers' needs in palliative care – to identify and ameliorate some of the burdens that these caregivers are likely to face as their loved ones near the end of life (Stajduhar, 2013). One such instrument is the *caregiver's unmet needs questionnaire* consisting of 30 common medical, psychological, and social/family needs (Buscemi, Font, & Viladricht, Buscemi, Font, & Viladricht, 2010). The measurement tool focuses on the unmet needs of family caregivers in order to better understand the family's perceived burden and consequences on the caregiver's physical, social, and emotional well-being. Caregivers complete the brief questionnaire by indicating whether they have or do not have each of the needs at the time of the assessment. Finally, caregivers rank their top five most important needs (Buscemi et al., 2010). Another tool, the *carer support needs assessment tool*, encompasses the physical, psychological, social, practical, financial, and spiritual support needs of family caregivers of terminally ill people (Aoun et al., 2015). When selecting assessment tools and engaging family caregivers in facilitated discussions of their needs, rehabilitation professionals can be mindful of some key aspects of the assessment process: (a) caregivers appreciate a practical usefulness of an assessment tool; (b) caregivers appreciate emotional responses to their reflections; (c) caregivers value validation, reassurance, and empowerment; and (d) caregivers appreciate the acknowledgment of their experience when tapping other resources (Aoun et al., 2015). Practice-based evidence provided by more structured assessments of caregivers' needs is necessary to deliver effective, tailored services, including direct assistance, respite care, and caregiver education designed to meet the explicit needs of family caregivers (Family Caregiver Alliance, 2006; Ornstein et al., 2017).

Helping Family Caregivers Make Informed Decisions

Family caregivers supporting a loved one in end-of-life care are faced with a number of extremely stressful decisions, including but not limited to best ways to manage symptoms, transitions to long-term care or hospice, choices around medical treatments, or decisions to hire addition caregivers (Ornstein et al., 2017). Rehabilitation professionals are in a position to facilitate family conversations (both within the family and with healthcare professionals) and to ease the burden of decision-making. Here again, caregiver assessments conducted by rehabilitation professionals can elucidate the challenges of caregiving; enhance the partnership with caregivers; and help rehabilitation professionals maximize opportunities to serve families with excellent communication, empathy for family emotions and relationships, and attention to grief and bereavement. For example, rehabilitation professionals may consider – with family clients and their caregivers – choices around how the client and caregiver want to spend their remaining time together. What they want to do, with whom, and what supports might enable those activities all comprise goals of the rehabilitation team. Through empathetic, family-centered communication, clients and rehabilitation professionals can move forward toward goals to maximize the quality of life remaining (Pickens & Long, 2016).

Outcomes in End-of-Life Care

Rehabilitation professionals must account for intervention efficacy and effectiveness. In the context of the medical model, rehabilitation services are often measured by improvements in functional performance. Although there are functional assessments customized to hospice and palliative care, such as the *Palliative Performance Scale version 2* (PPSv2) (Victoria Hospice Society, 2006) and the *Revised Edmonton Functional Assessment Tool* (EFAT−2) (Kaasa & Wessel, 2001), a client's probable functional decline due to illness progression places clinicians at losing odds to validate services based on performance outcomes. Global constructs – such as quality of life, hope, or satisfaction – may accommodate functional loss and show positive changes. Because multiple disciplines simultaneously work toward improving these areas, it may be difficult to account for specific disciplinary contributions (Cooper & Kite, 2015).

To capture positive therapeutic outcomes, treatment goals need to be client-centered, utilize discipline-specific interventions, and focus on participation. Cooper and Kite (2015) suggest using SMART goals, which are specific, measurable, attainable, realistic, and time-sensitive. Goals must link directly to intervention to show discipline-specific outcomes. By centering goals on participation rather than performance, intervention can then accommodate functional decline and enable the client to be involved in a meaningful activity (Koenig, 2014).

Outcomes of client-centered goals are best detected with client-centered measures. Standardized measures have preset hierarchical levels based on norms (Turner-Stokes, 2009). Client-centered measures are customized to the client's strengths, allow the client to direct intervention planning, and can detect subtle changes that standardized measures miss (Koenig, 2014; Turner-Stokes, 2009). For example, a client may set a goal of transferring to a wheelchair and going outside onto the porch with assistance. Given the client's debilitated condition, a rehabilitation professional may modify a wheelchair to enable the client to transfer with a ceiling lift and tolerate being up in the chair with less pain. In a rehabilitation model, on the *Functional Independence Measure* (FIM), the client would be a FIM level 1-dependent for transfers at the beginning and end of the session. On this measure, there would be no indication of change. Using a client-centered measure, such as *goal attainment scaling* (Kiresuk & Sherman, 1968), the goal could be divided into five levels based on the client's goal and strengths – thus capturing the personal success of treatment interventions otherwise missed on the FIM (see Tables 24.1 and 24.2).

When working with clients living with a terminal illness, clinicians need to consider treatment interventions tailored to the client's personal goals that are perhaps atypical to traditional rehabilitation settings. Corr and Corr

Table 24.1 Scaled levels

Rating level	Level description
−2	Much less than expected outcome
−1	Somewhat less than expected outcome
0	Expected outcome
+1	Somewhat more than expected outcome
+2	Much more than expected outcome

Note: Adapted from "Goal Attainment Scaling: A General Method of Evaluating Comprehensive Mental Health Programmes," by Kiresuk and Sherman (1968)

Table 24.2 Example of goal setting, using goal attainment scaling outcome measure

Rating level	Level description
−2	Client will verbalize desire to get up to wheelchair
−1	Client will be able to transfer to wheelchair via ceiling lift
0	Client will be able to comfortably sit up in wheelchair bedside
+1	Client will be able to comfortably wheeled outside to porch
+2	Client will be able to sit comfortably in wheelchair on porch for 1 h

(2013) proposed the *task-based model* to define four primary task work areas a dying person may engage to cope with dying. The physical tasks focus on bodily needs and attending to physical distress. The psychological tasks involve building and maintaining psychological "security, autonomy, and richness in living" (Corr & Corr, 2013, p. 158). Social tasks seek to sustain and build interpersonal attachments and interactions with social groups. Spiritual tasks aid in discovering meaning, connectedness, transcendence, and hope. Selection and fulfillment of a task is based on one's personal value system (Corr & Corr, 2013). Understanding the client's value system and the *task-based model* may guide development of meaningful goals and potentiate limited time.

Therapeutic interventions with hospice and palliative care clients may not fit the typical rehabilitative model. A client's probable disease progression often nullifies functional performance gains. However, by focusing on participation rather than performance, outcome success can be redefined. Client-centered goals and outcome measures more readily identify and enable achievement of end-of-life wishes, as well as validate treatment interventions.

Grief and Bereavement

People often reflect on Elisabeth Kübler-Ross' five stages of grief (Kübler-Ross, 1970) to understand the grieving process. Historically, the stages of denial, anger, bargaining, depression, and acceptance have been depicted as a linear process over time with acceptance being an indication of resolved grief (Stroebe, Schut, & Boerner, 2017). Empirical research, however, refutes sequential progression through stages. In a study of the association of loss and the five grief stages over time among young adults who were bereaved by natural (n = 441) and violent (n = 173) causes, there was only a limited support for stage theory (Holland & Neimeyer, 2010). Experiences of great distress (e.g., disbelief, yearning, anger, and depression) were found juxtaposed with feelings of acceptance in an asynchronous pattern, suggesting distress and acceptance are different states rather than distinct stages of grief (Holland & Neimeyer, 2010). Experts recommend rehabilitation professionals to disregard stage theory to avoid generalization of grief reactions and to support individual coping processes (Corr, 2015; Stroebe et al., 2017).

Clients addressing end-of-life experience a series of losses from skills and abilities to relationships. Rehabilitation professionals readily recognize these physical losses but also need to recognize the emotional ongoing losses and impact on participation in daily life – including therapy. How a person grieves is affected by their life experience and social supports (NHPCO, 2016). Clients and families may experience anticipatory grief, feeling many of the physical and emotional pains of losing the presence of a loved one.

A client's death provides closure to the client-professional relationship yet is only part of the process of end-of-life care for the family.

Hospice services provide bereavement care for families for a year or more. Regular phone calls, support sessions, and memorial services and activities create a “healthy space” for the bereaved family to receive support from a knowledgeable and caring community.

Key Research and Practice Message

Practice Recommendations

End-of-life issues are broad for clients living with life-limiting illnesses, their families, and rehabilitation professionals. In order for rehabilitation professionals to manage these issues and improve the lives of people in the last chapter of life, a paradigm shift is required. Rehabilitation professionals providing end-of-life care in any setting must think beyond traditional rehabilitation services for functional recovery to focus on the full range of needs of the client and family. End-of-life care requires attention to client and family needs, cultural values, and subtle ethical challenges. Rehabilitation professionals play an important role in providing quality end-of-life care through a range of interventions including pain management

- Positioning
- Adapted self-care and mobility
- Swallowing and feeding
- Energy conservation
- Environmental modification
- Caregiver education
- Legacy-making

Integrating therapy with other professionals in hospice and palliative care can reduce negative outcomes for clients, empower and engage clients for improved quality of life, strengthen hospice and palliative care programming, and provide an enriching, theory-driven, research-informed practice for the rehabilitation professional (Barawid et al., 2015). Hospice and palliative care teams with the full range of rehabilitation services are best able to address both immediate and long-term needs of this diverse group of clients. Working with clients and families at end-of-life can be a challenging and rewarding experience for the rehabilitation professional.

Future Directions in Practice and Research

Improving quality of care provided to people who are dying and their loved ones will include construction and validation of outcome measures, evaluation of best practices, and development of client and family education. Practice will be enhanced by exploring the meaning of outcomes for client, families, and professional care teams, as well as evaluating outcomes of organizations providing hospice and palliative care services. Lastly, research is needed to demonstrate how multiinstitutional systems provide cost-effective, evidence-based, end-of-life care with enhanced use of rehabilitation services.

Conclusion

Rehabilitation professionals play an essential role in the care of terminally ill clients. Integrating a paradigm shift from improving performance capacity and toward participation in meaningful activity, rehabilitation professionals can accommodate the dying process and enable clients to achieve meaningful, client-centered goals. Rehabilitation professionals also aid in supporting family members and caregivers through the dying process and the bereavement period. Future research on outcome measures, best practices, caregiver training, and multi-institutional system organization will advance practice and enhance the quality of end-of-life care.

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Part IV

Future Research and Practice Directions

Prolonging Independence Versus Effects of Institutionalization

25

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Overview

As humans we are born in an extremely vulnerable and dependent state as infants who gradually develop the skills needed for independent living. At the other end of life, the process almost always reverses order, with a gradual loss of the skills required for independent living. Unless death or disablement is rapid, most humans will experience a gradual decline and loss of the abilities which have allowed us to be independent for most of our lives. The sequence of loss of independence in our later years due to cognitive decline is in reverse order of how we acquired our independence in childhood and adolescence. For example, executive skills and judgment are some of the last skills that we acquire as adults and first skills that we lose. The ability to manage continence is somewhere along the midway point in the continuum, while the loss of the ability to feed oneself and swallow are very late in the process of disablement.

Maintaining and prolonging independence are strongly related to both our physical and cognitive abilities. In persons who become acutely disabled, as a result of trauma or sudden illness at any stage of life, cognitive functioning can be preserved, and such individuals can continue to participate autonomously in decisions about their care and daily life. Adults who have physical disabilities that render them dependent on others, but are still cognitively intact with decisional capacity and financial and social (friends/family) resources, are often able to continue to live independently in the community as long as those supports remain in place.

As individuals mature and move along the continuum of independent living in our lives, we gradually move from dependence to independence, usually within a supportive family unit that is able to provide the structure and supports that are needed until full independence is achieved. At the opposite end of life, most care is also rendered by families, and the configurations of available family members to provide such needed care are highly variable at both ends of the spectrum. Sometimes a spouse or a sibling is the primary caregiver. Often, the primary caregiver is an adult child. Some families are large and have many family members who can contribute to meeting the care needs of the frail older adult, while other families may be limited to a single supporting individual. In families with more financial resources, hired caregivers can supplement family members' care. In persons who experience more gradual cognitive impairment with age, their capacity to participate in decisions about their care and life often gradually deteriorates over time. At the same time, preserving as much independence and autonomy for as

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long as possible is a common goal for older adults in western societies, because this is closely related to quality of life in western cultures where autonomy is highly valued.

It is estimated that 29% of older adults in the USA living in the community receive some type of assistance from a family caregiver (National Academies of Sciences Engineering Medicine, 2016). Family caregivers are responsible for meals, transportation to and from all appointments (both medical and nonmedical), medication management (refills/set up) and administration, complex medical procedures such as wound care, financial obligations and management, and general supervision of the older adult. As frailty and cognitive impairment progress, so do the responsibilities and duties of the caregiver. Even when the family has resources, such as an available stay-at-home caregiver, the duties of caregiving can negatively impact the health and well-being of the caregiver (Bucki, Spitz, Etienne, Le Bihan, & Baumann, 2016; Sayegh & Knight, 2011). It is estimated that family caregivers provided over $221 million worth of unpaid caregiving to their family members with dementia in the USA (2016 Alzheimer's disease facts and figures, 2016).

Circumstances that most often interfere with an older adult's ability to remain independent are physical frailty or dementia (Kojima, 2018; Middleton, Li, Kuo, Ottenbacher, & Goodwin, 2018; Tanuseputro et al., 2017). Adult children are not always available to meet frail or demented aging parents' needs. Family members may be estranged from frail parents or live in a geographically distant location. Some older adults are childless and lack extended family members who are willing or able caregivers. Adult children may not have the resources, both in terms of social or financial capital, to be able to meet their parent's needs. The older adult who is becoming frail and beginning to need support frequently lacks insight about his/her situation. Those who are aware of their increasing needs often have a strong desire not to be a burden on their family and often attempt to hide their growing frailty.

Thus, as older adults lose the ability to maintain their independent lifestyles, institutionalization can be the only or best option for some (Betini et al., 2017; Tanuseputro et al., 2017). Other older adults of similar functional status may have more resources (family or financial) and thus the ability to meet their needs and maintain a lifestyle that is more independent. The purpose of this chapter is to discuss the effects of institutionalization on older adults' ability to maintain or prolong their independence. Institutionalization within the context of this chapter will mean admission to a long-term residential care or retirement facility.

The Effects of Non-independent/Institutionalized Care

The concept of independence for older adults has received a great deal of attention in recent years. It is closely related to the concept of autonomy. Hillcoat-Nallétamby (2014) examined the meaning of "independence" among older adults in three different residential settings (Hillcoat-Nallétamby, 2014). Because the qualitative data were collected in Wales, the definitions of types of residential living arrangements for older adults are slightly different but still generalizable to western societies. The three specific residential settings which were compared in this study were (1) community settings, where older adults continue to live in their own homes with care and services to allow them to remain in their homes; (2) residential care homes, which were defined as "communal supported living environment offering specialized care to meet medical, physical, and cognitive needs, but not to the higher level of nursing home requirements"; and last (3) extra care setting which consisted of self-contained private living quarters with communal activities such as dining, organized social activities, and 24-hour support staff. In the USA, these levels would be (1) community-dwelling single-family homes, (2) assisted living, and (3) independent retirement living.

Across all settings, the author found the following five themes: "accepting help at hand"; "doing things alone"; "having resources, family/friends to help"; "having resources, ability to pay for help"; and "preserving mental and physical capacity." Various other themes also emerged in only one or two settings, such as "making one's own decisions," "isolation," "companionship," "fear of institutionalization," "not being a burden," and "boredom."

Of the 91 participants in the Hillcoat-Nallétamby (2014) study, 75% (n = 68) were older women who have an average age of 80 years and are single, divorced, or widowed (n = 70, 77%). Even though these participants were from Wales, the profile is very similar to US cohorts. In the USA, persons who are admitted to a retirement living or a long-term care facility are primarily women and widows, and the average age is 85 years (Harris-Kojetin et al., 2016). The most common denominator among all nursing home residents is dementia. Those who live in independent retirement living or assisted living have less dementia and frailty. Those who live in skilled nursing facilities are almost all physically frail and unable to live independently. Admission criteria for nursing facilities in the USA include dependence in one or more activities of daily living (ADLs), such as eating, dressing, toileting, bathing, continence, and transferring. Residents in other retirement living situations, such as assisted living, or independent living may be independent in all ADLs but require support in instrumental activities of daily living (IADLs), such as cooking, transportation, medication management, and shopping. It should also be noted that, for those who are able to live independently in the community with the supports that they need, their level of independence/autonomy is the same as it would be in the nursing facility. Those with the least disability generally have the greatest independence, whether institutionalized or not (Patomella, Sandman, Bergland, & Edvardsson, 2016).

According to Rockwood, Stolee, and McDowell (1996) and Resnick et al. (2016), a significant proportion of nursing home residents are admitted to nursing facilities for rehabilitation after a qualifying acute care hospital stay (Resnick, 2016). The most common diagnoses are a reflection of the most prevalent diagnoses that Medicare patients have who are hospitalized, such as myocardial infarction, stroke, congestive heart failure, pneumonia, total hip and knee arthroplasty, and injuries sustained from falls (such as fractured femur and/or pelvis (Rockwood, Stolee, & McDowell, 1996). Dementia or cognitive impairment is a very common comorbidity (Resnick, 2016; Rockwood et al., 1996).

Medicare will cover a limited stay for rehabilitation designed to restore the patient with Medicare Part A to their previous level of functioning so that they may return to the community (Medicare.gov, 2018). There are different levels of rehabilitation therapy intensity, and the attending physician and interdisciplinary team must determine the level of skill and intensity best suited to the patient's needs. The Medicare benefit extends for up to 100 days of coverage if patients are continuing to participate and make progress toward their identified rehabilitation goals. Only the first 20 days of care is fully covered by the Medicare benefit, with gradually increasing co-pays required from day 21 forward.

When patients reach their maximal functional and physical status or 100 days has been covered, the Medicare benefit requires that they be discharged from rehabilitation services in the nursing facility. Few patients need the full 100 days. If patients are not able to return to their previous living arrangements, other solutions (such as a permanent nursing home residence [not paid for by Medicare for rehabilitation]) are a possibility.

Approximately 50% of the patients admitted to a nursing facility for a rehabilitation stay are able to return to their previous situation at home or in assisted living or independent living (Keswani et al., 2016). The other 50% may be admitted as residents to a nursing facility as a permanent resident if they do not have resources to manage their private care at home. Medicare only covers the rehabilitation stay, and does not cover the board and care expenses of a nursing home resident after the conclusion of a rehabilitation stay.

In fact, because of the Omnibus Budget Reconciliation Act of 1987 (OBRA) (Kapp, 2008), residents of long-term care facilities have greater supports in place to preserve their autonomy and quality of life than the same person living in the community. OBRA set in place a regulatory system that requires that each individual in a nursing facility receives the necessary care and services to achieve and maintain "the highest practicable physical, medical and psychological well-being" that can be obtained (Medicare.gov, 2018). All residents' quality of life and condition are monitored at least quarterly, and aggregate reports for each facility are publicly available (Medicare.gov, 2018).

The risk factors for nursing home placement are increasing age, low income, low social engagement, poor family support (lack of spouse or children), and cognitive or functional impairment (Andel, Hyer, & Slack, 2007). Because many older adults and new nursing home admissions have limited financial resources, new nursing home residents often must apply for Medicaid as a payment source. Social workers, who can assist families with the navigation and application for such programs, are essential interdisciplinary team members in nursing home settings. The expenses associated with institutionalization quickly deplete many older Americans' financial reserves (Andel et al., 2007).

Although some people may fear that living in institutional settings will lead to a lack of independence, institutional living can allow older adults to do more than they could while living in the community independently. For example, by selling an aging single-family home and choosing to live in retirement housing, the former homeowner is free from the demands of home maintenance, repairs, and property taxes. Living in a more communal collective environment can also allow previously isolated and lonely older adults the opportunity to establish new social relationships with new peers and staff.

The reasons for admission to institutional living are almost always connected to physical frailty and/or cognitive impairment. Both of these conditions are also almost always progressive over time. Although institutionalization may seem to have a negative impact on individual independence/autonomy, the intent of these policies is actually designed to be supportive of as much individual autonomy as possible for as long as possible. Institutionalization as an intervention to preserve independence and safety may be a viable option for older adults.

Practice Recommendations

The current best practice for rehabilitation decisions is to perform an interdisciplinary assessment of each individual patient needing rehabilitation in order to develop the best possible plan for provision of the needed services, which have the potential to restore individuals to their highest possible level of functioning. The clinician in charge of writing the discharge orders should include all the recommendations for services that could reasonably help the patient achieve his/her goals for rehabilitation. Team members assist the patient and family to consider and choose an available facility in a location that is acceptable and which can provide all the skilled services needed by the patient for rehabilitation. It is strongly recommended that the clinical team consider all the comorbid conditions that the patient and his/her healthcare team must deal with and choose the best possible site to manage all the comorbid conditions of complex patients.

Future Directions in Practice and Research

One of the most fascinating pieces of information gleaned from the literature to date is that patients with dementia may do well in rehabilitation, seemingly in spite of their cognitive impairment. An easy assumption would be that persons with dementia might be considered for exemption from rehabilitation services, assuming that their cognitive disability might prevent them from achieving their rehabilitation goals. While having significant cognitive impairment does slow acquisition of new skills and knowledge, and such patients may require a longer period of rehabilitation, many patients with cognitive impairment do very well and are able to successfully return to their premorbid level of independence.

Rehabilitation services provided by physical therapy, occupational therapy, speech therapy, and nursing care even have the potential to restore some individuals to a functional status better than their immediate premorbid condition.

One of the market trends that has surfaced over the past 10–20 years in the USA is the development of facilities advertised to provide care specifically for cognitively impaired older adults. It is fascinating to this author that, even though these facilities go to great efforts to distinguish themselves in the market as specializing in dementia care, their outcomes for the patient with dementia are no different than other traditional nursing facilities. We really have very little data on which to base decision-making around rehabilitation efforts for patients with dementia.

Summary and Conclusions

Physical frailty and cognitive impairment are the two greatest threats to individual autonomy and independence, followed by social and economic supports. Persons who are physically frail, but have adequate cognitive reserve as well as social and economic supports, are often able to maintain an independent lifestyle with or without institutionalization. Persons with moderate to severe cognitive impairment typically are more dependent on others for every need, regardless of their physical function. Whether these persons reside in an institution or do not, they are quite dependent on others. Institutionalization makes no impact on prolonging the independence of persons with dementia.

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Health and Wellness Programs for Older Adults

26

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Overview

One of the principles of the *World Health Organization* defines health "as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 2017). Wellness programs are utilized across numerous population groups, with the goals of promoting behaviors conducive toward maximal and sustained health practices throughout the life span of individuals. Health and wellness programs for older adults are essential in preventing physical, emotional, and cognitive declines that can occur during the aging process. Two major components of health and wellness in older adulthood include physical activity and nutrition (caloric balance). This chapter will first examine the key components that should be included in a comprehensive physical activity or nutrition program, with aims to increase maximal function for the older adult. Once these key components are outlined, the remainder of this chapter will take into consideration the factors related to geriatric syndromes and will provide evidence-based approaches to remediate/prevent these conditions. The rationale for what makes these evidence-based interventions effective is provided to allow the reader to formulate how a comprehensive wellness program, which includes physical activity *and* nutrition, may be designed to address the needs of the older adult.

Physical Activity

Increasing physical activity should be one of the prime objectives of any wellness program that caters to older adults. With the improved physical fitness that results from a well-designed physical activity program, older adults may enjoy increased independence, decreased perceived exertion as they perform their basic and instrumental activities of daily living, and enhanced quality of life (Hughes, Seymour, Campbell, Whitelaw, & Bazzarre, 2009). Improvements in levels of physical activity and fitness have been shown in numerous studies to reduce morbidity and mortality due to cancer, heart disease, chronic respiratory diseases, and accidental falls in seniors (Hughes et al., 2009). The following includes key components of physical activity that can improve the health and well-being of older adults.

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Key Components of Physical Activity

Muscular Strength and Power

Most evidence-based wellness physical activity programs that address the needs of older adults should include exercises to improve muscular strength, power, joint flexibility, cardiorespiratory fitness, sensorimotor coordination, and agility (Hughes et al., 2009). Improvements in muscular strength and power become increasingly important as individuals age (Hughes et al., 2009). Muscular strength is defined as the external force that can be generated by a specific muscle or muscle groups (Reibe, 2018). This is commonly expressed in the amount of force produced in pounds or kilograms. The recommendations are for the older adult to engage in resistance-training exercises at least 2 days per week for all muscle groups, using weights that range from 40% to 50% over time for the amount they can lift one time and then progressing to higher intensities such as 60–70% of their one repetition maximum and greater over time (Reibe, 2018). Without the implementation of resistance training, muscle mass begins to decline steadily as individuals enter their third decade of life. Steeper declines in muscle mass occur with ensuing loss of muscular strength sometime during the fifth decade of life (Law, Clark, & Clark, 2016). The loss of muscle mass and strength after individuals reach 50 years old ranges from 1–2%/year to 1.5–5%/year, respectively. At this rate of decline, the typical 70-year-old individual has the capacity to lose anywhere from 20% to 40% of muscle mass, with a concomitant 30–100% reduction in muscular strength as compared to their younger years. Thus, preservation of muscle mass is critical to maintain independence and function. *Sarcopenia* is defined as the loss of muscle mass that is associated with aging, with concomitant decrements in strength and physical function (Law et al., 2016). This loss of strength can be attenuated with a progressive resistance training program, along with a sound nutritional plan to provide the stimulus, micronutrients, and macronutrients necessary for muscular growth and repair (Sapega & Drillings, 1983). Tasks such as transfers from sit to stand, climbing stairs, and carrying groceries typically do not require maximal force output from the muscles; however, a reduction in maximal force potentially requires the older adult to perform tasks at a higher relative amount of their available strength, thus increasing the physiological demands on the older adult to do everyday tasks. Numerous studies have shown that older adults who participate in progressive resistance training programs have the capacity to increase their relative muscular strength to improve physical performance and to reduce accidental falls (Sapega & Drillings, 1983).

Muscular power is defined as the ability of the muscles to perform a certain amount of work over time or to produce relatively high amounts of force in a short period of time (Sapega & Drillings, 1983). Typically, individuals who possess functional levels of muscular power can produce muscular force at joint angular velocities to perform tasks, such as standing up from chair, placing dishes into a cabinet, loading clothes into a washing machine, and rapidly stepping forward to catch oneself from a fall. Physical activity programs that aim to reduce falls and improve physical function utilize a combination of exercises to improve muscular strength, power, and balance in order to reduce the incidence of injurious falls in older adults (Avin et al., 2015).

Cardiorespiratory Fitness

Cardiorespiratory fitness relates to the ability to perform physical activities that require the use of large muscle groups used dynamically over prolonged periods of time (Reibe, 2018). The intensity of the cardiorespiratory exercise dictates the muscular demands for oxygen by the working muscles and is dependent on the delivery by the heart, lungs, and blood vessels (Resnick & D'Adamo, 2011). Heart disease is the number one cause of mortality for adults 65 years of age or older (Centers for Disease Control and Prevention, 2017). For older adults, improvement in cardiovascular fitness means they can perform their activities of daily living without undue fatigue (Fletcher et al., 1996). In addition, the improvements that are made with chronic cardiovascular training, such as reductions in blood pressure, cholesterol, and fasting glucose, are numerous and well documented (Bouaziz et al., 2017). The older adult should engage at least 150 min of moderate to vigorous cardiovascular exercise, such as walking, cycling, swimming, or dancing, each week, using bouts as little as 10 min at a time to acquire the physiological benefits (Reibe, 2018).

Flexibility

Flexibility is defined as the ability to move a joint or series of joints through their full range of motion (Reibe, 2018). Lack of flexibility contributes to joint and muscular stiffness that limits the older adult's ability to move effortlessly. Agility and coordination are often regarded as skill-based physical fitness attributes that are often viewed as important for younger, athletic individuals but are of increasing importance for the older adult. Agility is defined as the ability to change position of the body in space with speed and accuracy (Reibe, 2018). Instrumental activities of daily living, such as shopping in a crowded store, often require the individual to change directions. Coordination is defined as the ability to execute movements smoothly and accurately, using sensory inputs to adjust the movement patterns (Reibe, 2018). Activities such as stepping over objects, walking on uneven surfaces, or reaching to grab an object all require sensory inputs to aid in the precision of the muscular efforts needed to execute the tasks in a flawless manner. Acquisition of both skills serves to reduce falls' risk and improve the ability for the older adult to execute tasks safely.

Evidenced-Based Physical Activity Wellness Programs

Now that the physical fitness attributes have been defined, we will examine three evidence-based wellness programs that are designed to improve the wellness of the older adult. Two of them utilize a traditional face-to-face group format, and the other employs an individualized approach to reach older adults using distance-based means such as the telephone and/or the Internet.

Enhance®Fitness

Enhance®Fitness is an evidence-based group exercise program designed by Sound Generations (formerly Senior Services) and the University of Washington Health Promotion Research Center in 1993 (Enhance, 2017). The program has received an endorsement by the National Council on Aging. The program consists of a 5-min warm-up, 20 min of cardiorespiratory exercise, 20 min of resistance training using ankle or wrist weights, 10 min of stretching with balance exercises incorporated throughout the exercise session, and a 5-min cooldown. The program is taught by an instructor who is certified by the Enhance®Fitness company. Clinical effectiveness of this program is supported by published studies. Greenwood-Hickman and colleagues (Agmon, Kelly, Logsdon, Nguyen, & Belza, 2015) noted a 30%–40% reduction in the incidence of falls that require medical care for older adults who participated in the **Enhance®Fitness** program. They also found a dose-response relationship for this reduction in fall incidence, as noted by participants who used the program at least two or more times during all the years they were enrolled in their health insurance plan; it had the largest reduction followed by more reduction for participants who used the program less frequently. Another study noted that for 28 community-dwelling adults who participated in the 1-hour **Enhance®Fitness** program, three times per week over a 6- to 10-week period, the participants' ability to perform two walking performance tests was improved that was assessed via gait speed and agility (Agmon et al., 2015). Gait speed is a critical measure of physical performance that is strongly correlated with morbidity and mortality from all causes. Gait speed was measured via the distance covered in a 1-min walk test, both in isolation and while performing cognitive test. Agility was measured with the Timed Up and Go test performed in isolation, and while carrying an object, all improve with lowered times perform those tasks. This study noted that walking performance also improved for the participants, while they did the two walking tests while performing cognitive tasks, suggesting that the program elevated the ability to perform higher-level executive functions such as memory, thought processing, and execution of a task in a fluid and timely manner.

The key strengths of the **Enhance®Fitness** program lies in the use of a group format, which provides increased participant satisfaction and engagement that fosters compliance. The program also addresses each physical fitness component as previously outlined, which results in the improvements made during functional tasks such as walking and carrying objects, but also with other fitness components such as upper and lower body strength assessed via the 30-s arm curl and chair stand tests, respectively (GeriFit, 2017). The one potential drawback of the program is the significantly high cost that averages $1713 and $873 during the first and second years of program implementation (Palmer et al., 2016). The majority of these costs are related to the salary and wages of the staff to deliver the program, the training requirements to achieve the certification, and the purchase of the equipment to be used for the program.

Geri-Fit

Geri-Fit is another evidence-based group exercise program that is endorsed by the National Council on Aging as a highly effective evidence-based exercise program for older adults. **Geri-Fit** is conducted twice a week for 45 min, with the exercises performed in the seated or standing position. This program emphasizes progressive resistance training using light dumbbells (2 lbs) and exercise bands to strengthen the major muscle groups. The participants are prescribed a specific volume (number of repetitions x number of sets) to achieve before the load is increased (4–5 lbs. dumbbells) to provide a progressive overload to the muscle groups. Additional fitness components, such as flexibility, cardiovascular, balance, fall prevention, and gait training exercises, are included during each session. In a published study, 19 older adults (mean age, 74.2 years) had a reduction in postural sway after completing 90 days of the **Geri-Fit** program (Goble, Hearn, & Baweja, 2017). Increased frequency and amplitude of postural sway are common in older adults and are risk factors for falls; interventions such as Geri-Fit that reduces excessive or frequent sway have the potential to reduce the number of falls in this population.

The **Geri-Fit** instructors must possess an exercise science or a clinical degree in exercise physiology, kinesiology, and physical or occupational therapy to name a few or have a personal trainer certification from a nationally recognized certifying body such as the American College of Sports Medicine or the National Strength and Conditioning Association. In addition to the aforementioned qualifications, the instructors must have received online training and certification from Gerifit.com. The program costs $2500 to receive the license from **Geri-Fit**, which includes the online training and certification for two instructors.

Active Choices

Many older adults reside in rural or urban areas that are devoid of community centers that offer group fitness classes for older adults. Distance-based media, such as the Internet and the telephone, have shown to be promising health promotion tools to reach individuals who otherwise would not have access (Korda & Itani, 2013). One such program is **Active Choices**, a telephone-assisted physical activity program. The program was implemented in 2001 and is offered in 13 states of the USA, Canada, and Australia (National Council on Aging). This is a 6-month program that provides feedback, guidance, and instructions to the older adult using an individualized approach. This program empowers the participants to choose the location and time of day that is most convenient for them to exercise. The premise of this program is built upon the general desire of older adults to exercise in their homes or locations that are familiar to them. The program provides an initial 30–40-min consultation with a health educator. During this session, a general pre-participation screen is performed to ascertain the participant's risk for cardiovascular disease and to understand their current levels of physical function. An exercise plan is developed based on the participant's goals, and written exercise instructions are provided. Exercise logs are used to track their progress, and they are given information on physical activity resources in their community. After the initial phone call, a series of 10–15-min follow-up phone calls are utilized throughout the duration of the program. Typically, the initial frequency of these follow-up phone calls is weekly and then decreases to bi-weekly and monthly. These follow-up phone calls provide support, feedback, and the opportunity for the participant to problem-solve. Some organizations have used optional resources to maintain and reinforce the physical activity behaviors developed in this program. Some facilities mail "tip sheets" and/or newsletters to educate their participants on additional and unique ways to stay physically active, while others mail resource guides that provide the location of venues such as parks, walking trails, and community centers that have physical activity programs that cater to the older adult. Based on the resources available, other facilities provide small gifts, such as t-shirts, to help keep their participants motivated. Lastly, other facilities provide face-to-face functional fitness assessments and monthly social gatherings to keep their participants connected and engaged, which enhances the maintenance of desirable behaviors over time. The **Active Choices** program does not have a licensing requirement, but there is a one-time cost to the facility of $295 to purchase an electronic training manual that provides coach and counselor training and forms that can be reproduced. The actual training cost starts at $1200 per facility and varies based on the number of individuals trained and whether the training will be conducted on- or off-site. There are ongoing costs primarily due to salaries for a full-time program coordinator, a part-time recruitment coordinator, a full-time health educator, and a part-time administrative assistant.

There is solid evidence to support the **Active Choices** program based on its reported effectiveness across a wide range of populations based on ethnicity, residential status (rural vs. urban), and healthy (sedentary older adults, worksite populations) vs. clinical populations (low-risk cardiac patients, individual who are obese). One study conducted at the Stanford Cardiac Rehabilitation Center found that patients who had an uncomplicated myocardial infarction presented with similar improvements in functional capacity and exercise adherence, relative to patients who received medically supervised group exercise training at a lower cost (Castro & King, 2002).

Behavioral Components of Physical Activity Wellness Programs

Each of these geriatric wellness programs previously discussed utilize structured exercise plans to enhance each key component physical fitness. A common theme of these programs is the underlying behavioral strategies to promote adoption and long-term adherence. Various theoretical models can serve as guides to determine who are the most suitable candidates to engage in these types of programs and how to keep them active over time (Rhodes et al., 1999). Individuals who have made the commitment to adopt an exercise program tend to realize that the benefits of exercise (i.e., improved health, increased vigor, higher-quality of life) outweigh the costs (expenditure of time, energy, effort, and monetary resources) (Rhodes et al., 1999). These individuals may perceive themselves as being vulnerable to contracting or advancing a chronic disease that can be prevented or managed with physical activity. Often, the candidates who initially adopt a physical activity program may believe that contraction or advancement of the chronic disease is serious enough to warrant a lifestyle change, particularly if these series of events occurred to a friend or family member (Rhodes et al., 1999).

Based on theoretical models of behavior change, it appears that individuals who have made a mental commitment to begin an exercise program in the near future are the most suitable for these types of programs, as they most likely have adopted the perceptions regarding exercise and their health as discussed previously (i.e., Dishman, Vandenberg, Motl, & Nigg, 2010). Once participants enter a structured physical activity program, many of these programs utilize reinforcement tools that are rooted in the theory of operant conditioning. Operant conditioning involves the use of reinforcements that is valued by the individual to support or extinguish a behavior (Buckworth & Buckworth, 2013). In the case of someone who has been conducting an exercise regime as prescribed, the use of verbal praise from an exercise instructor who is well-liked and respected by the individual provides a positive reinforcement to continue. This reinforcement provides a symbolic consequence to the behavior, whereas organizations that provide free memberships to their fitness facilities to encourage older adults to exercise utilize the operant conditioning concepts of symbolic antecedents. Symbolic antecedents facilitate anticipated behaviors, such as an individual who has expressed a desire to exercise but lacks a venue to exercise, which is reinforced via a free fitness facility membership.

Social cognitive theory relies on the use of social modeling, such as peers and instructors, who can demonstrate the practicality of adopting and maintaining healthy behaviors over time (Reibe, 2018). This model allows for improvement in self-efficacy which is a key tenet of the theory. Self-efficacy is defined as the confidence that an individual has to be successful in executing a behavior under conditions that they perceive as adverse. These adverse conditions may be inclement weather, lack of time, feelings of fatigue from work, or other daily tasks. The physical activity programs described all use trained instructors who provide instructions and tips to increase physical activity. Monitoring, whether it is face-to-face when an instructor watches a participant successfully execute a particular exercise, or feedback provided via the telephone when a health coach reviews a participant's exercise logs, can all serve as valuable interactions to enhance self-efficacy and mastery of the task of becoming more physically active.

Both the group and individual wellness programs all utilize social contacts, either from group or individual interactions, to provide social support, which is vital source of guidance and problem-solving; attachment to others in the group or the instructors; social integration that provides a sense of belonging; reliable alliance that gives the individual a sense that he or she can count on others for help or support; reassurance of worth, which allows the individual to feel that he or she has something unique to contribute to the interaction with others; and opportunities for nurturance which allows the individual to experience helping others in a group setting (Reibe, 2018). The group-based wellness programs may have a distinct advantage over the individual-based wellness programs because the group-based programs utilize a cohort of individuals who are all simultaneously striving for the same common goal to increase their physical activity. For many older adults, having individuals who they can identify with regard to their age, stage of life, health, and physical impairment challenges can serve as a powerful method to increase self-efficacy.

Mastery of experience is an important concept that aids in the persistence of healthy behaviors over time. As an individual gains a sense of accomplishment by performing meaningful tasks that were not previously achievable, this can be a powerful motivator for persistence of a healthy behavior. Even simple acts, such as when an instructor is present to correct or provide affirmation that an exercise task is done correctly, can enhance mastery of experience. Often improvement in physical fitness and performance is the outcome of a proper executed well-planned physical activity program. Consistent use of valid outcome measures to track progress in the older adult can serve to heighten the mastery of experience, particularly if improvements are realized by the individual (Reibe, 2018) (Adapted from the American College of Sport Medicine's Guidelines for Exercise Testing and Prescription, 10th Edition, Table 26.1 summarizes the common physical performance tests used for the older adult population (Cress et al., 1996; Guralnik et al., 1994; Reibe, 2018; Rikli & Jones, 2001)). The outcome measures delineated in Table 26.1 should be administered at baseline and periodically throughout the program, typically in intervals as short as every 2 to 4 weeks, up to 8 to 12 weeks. It is important for the older adult to understand areas of fitness that need to be emphasized and areas where improvements have been made. These outcome measures can serve as tools to modify certain portions of the program to emphasize fitness attributes that may be lacking. The program instructors should understand the use of age- and gender-based norms for these outcome measures when determining areas of physical performance to emphasize. It is paramount that the clientele encountered by the health and fitness professional possesses similar characteristics as the population that was used to derive the age- and gender-based norms to ensure valid comparisons.

Quality assurance is another key component for physical activity programs that cater to older

Table 26.1 Commonly used physical performance tests

Measure and description	Administration time	Cutoff indicative of lower function
Senior fitness test		
Seven items: 30-s chair stand, 30-s arm curls, 8 ft up and go, 6-min walk, 2-min step test, sit and reach, and back scratch with normative scales for each test	30-min total individual items range from 2 to 10 min each	≤25th percentile of age-based norms
Short physical performance battery		
A test of lower extremity functioning that combines scores from usual gait speed and timed tests of balance and chair stands; scores range from 0 to 12 with higher score indicating better functioning	10 min	10 points
Usual gait speed		
Usually assessed as the better of two trials of time to walk a short distance (3–10 m) at a usual pace	<2 min	1 $m*s^{-1}$
6-min walk test		
Widely used as an indicator of cardiorespiratory endurance; assessed as the most based norms distance an individual can walk in 6 min. A change of 50 m is considered a substantial change	<10 min	≤25th percentile of age-based norms
Continuous scale physical performance test		
Two versions – long and short – are available. Each consists of serial performance of daily living tasks, such as carrying a weighted pot of water, donning and removing a jacket, getting down and up from the floor, climbing stairs, carrying groceries, and others, performed within an environmental context that represents underlying physical domains. Scores range from 0 to 100 with higher scores representing better functioning	60 min	57 points

Source: Adapted from the American College of Sports Medicine's (ACSM) Guidelines for Exercise Testing and Prescription, 10th edition

adults. Besides the use of the objective physical performance measures described in Table 26.1, understanding the perceptions that older adults have regarding their own physical function, pain, or discomfort before, during, or after the program and the impact it has on other areas of their lives is paramount to promote adherence to the program (Reibe, 2018). There are numerous measures of self-perceptions of physical function that are disease or impairment specific, but simple questions that use ordinal-based scales can provide valuable information to the program facilitators of the impact that the physical activity program has on the quality of life of their participants. A list of these ordinal-based questions are reproduced from a published study by Hamar et al. and are displayed in Table 26.2 (Hamar, Coberley, Pope, & Rula, 2013). Many older adults have chronic musculoskeletal conditions such as arthritis. The exercise instructor should explain to the participants how to use the numeric pain scale Table 26.3 (Ritter, Gonzalez, Laurent, & Lorig, 2006). The use of this scale will allow the participants in the program the opportunity to more objectively express to the instructor any change in pain that may have resulted from a particular exercise. Prompt notification to the exercise instructor about a change in a participant's pain may foster a more collaborative approach toward managing the participant's pain by modifying the program which may promote long-term adherence.

Nutrition

Optimal nutrient intake and nutritional status are key components to maintain health and wellness and improve quality of life, as well as physical and mental performance in older adults. Nutrition is the science that applies nutrients and other compounds found in food to growth and development as well as how these nutrients impact overall health and disease. Obtaining appropriate nutrients in older adulthood can be challenging. Energy (kilocalorie) requirements decrease in

Table 26.2 Study outcome variables

Measure name	Survey item	Item responses	Response classification
Health status	In general, would you say your health is	Excellent	Favorable
		Very good	
		Good	
		Fair	
		Poor	
Health status change	Compared to 1 year ago, how would you rate your health in general now?	Much better now than 1 year ago	Favorable
		Somewhat better now than 1 year ago	
		About the same as 1 year ago	
		Somewhat worse now than 1 year ago	Unfavorable
		Much worse now than 1 year ago	
Functioning –climbing stairs	Does your health now limit you in [climbing several flights of stairs]? If so, how much?	Yes, limited a lot	Unfavorable
		Yes, limited a little	
		No, no limited at all	Favorable
Social limitations due to health	During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?	All of the time	Unfavorable
		Most of the time	
		Some of the time	
		A little of the time	Favorable
		None of the time	
Work or activity limitations due to health	During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health? Were limited in the kind of work or other daily activities	No, none of the time	Favorable
		Yes, a little of the time	
		Yes, some of the time	Unfavorable
		Yes, most of the time	
		Yes, all of the time	
Physical health	Thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?	Freeform (number of days)	N/A
Emotional health	Thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?	Freeform (number of days)	N/A
Activities of daily living	Because of a health or physical problem, do you have any difficulty doing the following activities? (separate responses for each following activity: bathing, dressing, eating, getting in or out of chairs, walking, using toilet)	I am unable to do this activity	Impaired
		Yes, I have difficulty	
		No, I do not have difficulty	Not Impaired

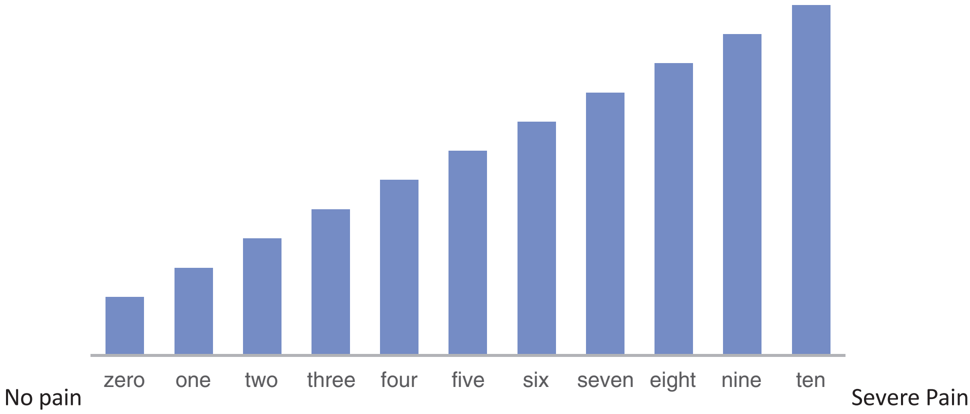
Source: Hamar et al.(2013)

proportion to reductions in physical activity and resting energy expenditure, while the need for vitamins and minerals is either increased or remains constant (Centers for Disease Control and Prevention, 2008). Therefore, incorporating a variety of nutrient-dense foods, such as whole grains, dairy, fruits, vegetables, and high-quality protein sources, is critical in older adults. In addition to maintaining physiological needs, food contributes to the social, cognitive, and cultural needs that are often limiting in older adults.

Factors That Contribute to Poor Nutritional Status in Older Adults

Several factors contribute to poor nutritional status in older adults. Optimal nutrient intake can be

Table 26.3 Visual numeric pain scale



Source: American College of Sports Medicine's (ACSM) Guidelines for Exercise Testing and Prescription, 10th edition

difficult as age progresses because of altered health and functional status, polypharmacy, financial limitations, cognitive decline, lack of support or socialization, and environmental issues.

Chronic Diseases

Older adults often have physical, mental, or environmental conditions that impact dietary intake and nutrient status. Over 85% of adults over the age of 65 have at least one chronic disease, and almost half have at least two chronic diseases (Centers for Disease Control and Prevention, 2008). Interestingly, over 60% of deaths related to chronic disease are a direct result of nutritional status (Centers for Disease Control and Prevention, 2013) indicating diet directly impacts the development, but also the treatment, of many chronic diseases (e.g., diabetes).

Polypharmacy

Polypharmacy is a major concern in adults over 60, with over 75% taking at least two prescription drugs and almost 40% taking five or more (Little, 2017). The most commonly used prescription medications in older adults include cholesterol-lowering medications, beta-blockers, and diuretics. Usage of multiple over-the-counter and prescription medications increases the risk of nutrient-drug interactions. Certain medications can increase the excretion of certain key vitamins and minerals, such as potassium, magnesium, and zinc with diuretics (Little, 2017). Many medications influence appetite and taste perception, as well as digestion, nutrient absorption and utilization, and excretion (Little, 2017).

Senses and Oral Health

Changes in taste, smell, and vision can also impair nutrient intake during older adulthood (Winkler, Garg, Mekayarajjananonth, Bakaeen, & Khan, 1999). Although smell is the primary sense lost, the ability to detect bitter and salty tastes diminishes with age, while sweet and sour flavors are sustained (Winkler et al., 1999). Ill-fitting dentures can impact the ability to chew certain foods and promote the avoidance of meats, as well as raw and dried fruits and vegetables. Difficulty swallowing and gastroesophageal reflux disease (GERD) are also common in older adults.

Fluid Balance

Many older adults are not able to adequately detect thirst, which can result in dehydration and electrolyte imbalances. The inability to concentrate urine, decreased thirst sensation, and changes in endocrine function contributes to dehydration risk (Oates & Price, 2017). Interventions targeting fluid and hydration status are primarily conducted in nursing homes and hospitals in patients already in negative-fluid balance (Oates & Price, 2017). Thus, there is limited evidence on improving fluid intake in free-living older adults.

Physical Status and Cognition

Age-related changes in body composition (decreased muscle mass and bone density) can impact strength, endurance, mobility, and functional status. For older adults, especially those living independently, negative changes in physical status can impact the ability to shop for, and prepare, healthy foods. Depression and altered mental status can also impact nutrient status, as well as beliefs and habits related to dietary intake during aging.

Income and Environment

In 2015, 8.8% of US adults were at or below the poverty level (Proctor, Semega, & Kollar, 2016), and, typically, older adults with poorer health status are below poverty with minimal access to healthcare. In addition, low-income older adults may live in a food "desert," with extremely limited access to healthy, nutrient-dense foods. Lack of transportation to purchase healthy foods may also be limited. Religious and cultural beliefs can influence nutrient status as well.

Nutrient Needs in Older Adults

Two major nutrient classifications include *macronutrients* and *micronutrients*. Macronutrients provide energy in the form of kilocalories and include carbohydrates, protein, and fat. Micronutrients do not provide energy, but are either components of cofactors required for enzyme function for energy metabolism or serve a structure/function role (e.g., calcium in the bone and teeth). Micronutrients can be divided into vitamins (water-soluble and fat-soluble) and minerals (major, trace, and ultra-trace).

Nutrient needs change during the aging process. While all nutrients are important and essential, the nutrients of concern in older adults include energy, protein, fiber, vitamin B12, folic acid, vitamin D, and calcium (Bernstein, Munoz, & Academy of Nutrition & Dietetics, 2012). The following provides details on why these nutrients should be assessed and monitored in older adults. More information on the nutrient needs of older adults can be found in the position paper from the Academy of Nutrition and Dietetics (Bernstein et al., 2012).

Energy

Energy needs decrease throughout adulthood, which is primarily related to inactivity patterns. Lack of activity leads to lower muscle mass which decreases energy requirements at rest. Muscle mass is the primary contributing factor of metabolic rate (the amount of energy expended at rest, as well as during activity). Without reductions in overall energy, especially foods that are not nutrient dense, fat accumulation occurs and can impair overall health. Because energy needs are reduced in older adulthood, the intake of nutrient-dense foods should be emphasized, while foods high in calories but low in nutrients should be discouraged. Unfortunately, more than 90% of adults between 51 and 70 years of age consumed more empty, non-nutritive calories than needed (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010), suggesting this should be a component of older adult intervention programs. "Empty calories" include foods that are often processed and high in sugar, refined starches, and solid fats but low in vitamins and minerals. Alcohol is also considered "empty calories." The maximum amount of "empty calories" for adults over the age of 50 is 426 kcal for males and 290 kcal for females (Krebs-Smith et al., 2010). Although obesity is often viewed as being well-nourished, the presence of undernourishment (malnutrition) is a phenomenon that often coincides with obesity. Obesity-related malnutrition results from excessive caloric intake of foods low in essential micronutrients.

Energy needs are based on several factors, including age, sex, height, weight, and activity patterns. The estimated energy needs for older adults, based on age, sex, and activity level, can be found in Table 26.4. Table 26.4 provides an estimate of energy needs for individuals, not necessarily populations as a whole. Thus, wellness interventions assessing the individual needs of the participants should use Table 26.4 as a guideline for daily energy needs.

Table 26.4 Energy requirements of older adults according to age, sex, and activity levels

	Males			Females		
Age (years)	Sedentary[a]	Moderate activity[b]	Active[c]	Sedentary[a]	Moderate activity[b]	Active[c]
51–55	2200	2400	2800	1600	1800	2200
56–60	2200	2400	2600	1600	1800	2200
61–65	2000	2400	2600	1600	1800	2000
66–70	2000	2200	2600	1600	1800	2000
71–75	2000	2200	2600	1600	1800	2000
76 and up	2000	2200	2400	1600	1800	2000

Source: Institute of Medicine (2002)
[a]Sedentary: physical activity associated only with independent living
[b]Moderate activity: physical activity equivalent to walking about 1.5–3 miles per day at 3–4 miles per hour, plus independent living activities
[c]Active: physical activity equivalent to walking more than 3 miles per day at 3–4 miles per hour, plus independent living activities

Although excess energy particularly from poor nutrient-dense food is a concern in older adults, undernutrition is also present. Community-dwelling undernutrition ranges from 5% to 15% (Favaro-Moreira et al., 2016; Kaiser et al., 2010), highlighting the importance for appropriate individualized nutritional interventions with screening indices.

Protein

Protein is required to maintain muscle mass and metabolic function during aging. Regular consumption of high-quality protein-providing essential amino acids is necessary but challenging due to economic, social, and physiological limitations. The Recommended Dietary Allowance (RDA) for protein in older adults each day is 0.8 g/kg body weight. However, some evidence shows that consuming 1.0–1.2 g protein per kg body weight (up to 18% of energy from protein) may be more beneficial to mitigate muscle loss (Houston et al., 2008). High-quality protein sources primarily come from animal sources (eggs, dairy, meat, poultry), as well as fish, soy, beans, peas, nuts, and seeds. Suggested protein intakes of 25–30 g at each meal have been shown to provide maximum health benefits in older adults (Paddon-Jones & Rasmussen, 2009).

Fiber

Fiber is beneficial to maintain a health gastrointestinal (GI) tract, improve glycemic control, lower cholesterol and body weight, and contribute to fullness. Rich food sources of fiber include fruits, vegetables, and whole grains. Dietary supplements (e.g., Citrucel, Metamucil) can also be used to meet dietary fiber recommendations, although food sources of fiber are encouraged over supplements. Fiber-rich foods are nutrient dense and high in vitamins, minerals, and antioxidants. Adequate fluid should be assessed with fiber intake in older adults to prevent bowel obstruction or constipation. Men and women over the age of 51 should consume 30 g and 21 g, respectively, of fiber daily (or 14 g for every 1000 kcal) (Institute of Medicine, Dietary Reference Intakes, 2006). Older adults currently do not meet the recommendations for dietary fiber which is considered a nutrient of concern by the Dietary Guidelines for Americans 2015–2020 (US Department of Health and Human Services and US Department of Agriculture, December 2015). In fact, older female adults that consume more fiber have higher resting metabolic rates, which can imply higher muscle mass and less sarcopenia (Patterson, Wang, & Ortiz, 2018).

Vitamin B12 and Folate

Vitamin B12 is a water-soluble vitamin that can be stored in the liver for 3–5 years. Vitamin B12 is found only in animal sources and, with reduced intake of animal proteins over time, can result in deficiency. Deficiencies in this vitamin can also occur with gastritis or chronic use of antacids or medications used to treat GERD. A low stomach pH and intrinsic factor released from the stomach are essential for vitamin B12 to be absorbed in the small intestine. An estimated 6–15% of older adults are deficient in vitamin B12, while ~20% have inadequate status (Allen, 2009). Deficiency in this vitamin can cause macrocytic anemia, peripheral neuropathy, neurological complications, and elevated homocysteine concentrations in the blood which is a risk factor for cardiovascular disease.

Folate is also a water-soluble vitamin and, unlike vitamin B12, cannot be stored in the body and requires regular consumption. Folate is necessary for vitamin B12 to function as a methyl donor in cells. Deficiency of folate can cause macrocytic anemia. Good sources of folate include green vegetables, fruits such as avocado and orange juice, soy, beans and peas, and fortified grains, cereals, and pasta.

Calcium and Vitamin D

Over ten million adults over the age of 50 have osteoporosis, with another 33 million with low bone mass (Wright et al., 2014) indicating the importance of appropriate vitamin D and calcium intake during the aging process. Vitamin D is necessary for dietary calcium absorption in the small intestine. Low vitamin D levels cause calcium to be removed from the bone, ultimately causing osteoporosis. Vitamin D deficiency in older adults is twofold: low dietary intake due to scarce sources (fatty fish and fortified dairy) and low de novo production from sunlight exposure to the skin. In addition to reduced ability to synthesize vitamin D in the skin, older adults spend more time indoors and cover their bodies with clothing. Sources of calcium primarily include dairy products. Adults 51 years and older should consume three cups of dairy or equivalent products daily; however, this population consumes only ~1.5 cups daily (US Department of Health and Human Services and US Department of Agriculture, December 2015). The recommended daily allowance for vitamin D for 51–71 years old is 600 IU daily, but the amount increases to 800 IU at age 71. Calcium requirements for males age 51–70 is 1000 mg/d but increases to 1200 mg/d at age 71 and above. Females above 51 years of age need 1200 mg of calcium daily because they have a higher risk of developing osteoporosis after menopause than men (Institute of Medicine, 2011).

Additional Nutrients of Concern

In addition to the aforementioned nutrients, sodium, potassium, and magnesium are additional nutrients of concern in older adults. Sodium is primarily found in processed foods, cured meats, seasonings, and sauces. Wellness interventions targeted for older adults should include nutritional components that focus on increasing or decreasing the intake of nutrient-dense foods to allow appropriate energy, protein, vitamin B12, folate, vitamin D, and calcium. In addition, fluid intake must be appropriate to meet activity patterns and avoid dehydration.

Dietary patterns may be a more practical approach when developing intervention programs instead of focusing on individual nutrients. Dietary recommendations based on patterns focus on food groups already consumed in a population but reinforce those that are nutrient dense and health promoting. The Dietary Guidelines for Americans 2015–2020 provide key recommendations based on dietary patterns in the following categories, vegetables (dark green, red and orange, legumes, starchy, and other), fruits, grains (whole and refined), dairy, protein foods (seafood, meats, poultry, eggs, nuts, seeds, and soy), and oils, and limit on additional calories from other sources (US Department of Health and Human Services and US Department of Agriculture, December 2015). For example, half of grains consumed should be whole grains based on these recommendations.

Nutritional Screening in Developing Wellness Programs

Nutrient needs are individualized and differ from person-to-person according to multiple factors (genetics, body composition, medications, chronic diseases, environment, and resources, among many more). However, when developing a wellness intervention program for a population, it is important to assess the nutrient needs of the population to determine targeted nutritional intervention strategies. The screening tools may include dietary intake, factors affecting food intake, access to food, clinical conditions, and anthropometrics. Several tools are available to determine malnutrition and areas of nutritional focus, which can be found in a review article by Phillips, Foley, Barnard, Isenring, and Miller (2010).

Health and Wellness Interventions with a Nutritional Component

Promoting health and wellness is critical during older adulthood to optimize quality of life and prevent onset of chronic disease. The health and wellness interventions listed below include a nutritional component. In addition to community- or population-based interventions, several government programs are available to improve the nutritional status of US older adults, which are also mentioned below.

Eat Better and Move More

The "Eat Better and Move More" program included ten community-dwelling sites across the USA, with the purpose of educating adults aged 60–90 to live longer, healthier lives by eating a nutrient-dense diet and being physically active (Wellman, Kamp, Kirk-Sanchez, & Johnson, 2007). The program included a guidebook that included weekly mini-sessions over 3 months and was instructed by a trained lead person. The nutritional education session emphasized the health impact of fruits, vegetables, calcium-rich foods, and dietary fiber. Appropriate portion sizes were also highlighted, as well as physical activity. The programs were primarily held in community, recreational, or dining centers. Each participant was given a "tips and tasks" sheet to check their consumption of certain foods each day during the intervention. The sheets were evaluated weekly, and a 10% improvement goal was formed based on prior week's nutrient intake. In addition to age, inclusion criteria included the ability to walk with or without assisted devices and the ability to complete a consent form. Upon enrollment, the participants completed demographic, health, and activity questionnaires. The *Nutrition Screening Initiative Questionnaire* (Nutrition Screening Initiative, 1991) assessed baseline nutritional status. The questionnaires also included a statement to assess willingness to change.

Of the 999 older adults who participated across the 10 sites, 620 completed the entire program. Eighty-two percent were women and over 40% were minority. The completion rate ranged from 35% to 85% depending on site, and those who completed the intervention were healthier, less likely to be at nutritional risk (15% versus 30%), and less likely to be at or below the poverty level. Over one-third of participants increased the number of fruit servings, 37% increased the number of vegetable servings, 33% increased fiber, and 42% increased calcium-rich food sources. Over 30% of participants also increased fluid consumption. As importantly, over 90% of the participants reported the program helped them "eat better." The major limitation of the program, though, was the vast differences among completion rates across sites. Population diversity was limited at certain sites, suggesting the outcomes at certain locations could not be extrapolated to other sites with different ethnic groups. Individuals with the highest nutritional risk score were less likely to complete the entire program. In addition, no control group(s) were selected for the results to be compared against. Moreover, this program monitored dietary intake by utilizing a checklist. One limitation using checklists is that it may not include all foods consumed by a population. The importance of developing a dietary intake tool specific to the population of interest would best represent overall diet patterns. In addition, the amount of food consumed, and preparation methods, should be included in the data collected.

Healthy Eating Every Day (HEED)

The **Healthy Eating Every Day (HEED)** program (Carpenter & Finley, 2017) was developed for wellness providers at community-based organizations, colleges, and private organizations or workplaces. The 20 sessions include topics such as healthy eating, setting goals, eating out, creating shopping lists, supplements, managing time and stress, and staying motivated. Schlaff et al. (2016) modified the 20 session HEED program to include only 12 weeks, with a purpose of allowing older adults to identify reasons for poor dietary intake and how to adopt a lifestyle to permanently improve dietary intake. Adults 50 years and older were recruited if inactivity patterns were reported. Upon screening, participants were randomized into a physical activity or nutrition group. At screening, the participants utilized the *National Cancer Institute Fruit and Vegetable* all-day screener (National Cancer Institute: Cancer Control and Population Sciences, 2000) and *Fat- and Fiber-Related Behavior Questionnaire* (Kristal, Beresford, & Lazovich, 1994) were collected at baseline and 12 weeks. The intervention was administered in a group setting by a trained investigator. The groups met once per week for approximately 1 hour.

Results revealed that only 50 of the 72 original participants completed the study. The majority of participants were female (72%), married (62%), white (88%), and obese (68%) and had some college education (86%). A significant increase in fruit and vegetable consumption patterns (≥1.4 servings/d) was found alongside improvements in fiber- and fat-related behaviors. This intervention primarily measured dietary behaviors, not intake patterns of foods other than fruits and vegetables. The convenience population was primarily homogenous (white) with some college education; thus, the results cannot be extrapolated to other ethnic groups with different educational backgrounds. Overall, this intervention shows behaviors associated with dietary intake that can be positively change over 12 weeks. While this intervention did not assess nutritional deficiencies or inadequacies at baseline with the intent of tailoring the intervention to improve food sources associated with those inadequacies, the intervention did address behaviors that are a major component when addressing intervention program success.

Healthy Eating for Successful Living in Older Adults

The **Healthy Eating for Successful Living in Older Adults** program used educational and support methods to improve the nutritional status of older adults (National Council on the Aging, 2004). The main goals of the program were to improve nutritional knowledge, improve nutrition intake using peer-led behavior change, teach participants how to set goals, and solve problems related to nutrition. The program included educational sessions on dietary guidelines and label reading, food groups, meal preparation, and grocery shopping. A registered dietitian nutritionist was available to answer questions. The 6 sessions were 2.5 hours in duration, with 8–12 participants in each class led by trained instructors. The program includes a toolkit with program description, instructions on how to train the instructors, handouts, participant manuals, and materials to assess readiness and program evaluation. Any adult over the age of 60 with adequate cognition can participate.

Limitations of the program included updating materials from MyPyramid to MyPlate and the most current Dietary Guidelines for Americans; however, the principle concepts are sustained and can be used as an intervention tool. The evaluation of the program does not include specific nutrition-related changes that have resulted. Instead, the evaluation asks broad questions, such as "Have you made changes in your diet as a result of the workshop?" More specific questions would identify specific areas of change (e.g., vegetable intake, whole grain intake). To date, publications on this program are not available.

Federal Food and Nutrition Programs for Older Adults

Food and nutrition programs established by the federal government under the US Department of Health and Human Services (HHS) Administration on Aging and US Department of Agriculture Food (USDA) and Nutrition Service were developed to alleviate hunger and improve nutritional status among older adults. The HHS operates under the Older Americans Act Title I-VII to provide grants, incentive programs, and nutrition services (congregate and home-delivered meals, nutrition screening, assessment, and counseling) to older adults. Outcomes associated with participation in HHS programs include improvements in food, nutrients, fruit, and vegetable intake (Bernstein et al., 2012). Evidence shows that older adults participating in these nutrition programs were better nourished (31%) compared to nonparticipants (4%) and also had better socialization (17% higher average contacts per month) (Millen, Ohls, Ponza, & McCool, 2002). The USDA programs include the Supplemental Nutrition Assistance Program, Food Distribution Program on Indian Reservations, Commodity Supplemental Food Program, Senior Farmers' Market Nutrition Program, and Child and Adult Care Food Program. Qualifications for each program differ, but all include being at or below a certain percentage of the federal poverty level (Bernstein et al., 2012). Some evidence shows these programs are beneficial in improving the beliefs and intake patterns of nutrient-dense foods. The Senior Farmers' Market Nutrition Program has been shown to improve fresh fruit and vegetable intake by 1.31 servings/d, and positive attitudes toward fruit and vegetable consumption best predict improved consumption (O'Dare Wilson, 2017).

In summary, health and wellness interventions for older adults should include nutritional components to ensure adequate nutrient status. Nutrition interventions should include an educational and behavioral component, based on the needs of the population (or individual). Nutritional needs can be identified, using screening tools at baseline, such as a food frequency or other health-related questionnaire. The intervention should be tailored to the needs of the population, and if not determined, the nutrients of concern (e.g., energy, protein, fiber, folate, vitamin B12, calcium, and vitamin D) should be incorporated into the program. Ideal programs will also target the needs of the population according to culture, race/ethnicity, SES, and environment. Populations of low SES should consider federal nutrition programs to improve diet quality. More research on nutrition intervention programs in the older adult population, especially of longer duration (>12 months) to include health-related outcomes, are highly desired.

Key Research to Practice Message

Practitioners with expertise in teaching effective physical activity and dietary behaviors should adopt many of the principles and tenets from the public health literature to design a wellness program for older adults. One such tenet is the utilization of a needs analysis of the population to determine what the predisposing, reinforcing, and enabling factors are with regard to the adoption and persistence of healthy dietary and physical activity practices.

Older adults comprise a population that is heterogeneous in their health states, beliefs, values, and socioeconomic status. Wellness programs must be designed based on those varied attributes of the population to be effective. For example, older adults from certain religious groups may view physical activity as a task that is shunned upon. Older individuals may also have genetic or medically induced issues that may inhibit the digestion, absorption, and utilization of certain nutrients that are necessary to sustain health and elevate physical activity levels. The population needs assessment, which can be in the form of surveys or questionnaires, is described in the various public health planning models (Banerjee et al., 2015; Institute of Medicine (U.S.). Committee on Using Performance Monitoring to Improve Community Health, Durch, Bailey, & Stoto, 1997; Kreuter 1992; Mazloomymahmoodabad, Masoudy, Fallahzadeh, & Jalili, 2014) to expose the factors that may serve as barriers or facilitators toward adopting a healthy lifestyle. As the needs assessment unfolds, the practitioner can tailor a wellness program that targets such predisposing factors such as negative attitudes toward sustaining a regular physical activity and dietary program via education.

The practitioner should use appropriate teaching strategies to promote program adherence and then utilize existing research to elucidate the reinforcing factors to sustain motivation and adherence. One example includes identifying influential individuals in the program who demonstrate effective dietary and physical activity behaviors for others in the program to model themselves after. Wellness programs can be powerful reinforcement tools as they put to practice the key behaviors that need to be changed at the individual and group level. The practitioner should use the research to develop the most effective strategies to enable the older adult to adopt and sustain healthy dietary and physical activity behaviors.

The wellness program should equip the older adult with the necessary skills to conduct the dietary and physical activity program independently while being agile enough to adapt to changes that typically occur during that particular stage of life. For example, progression of a chronic disease may necessitate a modification or temporary cessation of the exercise and dietary regimen. If the individual is medically cleared to return to the previous regimen, financial resources that were used to obtained nutritious foods may need to be shifted toward the management of the advancing chronic condition, or functional status may be declined that may warrant a different venue, such as the home to conduct the exercise regimen. The clinician must be able to provide enabling strategies to the older adults that are flexible in their recommendations while still achieving the overall objective.

In summary, implementation of effective wellness programs for older adults must be rooted in science that is conducted as an art. The science is derived from the research on theories of change while understanding the specific barriers and facilitators toward achieving the desired behaviors of the older adult population. The art of the program should be apparent during its implementation as its delivery addressed the unique needs of the older adult population. The exercise and nutrition professional should use the published literature as a guide toward the development of an effective wellness program that is tailored to the specific needs, attributes, and desires of their specific population of older adults.

Practice Recommendations

Prior to establishing an intervention, evidenced-based programs should be reviewed to identify strengths that would meet the goals of the intervention program to be developed. Determining barriers for underutilization of established governmental or private wellness programs currently available to the population of interest should be identified. Methods to overcome those barriers should be incorporated into the newly developed intervention or, perhaps, including the underutilized program in the newly developed intervention. During the development stages, several key components should be addressed:

- Overarching goal of the program with measurable outcomes that can be achieved. Identify core elements.
- Population needs and reach alongside inclusion and exclusion criteria.
- Community partnerships and stakeholders for program funding and facilities. Find a cheerleader or champion for your program who will always be supportive.
- Cost of the program at start-up and for sustainability.
- Number, training, and specific roles of program staff.
- Establishing and measuring accountability for personnel.
- Recruitment methods and getting the "word out." Promoting your program to the target audience.
- Identify "value" of the program (e.g., reduce medication costs, improving cognition).
- Methods used to document outcomes to determine effectiveness.
- Maintenance and ongoing measures to evaluate the long-term effectiveness.
- Dissemination of the program strengths and weaknesses through the public, health, and scientific communities.
- Creating policy to promote the health of older adults.

For more information on establishing evidence-based, community programs to improve the health of older adults, consult the Centers for Disease Control Prevention Research Centers – Healthy Aging Research Network (Belza & The Prevention Research Centers-Health Aging Research Network Physical Activity Conference Planning Workgroup, 2007).

Future Directions in Practice and Research

The ultimate goal of wellness intervention programs for older adults should be to improve more than one aspect of health. The programs should include measures associated with quality of life, health, social, and economic status of the population. Interventions should be evidenced based and involve a collaborative team to include experts in the field of physical activity (e.g., physical therapists), nutrition (e.g., registered dietitian nutritionists), mental health (e.g., licensed psychologists or counselors), and nurses or physicians to develop a well-rounded program that encompasses the older adult as an individual, as well as at the population level. The programs should be tailored to specific populations or groups based on areas of need and greatest potential for impact. However, the program should aim to maximize generalizability either in a specific location, ethnic group, or sex. The goals of the program should include measurable and sustainable outcomes that can demonstrate effectiveness or lack thereof. Continual revision of the components that do not meet the objectives should be implemented. The results of the wellness program should be disseminated in scientific literature so best research-based practices can be identified and replicated.

Conclusions

Effective wellness programs for the older adult must include the key components of physical activity and nutrition previously discussed in this chapter. Other critical elements that were not discussed in this chapter include interventions that aim to reduce cognitive decline, promote socialization, improve economic status, and enhance spiritual awareness of the older adult. Wellness programs that target the older adult population must consider these aspects of health as they are key factors that relate to the ability of an individual to initiate and sustain sound physical activity and nutritional practices. Comprehensive wellness programs that are rooted in the art and science of health promotion will include these key aspects of health. Individuals tasked with the design and implementation of a wellness program must understand the evidence that supports the effectiveness of these programs (science), along with the creativity (art) to tailor a program that meets the unique needs of their population.

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27 Maintaining Cognitive "Fitness" in Older Adults

John R. Biggan and Emily C. Cunningham

Physical fitness is not only one of the most important keys to a healthy body; it is the basis of dynamic and creative intellectual activity. Intelligence and skill can only function at the peak of their capacity when the body is healthy and strong.

—John F. Kennedy

Overview

Age-related cognitive decline can appear to be inevitable. We should just resign ourselves to the fact that as we age we will forget where we parked the car, our reaction time will slow, and we will become more impulsive. Or should we? Evidence over the past 40 years indicates that there are stark differences between *normal* cognitive aging and *healthy* cognitive aging. In this chapter, we will discuss the relationship between physical health and cognitive health. Physical interventions that show promise at not only improving physical fitness but also cognitive "fitness" in older adults will also be described. By the end of this chapter, the reader will have a better understanding of the relationship between physical and cognitive fitness, the types of interventions that can improve both, and the mechanisms that are responsible for the improvement.

Cognitive "Fitness"

What is meant by cognitive *fitness*? This is a broad term that encompasses multiple abilities, including speed of thought, the ability to form new memories, and the ability to focus attention without being distracted (i.e., executive control). As Park and Reuter-Lorenz (2009) exhibited, these abilities tend to decline with age, particularly after the age of 60. However, theirs was a *normal* sample and may not be able to speak to the trajectory of these abilities in *healthy* aging. In fact, much of the literature indicates that older adults who are physically active and physically fit show significantly less decline as they get older (Spirduso & Clifford, 1978; Colcombe et al., 2003; for a review, see Bherer, Erickson, & Liu-Ambros, 2013). Furthermore, many clinical trials have found that physical activity interventions (e.g., walking, strength training) lead to observable improvements in both physical and cognitive fitness (e.g., Erickson et al., 2011; Liu-Ambrose, Nagamatsu, Voss, Khan, & Handy, 2012; for a review, see Colcombe & Kramer, 2003).

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Physical Fitness and Cognitive Health

In the early 1970s, in a laboratory in Austin, TX, the scientific study of the connection between physical activity and cognitive fitness was born. Waneen Spirduso and her colleagues (1978) began by recruiting two groups, one older (approx. 60 years) and one younger (approx. 20 years). Half of the participants in each group were incredibly active racquetball players, while the other half were incredible inactive: what we might refer to as "couch potatoes." This results in four groups: young-active, young-inactive, old-active, and old-inactive. Next, she gave these participants a very simple task called a Simple Reaction Time (SRT) task. An SRT works this way; a stimulus, often a light, is presented, and the participant reacts as quickly as they can, usually by pressing a button. The real-world equivalent of this would be when a warning (e.g., brake lights) appears and we react as quickly as we can to avoid the hazard (e.g., press the brake pedal to avoid colliding with the vehicle in front of you). The speed with which we are able to respond in these types of situations gradually declines, on average, along with aging. As such, the result that the fastest group was the young-active group was not a surprise. What was surprising was that the second fastest group was the old-active group, followed very closely by the young-inactive group – the difference between these two groups was not statistically significant. The slowest group by far was the old-inactive group, which was markedly slower than the other three groups. The 60-year-old racquetball players were not showing the typical pattern of cognitive slowing that is so often associated with aging, but the inactive group of older adults were.

This exciting work was replicated with other types of athletes (e.g., runners) and tasks to ensure that the benefits that were observed in the original experiment would generalize to other populations and tasks. Indeed, they did. The relationship between physical fitness and cognitive ability is one of the most robust findings in the scientific literature. Once the relationship was well-established, many researchers set out to determine if physical fitness was merely associated with good cognitive health or if it caused good cognitive health.

Types of Activity

Physical activity and physical exercise can take many forms and may affect cognition via a variety of mechanisms. In this chapter, aerobic exercise, strength and resistance training, as well as yoga will be discussed.

Aerobic Exercise

Aerobic exercise, sometimes referred to as *cardio*, is any physical exercise that leads to increased utilization of the heart and lungs and, as a result, improves heart and lung function. Examples include, but are not limited to, walking, jogging, swimming, and dancing. These are the most commonly studied interventions in older adults – especially walking interventions. This is in part due to the fact that these are the types of exercises in which many older adults are already engaged. Additionally, these types of exercises are easier to implement in large group settings of older adults as well as nonhumans (e.g., rodents). Rodents take to running wheels with little encouragement, whereas implementing other interventions such as strength training is considerably more difficult, though not impossible.

A 2003 meta-analysis by Colcombe and Kramer combined data from 18 aerobic exercise interventions in sedentary older adults. The analysis included both healthy older adults and patient populations. In it, the researchers found an overall benefit, such that older adults in the exercise groups had improvements in processing speed, memory, and executive function. Furthermore, longer interventions led to greater improvements than shorter interventions – as did more intense exercise interventions.

More recent experimental evidence, wherein older adults participated in either a 1-year walking intervention or a control group (i.e., stretching and toning), indicated that physical activity is able to improve cognitive health via alterations in brain structure (Erickson et al., 2011). Structural MRIs of these participants were taken prior to the intervention, at 6 months into the intervention, and at the end of the 1-year intervention. These MRIs showed steady increases in hippocampal volume at 6 and 12 months for the participants in the walking group and a steady decline in hippocampal volume in the control group. Moreover, the degree of volumetric change was significantly related to the degree of improvement on a memory task.

Overall, aerobic exercise has a long history of improved cognitive outcomes. That, combined with the more recent neurological improvements that have been observed, indicates that aerobic exercise is an efficacious intervention for slowing cognitive decline in older adults. The next question is, what other types of physical interventions have similar, or even larger, benefits? The following sections further explore a variety of physical interventions that show promise.

Strength/Resistance Training

Strength or resistance training is a class of physical exercise intended to increase muscular strength and endurance, typically through the use of weights, resistance bands, or body weight. The study of the effects of strength/resistance training (hereafter "SRT") on cognition in older adults has a somewhat more recent history than that of aerobic training, with many of the existing randomized controlled trials in this area taking place in the past decade.

The relatively recent upsurge in interest in the effects of SRT on cognition can be partly attributed to a meta-analysis by Colcombe and Kramer (2003), in which the beneficial effects of combined strength/aerobic interventions on cognitive performance in older adults were reported to be greater than those of aerobic interventions alone. Since that time, a number of trials have been conducted to evaluate the effects of resistance training programs in isolation, spanning durations of as little as 4 weeks to 12 months; sampling from populations of healthy older adults as well as those at risk of or currently diagnosed with dementia; varying in intensity, as well as situation (e.g., home- or gym-based); and assessing a range of outcomes including multiple domains of cognitive performance, as well as neurophysiological changes and changes in brain activity during task performance.

SRT Effects in Healthy Older Adults

Early reports on the potential impact of SRT on cognition in older adults were mixed. In one of the earliest trials reporting cognitive outcome measures, Tsutsumi et al. (1997) observed no significant effects of 8 weeks of resistance training at multiple levels of intensity on cognitive outcomes (mirror-drawing and mental arithmetic) in healthy older adults relative to a no-exercise control group. Similarly, Perrig-Chiello et al. (1998) reported that healthy older adults receiving 12 weeks of resistance training did not improve significantly over individuals in a no-exercise control condition on five cognitive outcomes. However, the authors do note that within the training group, individuals improved significantly pre- to post-training on measures of delayed free recall and both immediate and delayed recognition. In addition, 1 year following the intervention, individuals in the resistance training group showed greater long-term improvements in free recall performance than individuals in the control condition.

Subsequent reports in healthy older adult samples provide a somewhat more positive counterpoint to these initial results, using generally longer intervention durations as well as larger sample sizes to provide a more comprehensive picture of the cognitive effects of SRT. For example, Cassilhas et al. (2007) examined the effects of 24 weeks (~6 months) of resistance training at two different intensities (50% and 80% of one repetition maximum) and reported that both moderate- and high-intensity training led to improvements in cognitive performance relative to a control group performing stretching exercises. Liu-Ambrose et al. (2008) reported that for healthy older adults, after 6 months of participation in the Otago Exercise Program (a home-based program for fall prevention consisting of combined resistance and balance exercises), participants in the training group exhibited improved executive control relative to a control group receiving only guideline care, but no differences in set shifting or working memory performance.

In a longer-term intervention trial, Liu-Ambrose (2010) assessed the effects of 12 months of resistance training on the cognitive performance of healthy older women. They observed significant improvements in executive function for once- and twice-weekly resistance training relative to a control group, but no differences in performance on measures of set shifting and working memory. In addition, both training groups exhibited reductions in whole brain volume relative to the control condition. In a secondary analysis, Liu-Ambrose et al. (2012) report that twice-weekly resistance training led to increases in functional brain activity in regions of the left middle temporal gyrus, left anterior insula, and lateral orbitofrontal cortex. A further secondary analysis by Bolandzadeh et al. (2015) suggests that resistance training may slow white matter lesion progression (although significant reductions in WML volume were observed only for the more intensive twice-weekly resistance condition).

In one of the longest-duration and largest-scale intervention trials incorporating resistance training to date (the DR's EXTRA study), Komulainen et al. (2010) report that following a 2-year intervention in over 1000 healthy older adult participants, no significant differences in cognitive performance as a function of any of several treatment conditions (resistance training, aerobic training, diet, and combinations thereof) were observed relative to a control condition. They do note, however, that for resistance training, as well as several other exercise-based treatment conditions, improvements in aerobic fitness predicted improvements in immediate memory performance. Similarly, Lachman, Neupert, Bertrand, and Jette (2006) assessed the effects of resistance training on memory performance in older adults with at least one disability. After 6 months, they observed no overall group differences, but they noted that the *degree* of change in resistance level over the course of training was associated with improved memory performance in the training group.

SRT Effects in Older Adults with Dementia of Mild Cognitive Impairment (MCI)

An additional body of work has focused on the effects of SRT interventions on cognition in patients with probable MCI and dementia. Following 3 months of daily strength- and balance-focused dance therapy combined with music, Van de Winckel et al. (2004) reported that women with dementia (multiple infarct dementia or possible/probable Alzheimer's disease according to NINCDS-ARDRA criteria) showed improvements on multiple measures of cognition relative to control participants who received daily conversational visits. More recently, Nagamatsu et al. (2012) have reported the results of a 6-month randomized controlled trial (ExCEL) examining the effects of resistance training and aerobic training in older adult women with probable MCI. Relative to a control group performing only flexibility, balance, and relaxation exercises, individuals in the twice-weekly resistance training condition showed improvement on multiple measures of cognition, with concurrent changes in functional brain activity. However, the authors note that compliance with the intervention was low (between 50 and 60% attendance across conditions) and that because of this, the effects they report may be a "lower-bound" estimate of the effects of physical activity on cognitive performance. The authors conducted a number of additional analyses of this dataset, further concluding that both aerobic and resistance training contributed to improved spatial memory performance (Nagamatsu et al., 2013) and that aerobic training, but not resistance training, contributed to increases in hippocampal volume (ten Brinke et al., 2015). Following an analysis of the cost-effectiveness of each type of training, the authors note that both aerobic and resistance training result in healthcare cost saving and recommend both aerobic and resistance training as more cost-efficient intervention options than balance and tone training (Davis et al., 2013).

What is one to make of this apparently diverse set of results? These studies differ markedly in duration and intensity of interventions, quality of trial design, types of outcomes assessed, and level of compliance of participants. As such, even the best of trials may be a noisy estimate of the true effects of SRT on cognitive performance in older adults. In order to clarify the size and nature of SRT effects on cognitive performance, recent meta-analytic summaries have attempted to synthesize multiple SRT-only interventions. Kelly et al. (2014), for example, integrated six SRT interventions for cognitively healthy older adults and reported aggregate improvements in measures of reasoning, but not in measures of any other reported cognitive domain.[1] The authors suggest, echoing Chang et al. (2012), that it is possible SRT interventions affect some domains of cognition more than others. A further possibility, given that a number of trials report general associations between levels of improvement in physical performance and improvements in memory performance or performance along other cognitive domains, is that SRT alone may have a small positive effect on cognitive performance – possibly through indirect benefits to cognition as a function of improved physical and mental well-being – such that these types of trainings may give rise to more robust cognitive benefits when combined with aerobic exercise.

[1]For older adults with MCI or dementia, Groot et al. (2014) report no significant overall cognitive benefits of non-aerobic interventions. However, this meta-analysis included only patients with dementia (not those with MCI) and further grouped all non-aerobic interventions together, with the net result that few SRT interventions were incorporated into the analysis, and the effects of those that were included may have been washed out in aggregate effect estimates.

Combined Aerobic and Strength Training

Following Colcombe and Kramer's (2003) observation that combined aerobic and strength training may yield greater cognitive benefits for older adults than either type of training alone, many researchers have also explored the impact of combined interventions. In recent meta-analytic reviews of the literature, there appears to be some consistency to reports of the benefits of combined interventions on cognitive performance (e.g., Groot et al., 2016).

Combined Interventions for Healthy Older Adults

For healthy older adults, improvements in cognition (using measures of executive function, episodic memory, and processing speed) have been reported after as little as 4 weeks of combined aerobic, strength, and flexibility programs (relative to a wait-list control; Nouchi et al., 2014). After a 6-month intervention combining aerobic, strength, and flexibility exercises, older adult women showed improved/sustained performance in delayed recall and working memory tests relative to control participants (Klusmann et al., 2010).

An additional series of combined intervention studies have been conducted in conjunction with cognitive training interventions. Candela, Zucchetti, Magistro, and Rabaglietti, (2015) compared the effects of 16 weeks of physical activity and cognitive training and observed that older adults who participated in the combined physical activity training (aerobic, strength, mobility training) improved significantly on measures of long-term memory and selective attention relative to a control group. Linde and Alfermann (2014) report results of a 16-week physical/cognitive training intervention. Older adults in the physical activity arms of the trial performed a combination of aerobic and strength training exercises. These participants improved only on the "concentration" dimension of the cognitive outcome assessment battery, but this improvement was sustained over a 3-month follow-up. Desjardins-Crepeau et al. (2016) report the results of a fully crossed physical/cognitive training intervention. The physical activity component contained both aerobic and resistance components. Improvements in processing speed were observed for all intervention groups.

In addition to these positive findings, some researchers also report mixed results. Gajewski and Falkenstein (2012) trained healthy older adults for 4 months using a mixture of aerobic and strength exercises and observed some reduction in performance costs on a task-switching paradigm. Witte, Kropf, Darius, Emmermacher, and Böckelmann (2016) found inconclusive results of an intervention comparing both karate and combined physical activity – including "running exercises," coordination games, and strength exercises – to a control condition in healthy older adults. Taylor-Piliae et al. (2010) compared 6 months of tai chi or "western exercise" (endurance, resistance, flexibility) with an attentional control condition in healthy older adults. Only the tai chi group exhibited significant improvements in cognitive function.

In one of the largest-scale physical activity interventions to date, Sink et al. (2015) reported the effects of a 2-year combined physical activity intervention (walking, resistance, flexibility) on cognitive function in healthy older adults relative to a health education control. Overall, no group differences in cognitive outcomes were observed, but individuals in the physical activity condition who were over the age of 80 or in worse physical shape did show improvements on executive function composite scores relative to the corresponding control group participants.

Combined Interventions for Vulnerable Populations

Among older adults at risk of or currently suffering from cognitive decline, combined interventions also appear to have positive effects on cognitive performance. In a meta-analysis of physical activity interventions for patients with dementia (of both Alzheimer's and non-Alzheimer's types), Groot et al. (2016) examine the aggregate effects of combined interventions and conclude that such interventions contribute to significant improvements in global cognitive performance. In one such intervention, Bossers et al. (2015) report that for dementia patients, a 9-week program combining strength training and walking led to improved performance along multiple cognitive domains – including visual/verbal memory and executive function – relative to a social control group. This trial also included an aerobic exercise-only cohort who improved along fewer domains than the combined cohort, and the authors conclude that combined exercise is more effective than aerobic training alone in ameliorating the effects of cognitive decline.

In patients with MCI, the results are somewhat mixed. Nascimento et al. (2014, 2015), for example, report positive effects of a 16-week multimodal physical activity intervention on cognitive performance in older adults with MCI relative to a no-contact control group. However, Makizako et al. (2012) report that a 6-month combined aerobic, strength, and balance intervention did not significantly improve dual task performance in older adults with amnestic MCI relative to a health education control. As Gates et al. (2013) note in a general meta-analysis of physical exercise interventions on cognitive performance in patients with MCI, small sample sizes and moderate quality of many of the RCTs in this population render it difficult to draw firm conclusions.

A small number of studies have also evaluated the effects of combined interventions on other vulnerable older adult samples. Langlois et al. (2013) assessed the effects of an aerobic/strength intervention on cognitive performance in both frail and non-frail older adults and observed that individuals in the intervention group showed significant improvements in cognitive performance relative to the control group on measures of executive function, working memory, and processing speed. For sedentary older adults at increased risk of disability, Williamson et al. (2009) report that a 1-year combined aerobic, strength, and balance/flexibility intervention led to no significant group differences in cognition, but improvements in physical performance were associated with improvements in cognitive performance. In a sample of healthy nonagenarian participants, Ruiz et al. (2014) found that after 8 weeks of combined aerobic and strength training – heavily weighted toward resistance exercises – healthy nonagenarian participants did not show improvements in cognitive function.

As with the strength-only or aerobic-only interventions, combined interventions appear to confer benefits on participants. Overall, the benefits are larger depending on the individual's starting point. For example, based on the evidence, we could infer that an individual with dementia may derive more benefit from these types of interventions than a healthy older adult. This indicates that there may be a ceiling effect. Next, we discuss a widely practiced but less studied physical intervention.

Yoga

Although widely practiced around the world, with regard to cognitive health, yoga has not been studied to the same extent as other physical activity interventions, so the evidence base is limited. Recently, Gothe, Keswani, and McAuley (2016) randomized participants to either an 8-week Hatha yoga intervention or an active control group involving stretching and toning. They found that the older adults in the yoga group showed significant improvement in cognitive function following the intervention, something that the control group did not show. Hariprasad et al. (2013) observed similar findings. Following 3 months of yoga instruction, healthy older adults showed greater improvements over control participants across a wide range of cognitive measures, including those measuring memory, processing speed, and executive control.

These two studies are in contrast with earlier research by Oken et al. (2006), in which healthy older adults who took part in a 6-month Hatha yoga intervention did not show improvements on tasks measuring cognitive performance. The participants did, however, show improvements on measures of physical health and quality of life.

Clearly, the study of yoga as an intervention to improve cognitive function in older adults is still relatively young. Therefore, it is difficult to say with any certainty whether or not yoga yields beneficial cognitive results. Moreover, with the many different types of yoga that are currently offered, it is possible that certain types are more advantageous than others. This is an exciting area of study worth keeping an eye on.

Mechanisms

Neurogenesis

Years ago, it was believed that the aging brain did not produce new neurons (i.e., *brain cells*). Recent research has determined that this is incorrect and that neurogenesis – the production of new neurons – occurs in the hippocampus (Eriksson et al., 1998). The hippocampus is of particular importance to aging. It is the most crucial neural substrate supporting the formation of new long-term memories. Case studies of patients without functioning hippocampi describe profoundly impaired memory formation (e.g., Squire, 2009). In the famous case of patient HM, following a surgery to treat debilitating epilepsy that led to the removal of the hippocampus and some of the surrounding tissue, for all intents and purposes, he was unable to form new long-term memories including the layout of his new house or meeting new people. Unfortunately, for many older adults, this structure shrinks with age, and this age-related shrinkage is related to poorer long-term memory formation (Gorbach et al., 2017).

However, all is not lost. Although many older adults experience this decline, it is not inevitable. Physically fit middle-aged adults are less likely to display this kind of decline decades later (Tian, Studenski, Resnick, Davatzikos, & Ferrucci, 2016). Moreover, their ability to form new long-term memories is more likely to remain intact than their less active counterparts. This is likely due to the formation of new, healthy neurons and the maintenance of already existing neurons. In the rodent literature, where it is more feasible to confirm that neurogenesis has taken place, physical activity has been shown to enhance neurogenesis in the hippocampus and that neurogenesis appears to cause an improvement in spatial memory formation in these animals (van Praag, Shubert, Zhao, & Gage, 2005).

What about individuals who have been sedentary for years? Is it too late? Not according to the literature. Older rats, which provide reasonable analogue to humans, are able to increase neurogenesis in the hippocampus when they are provided with a running wheel later in life. Similar findings are present from human studies involving older adults. For example, Erickson et al. (2011) engaged 120 older adults in either aerobic exercise (i.e., walking) or an active control (i.e., stretching and toning) 3 times per week for 1 year. Before and after the intervention, the participants had structural MRIs taken of their brains. Following the intervention, the overall hippocampal volume of the participants in the control group decreased. However, the hippocampal volume in the aerobic exercise group *increased*, and the increase was greater for participants who had become more physically fit. Due to the invasive nature of assessing neurogenesis, the authors were unable to determine if neurogenesis had occurred in these participants. However, the corresponding findings from the rodent literature indicate that this is likely the cause of the increase in hippocampal volume, along with synaptogenesis and angiogenesis.

Synaptogenesis

In addition to neurogenesis, existing neurons are continuously creating new connections with one another in a process known as *synaptogenesis*. Any time that new information is stored in the brain, it is stored using synaptogenesis. This process is extremely active early in life, which accounts for the ease with which children are able to learn new skills and knowledge. With age, synaptogenesis slows. To some extent, this is a beneficial process. Were synaptogenesis to maintain the same level seen in children not only might learning new information be more common, forgetting old information would as well because similar processes are responsible for removing connections between neurons. That said, the rate of synaptogenesis in older adults is considerably less than optimal. As such, overcoming this and increasing synaptogenesis to a beneficial level have become the goal of pharmaceutical firms, producers of video games intended to influence this process, and researchers studying physical fitness and nutrition. While most of these are outside the scope of this chapter, studying the relationship between synaptogenesis and physical fitness is not.

Angiogenesis

Angiogenesis is the creation of new blood vessels. Like synaptogenesis, angiogenesis increases as a result of physical activity and leads to increased capillary bed density in important brain structures, such as the hippocampus (van Praag, Shubert, Zhao, & Gage, 2005). As capillary bed density increases, the ability to quickly supply brain regions with necessary nutrients (e.g., O_2 and glucose) improves. Moreover, waste products can be more quickly and easily shuttled away from the cells and removed from the body. This improvement to the cellular environment is encouraged by hormones and enhanced cellular functioning and cognitive performance.

Hormones

What causes the neurogenesis, synaptogenesis, and angiogenesis that appear to underlie the cognitive benefits physical fitness? The literature has not pinned this down yet, but considerable evidence indicates that *neurotrophic factors* may play a key role. Neurotrophic factors are endogenous proteins that confer benefits on neurons, from neurogenesis to angiogenesis and synaptogenesis. Examples of hormones that promote neuronal health include brain-derived neurotrophic factor (BDNF) and insulin-like growth factor 1 (IGF-1).

BDNF and IGF-1 both promote neuronal health and are upregulated following physical exercise. As such, it is widely believed that the increase in these beneficial proteins is the primary cause of cognitive improvements following exercise. Physical exercise, especially those that encourage stress reduction, may also lead to cognitive improvements by reducing the brain's exposure to damaging hormones, like cortisol. Cortisol is a stress hormone that can have deleterious effects on the central nervous system. For example, rodents exposed to chronic stress have significantly reduced hippocampal volumes and perform poorly on memory tasks (Sapolsky, Uno, Rebert, & Finch, 1990). Some types of exercise appear to reduce stress levels and, subsequently, cortisol, and this may lead to some of the improvements observed in this field.

Yoga is a particularly appropriate example of this. In their recent study, which was discussed earlier, Gothe et al. (2016) used a yoga intervention with older adults. In addition to the cognitive measures, these researchers also measured cortisol. By the end of the intervention, cortisol levels in the yoga participants significantly declined as did self-reported stress levels and these changes predicted change in performance on cognitive measures. As the study of the relationship between physical and cognitive fitness continues, cortisol is an excellent area of study not only with yoga but also with more traditional aerobic exercises, which have also shown an ability to reduce stress and anxiety (Rimmele et al., 2007). Until then, we can only speculate as to how physical exercise, stress reduction, and cognitive health in older adults interact.

Key Research to Practice Message

Over the last 40 years, a tremendous amount of research has clarified the relationship between physical and cognitive fitness. A healthy body leads to a healthy mind. This can be accomplished with aerobic exercise and, potentially, with strength and resistance training as well as stress reduction exercises, such as yoga.

Practice Recommendations

The literature indicates that aerobic exercise causes neurological improvements underlying the cognitive advances. Hippocampal volume increases as a result of aerobic exercise are most likely caused by the release of hormones, such as BDNF and IGF-1, which enhance neurogenesis and stimulate synaptogenesis and angiogenesis. This, in turn, leads to improved neurological function, which causes the cognitive improvements (e.g., improved memory performance). Given the strength of the evidence and broad impact of the intervention, aerobic exercise is recommended as the first choice for a physical intervention aimed at slowing cognitive decline in older adults. The appeal extends to the ease of implementation, which does not require expensive equipment or specially trained personnel. Additionally, aerobic exercise is a relatively safe and enjoyable intervention for most older adults.

Future Directions in Practice and Research

The strengths of aerobic exercise do not discount the potential opportunities available for other physical interventions in which the research is still in its infancy. For example, the evidence supporting strength and resistance training at improving cognition in older adults is more tentative as the field has not studied this form of exercise for as long. However, the evidence suggests that resistance training is, likely, also able to confer similar benefits on cognition to those seen with aerobic exercise. Yoga, too, has only recently begun to be studied for its relationship with cognitive health, and as such the evidence is considerably more limited and less consistent than it is for aerobic exercise or resistance training. Furthermore, if a benefit exists, it is likely due to a different mechanism than more traditional exercise, most likely reducing the negative impacts of stress hormones (e.g., cortisol).

As the literature expands in these areas of research, practitioners are being provided with additional options based on their clients' wants and needs as well as their access to specialized equipment and trained staff. For many, individualized care is a key goal and this will make that more of a reality.

Conclusion

The world is growing older (He, Goodkind, & Kowal, 2016). This may sound concerning. There may be a fear that large swaths of the population will become cognitively slower, have more difficulty with impulse control, and have a harder time remembering. This is one potential future. Another potential future recognizes that tools exist to mitigate some of the cognitive decline associated with aging: tools like physical activity and exercise. In that future, these tools are deployed to the vast majority of older adults. As a result of this deployment, many older adults experience healthy aging, maintaining both physical and cognitive fitness. This is captured in the immortal words:

> Any man could, if he were so inclined, be the sculptor of his own brain. (Father of modern neuroscience, **Santiago Ramón y Cajal**)

With the tools at our disposal, let us hope that we are so inclined.

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28 Sex, Gender, and Cultural Considerations for Rehabilitation Research with Older Adults

Melissa Biscardi and Angela Colantonio

Overview

Personalized medicine is proactive and tailored to each individual. Clinicians working with older adults are increasingly looking to personalized medicine to help with treatment and rehabilitation of illness processes. Sex and gender are important factors to consider in this approach. Although the terms sex and gender are often used interchangeably, they are two distinct but interrelated constructs (Canadian Institutes of Health Research, 2018). Both of these words have implications for health, aging, and rehabilitation. Personalized rehabilitation requires viewing the patient through a sex and gender lens as a first step to providing individualized care and improving health outcomes. It is well established that men and women manifest progress and react differently through many illness processes that affect older adults. These include, but are not limited to, depression, arthritis, osteoporosis, brain injury, and Alzheimer's disease (Albert, 2015; Alswat, 2017; Munivenkatappa, 2016; Neu et al., 2017; Van Vollenhoven, 2009). This chapter aims to address these concepts with examples relevant to persons who are both aging and aged with disability.

Sex and Gender: Are We Talking About the Same Thing?

Sex

Sex is a biological concept that refers to the anatomical and physiological attributes in males and females that are determined at the moment of conception. The National Institutes of Health (NIH) defines sex as being differences between males and females according to reproductive organs, chromosomal complement (XX for female and XY for male), and endogenous hormone profile (NIH, 2017). The genitalia are called primary sex characteristics, while the other differences that develop during puberty are called secondary sex characteristics and stem from hormonal differences between the two sexes. Sex is primarily associated with physiological features (genes and hormones) from which other biological differences, such as sexual anatomy, develop. Sex is usually categorized as female or male; however, there is variation in the biological attributes that comprise sex and how these attributes are expressed (CIHR, 2018).

Every cell in the body has a sex which is determined by the presence of the chromosomal complement, XX or XY. However, there are a large

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number of individuals who do not fit the XX or XY prototype. Genetic variants that may occur in sex chromosomes include but are not limited to XXY (Klinefelter's syndrome) which occurs in about 1 in 500 to 1000 male live births; X monosomy (Turner's syndrome) occurring in about 1 in 2500 live births; and XXX (triple X syndrome) occurring in about 1 in 1000 female live births (U.S. Department of Health & Human Services, 2017). In addition to these syndromes, it is estimated that 1 in 100 babies is born with bodies that differ in some way from standard male or female or with some biological characteristics of sex.

While biology influences how we develop, it is not the only determinant of behavior, personality, sexual preference, and so on. Biology does not determine the meaning that members of a culture assign to particular behaviors – which ones are valued, which ones are devalued, and how differences are perceived and treated. Gender, however, takes social and cultural differences into consideration.

Gender

Gender is considerably more complex than sex. Gender is a social concept which refers to the social (e.g., behavior/identity/psychosocial) and cultural (e.g., roles/norms) differences that society assigns people based on their biological sex. It is neither innate nor necessarily stable. It is not a dichotomous variable, although it is often framed this way in research that requires self-reporting of gender as male or female. Gender refers to behaviors, expressions, and identities of girls, women, boys, men, and gender-diverse people. Gender influences how people perceive themselves and each other, how they act and interact, and the distribution of power and resources in society. Gender is usually conceptualized as a binary (girl/woman and boy/man), yet there is considerable diversity in how individuals and groups understand, experience, and express it.

Gender is learned and grows out of cultural ideas that stipulate the social meaning and expectations of each sex (Wood & Eagly, 2009). We are surrounded by gender experiences from the time we are very young. It is constantly present and is called upon to explain a wide variety of behaviors, from driving styles to eating behaviors to movie preferences. The world bombards us with ideas of gender that build on biological sex; however, biological difference is often exaggerated and carried into domains to which sex is irrelevant, for example, why women are more likely to color over their gray hair than men. Individuals act in many ways to fulfill such gender expectations of society (NIH, 2017). Society's views of gender permeate public and private life to such a high degree that we tend not to question these views and to see them as normal and right. Table 28.1 presents the common definitions of sex and gender.

Gender determines access to healthcare, use of the healthcare system, and the behavioral attitudes of medical personnel. Typical gender differences in healthcare include differences in the use of preventive measures, use of healthcare services, the prescription of drugs, and referral for or acceptance of particular surgical therapies, such as pacemaker implantation or heart transplantation (Regitz-Zagrosek, 2012). In fact, a meta-analysis on physician's referral practices for cardiac rehabilitation found that women were significantly less likely to be referred to cardiac

Table 28.1 Definitions of sex and gender

Sex	Sex refers to the classification of living things, generally as male or female, according to their reproductive organs, endogenous hormone profiles, and functions assigned by chromosomal complement
Gender	Gender refers to socially constructed and enacted roles and behaviors which are rooted in biology and shaped by historical and cultural context. Gender varies across societies and over time: a person's self-representation as male or female or how that person is responded to by social institutions based on the individual's gender presentation and how individuals act to fulfill the gender expectations of their society. With continuous interaction between sex and gender, health is determined by both biology and the expression of gender

Adapted from Canadian Institutes of Health Research (2018) and National Institutes of Health 2018 rehabilitation when compared to men (Colella et al., 2015). As our understanding of chronic disease evolves, we understand that it is not only biological differences between men and women that need to be considered but also gender roles and cultural backgrounds. Men and women may manage chronic pain differently because of their gender roles; however, where they live and how rich or poor they are will also play a factor (Bartley & Fillingim, 2013).

Why Use the Concepts of Sex and Gender in Rehabilitation?

Considering sex and gender in rehabilitation of older adults not only provides for better care but also for more ethical care. Historically, healthcare has typically not been gendered, meaning that men and women were likely to receive the same care despite differences in physiologies, reproductive systems, and gender roles. It is increasingly necessary to give explicit consideration to sex and gender in the context of how individuals age and how rehabilitation can be tailored to provide more effective and sensitive healthcare. There are important biological and behavioral differences that affect the manifestation, epidemiology, and pathophysiology of illnesses. Despite these known differences, there is little gender-specific healthcare, prevention, management, and therapeutic treatment of many common illnesses. This omission is holding back more efficient and effective healthcare as individualized therapies are more effective than a "one-size-fits-all" approach (Gahagan, Gray, & Whynacht, 2015). Addressing sex and gender in healthcare requires consideration of many influencing factors, from training medical personnel to drug development, as well as sex- and gender-based research.

Sex, Gender, Culture, and Clinical Healthcare

A culture is made up of structures and practices that reflect and uphold a particular social order. This is done by defining certain social groups, values, expectations, meanings, and patterns of behavior as natural and good versus unnatural or wrong. Gender is central to cultural life, and society's views of gender are reflected in, and promoted by, a range of social structures and practices. How society views different genders will systematically empower certain groups over others. Western culture, as well as many others, has traditionally been patriarchal. This means that the ideology, structure, beliefs, and practices were created by men. Because of this, historically Western culture has reflected the perspectives and priorities of men more than those of women (Wood & Eagly, 2009). While this has been tempered over time, inequities between men and women in health status, provision of appropriate health services, and access to care continue to exist.

Gender norms, roles, and relations influence individuals' susceptibility to different health conditions and diseases that affect their enjoyment of good mental health, physical health, and well-being. Gender norms also have a bearing on individuals' access to, and uptake of, health services and on the health outcomes they experience throughout the life course. Vlassoff (2007) found that societies with high gender inequality are unhealthy for all individuals. For example, where gender influences status and power, this would also influence access to health services, resources, engagement in risk-taking behaviors, and environmental exposures.

You may believe that both women and men should have access to health education and healthcare services and that both should be involved in homemaking and grandparenting. You are not surprised when a woman knows something about home repairs or when a man prepares a good meal. These experiences and views depart from those of previous generations. However, in most cultures, there are behaviors that are not culturally acceptable for certain genders; these views are in constant evolution. Differences in acceptability can lead to differences in exposure to risk factors. For example, in Vietnam, more men smoke as it is not culturally acceptable for women to smoke. This puts men at a greater risk for smoking-related health issues such as emphysema and chronic bronchitis. In

North America, conventional masculine gender norms that emphasize independence and feminize expression of emotion and willingness to be vulnerable persist. These gender norms have been linked to men seeking psychotherapy less often than women for mental health issues despite men and women benefitting equally when remaining in counseling, being actively engaged, and participating in a therapeutic relationship with the counselor that is based on patient preferences (Ogrodniczuk, 2007).

Gender and cultural norms may influence patterns of service use. A woman living in an urban area in a developed country may consider preventative measures or seek treatment for osteoporosis. In contrast, women living in a rural environment, remote village, or a developing country may not have equivalent access to health education or access to care. With respect to health-seeking behavior, women in the United States visit their primary care provider to a greater extent than men for both physical health and mental health concerns. This may be related to gender differences in the subjective experience of illness and its social significance. Interestingly, both men and women are less likely to seek care for mental health concerns in comparison to physical health concerns (Thompson et al., 2016). For practitioners providing rehabilitation for older adults, consideration of sex and gender differences in health-seeking behavior will be important in goal setting and program planning.

Cultural norms and differences also affect communication. Personal space differs widely across different cultures. While an American is used to 5 feet of distance when conversing with another, German and Japanese individuals may be more comfortable with more distance. On the other hand, Arabic and Latino individuals normally stand much closer together when talking. Body language cues also differ across cultures. In addition, eye contact is a very important distinction among cultures. Westerners often insist on eye contact as a measure of attention and honesty, while it is considered disrespectful in some Asian and Latin cultures (Akechi et al. 2013). Although these general cultural differences exist, it is important to avoid stereotyping. One way to promote effective communication is to use reflective listening, that is, have patients explain back to you what it is that they understand. For example, when goal setting for rehabilitation of older adults, practitioners can have the patient repeat back what the goals and objectives of the session/week/month are and relate this back to the overall goal. Practitioners can also have patients reflect on their goals and rehabilitation experience.

Effective and culturally appropriate communication skills are important when rehabilitating older adults in order to provide education, set goals, and promote the best outcomes. Older adults are not too old to improve in function, start exercising, stop smoking, or change habits. Even in the presence of cognitive impairment, older adults are able to participate in rehabilitation and display improved function (McGilton et al., 2013). One of the greatest challenges for rehabilitation practitioners is to dispel these misconceptions about health promotion and rehabilitation in older adults. While older adults may enter into rehabilitation with lower functional-status scores, these patients make similar absolute gains in rehabilitation when compared to younger adults (Chan, Zagorski, Parsons, & Colantonio, 2013). Therefore, while older adults may start at a lower functional level when admitted to rehabilitation, they can make progress.

Sex, Gender, and Aging with Long-Term Health Conditions

Complex links exist among sex, gender, and health. While there are marked differences between the health needs of men and women, there are also marked similarities. There is clear evidence to support that chronic illness affects women and men differently. Numerous examples may be drawn upon. For example, female sex has been associated with increased risk for developing multiple sclerosis, and these findings have important implications for other sex-skewed neurological conditions, such as Parkinson's disease and schizophrenia. Women are at a greater risk of stroke, which has implications for rehabilitation planning. Lung cancer and chronic obstructive pulmonary artery disease remain a serious problem for both women and men owing to increased smoking prevalence among women and a greater sensitivity of women to tobacco toxicity (Dransfield, Davis, Gerald, & Bailey, 2006). Osteoporosis, a disease often associated with aging, is more frequent in women; however, because of this, it is frequently underdiagnosed in men. Osteoporosis is a hidden cause of hip fracture in both men and women and has significant implications for rehabilitation of older adults.

Sex, Gender, and Clinical Health Research

While the importance of considering sex and gender differences in planning rehabilitation of older adults is crucial, research has been strongly sex-biased, until recently. As a result, the research on which practice has been based is also sex-biased. In recent decades, clinical trials have not adequately enrolled women or analyzed sex-specific differences in clinical research data. This has most commonly been due to the assumption that findings on males apply to females or that the hormonal cycle in females may confound the effects of experimental manipulations (Wizemann & Pardue, 2001). Some researchers consider males to be representative of the human species, and differences from the male norm as being atypical or abnormal, and still others seek to protect women from adverse effects of drugs (Marts & Keitt, 2004). However, epidemiological and clinical studies of men often generate different results from those of women. This is exemplified by sex differences in response to many drugs (Soldin & Mattison, 2009). Between 1997 and 2001, eight out of ten drugs withdrawn from the market were due to adverse effects in women (Heinrich, 2001). Furthermore, widespread prevalence of sex differences in human disease, and the neglect of women in biological research, negatively impacted the health of women (Correa-de-Araujo, McDermott, & Moy, 2006). Understanding of the consequences of this exclusion, agencies in both Canada and the United States have worked hard toward the inclusion of women in clinical trials and appropriate analysis and reporting of sex-specific data.

In 1993, the NIH Revitalization Act came into law in the United States. The Act requires that the inclusion of women in clinical trials must be considered for all clinical research efforts. Exceptions to this are considered in the study of diseases that exclusively affect men or where involvement of pregnant women may expose the fetus to undue risks. The Act stated that gender differences should be noted and evaluated. If women are not to be included, a clear rationale should be provided for their exclusion. It further requires that a *clinical trial* which includes women and people from racial and ethnic minorities as participants be designed and carried out to provide for valid analysis of whether the variables being studied affect these subpopulations differently than the other participants.

In 1997, Health Canada published similar guidelines with the *Food and Drug Act and Regulations* policy on the Inclusion of Women in Clinical Trials During Drug Development (Government of Canada, 1997). Unlike the NIH Act, the Canadian guidelines only encourage the enrollment of a representative number of women for those drugs that are intended to be used specifically for women or in populations that are expected to include women; it was not made a requirement. The guidelines advocate for the inclusion of women of child-bearing potential and postmenopausal women in all stages of drug development. In addition, the Women's Health Strategy of Health Canada made a commitment in 1999 to have gender-based analysis (GBA) integrated into policy and program development.

While these policies encouraged the inclusion of women in human trials, they did not include a similar initiative regarding the study of cells and animals. The continued overreliance on male animals and cells in preclinical research obscures key sex differences that could guide clinical studies. Inadequate inclusion of female cells and animals in experiments, and inadequate analysis of data by sex, may well contribute to irreproducibility in preclinical biomedical research (Clayton, 2016). In the past, not including female rats has been justified due to the variable nature of female data that may be caused by hormonal fluctuations associated with the female reproductive cycle. However, research has shown that, when female rats are used in neuroscience experiments without regard to the estrous cycle stage, their data are not more variable than those of male rats. This is true for behavioral, electrophysiological, neurochemical, and histological measures (Becker, Prendergast, & Liang, 2016). Similarly, a recent meta-analysis reported that female mice are not inherently more variable than male mice across diverse physiological traits (Prendergast, Onishi, & Zucker, 2014). In other research, similar results have been obtained for measures of gene expression in mice and humans (Itoh & Arnold, 2015).

Despite changes in policies governing research practices and funding over the past 20 years, women remain underrepresented in clinical trials, and research on women-specific outcomes of illnesses is underrepresented in the literature in most research domains. For example, cardiovascular disease is the number one killer of both men and women in the United States; however, women remain underrepresented in clinical trials for cardiovascular disease treatments (Melloni et al., 2010). This is also the case for cancer, the second leading cause of death for men and women in the United States, where men were reported to make up 60% to 73% of participants in clinical trials between 2001 and 2010 (Kim & Menon, 2009; Kwiatkowski, Coe, Bailar, & Swanson, 2013). In addition, even when women have been included as participants, a sex and gender analysis is not always reported for various health outcomes (Colantonio, 2016; Johnson, Greaves, & Repta, 2009; Mollayeva, El-Khechen-Richandi, & Colantonio, 2018; Oertelt-Prigione, Parol, Krohn, Preissner, & Regitz-Zagrosek, 2010; Tannenbaum, Greaves, & Graham, 2016).

While in many research domains women have traditionally been underrepresented compared to men, there are areas that suffer from the opposite problem. For example, in psychotherapy research, women have been studied and published about significantly more than men (Bedi, Young, Davari, Springer, & Kane, 2016). In fact, when examining research studies that intentionally seek to look at a particular gender, female-specific research outnumbers male-specific research 15:1 (Bedi et al., 2016). Well-established evidence-based guidelines exist regarding ethical approaches to psychotherapy with girls and women (American Psychological Association, 2007; Canadian Psychological Association, 2007); however, comparable guidelines do not exist to serve the unique needs and preferences of boys and men. This is despite both women and men suffering from mental health issues across the life span. A World Health Organization (WHO) report on mental health service utilization in 12 countries found that men were significantly less likely to receive treatment for mental health issues in 10 of the 12 countries (Wang et al., 2007). This report also found that age was a significant predictor of mental health service use in both men and women, which highlights the need not only for research on ethical approaches to psychotherapy with men but also best approaches for psychotherapy research in older adult men and older adult women.

In the not-so-distant past, a number of other specific groups have been systematically excluded from research. For example, early research excluded gay individuals and racial minorities. In fact, racial minorities were historically underrepresented in the vast majority of clinical trials, and almost no early trials focused on illnesses that primarily affect minority populations. This was despite the growing evidence that racial minorities responded differently from whites to certain drugs and also may experience disease progression differently (Emanuel et al., 2008). Despite changes in regulations regarding the inclusion of LGTB individuals and minorities, research continues to underrepresent these groups (Emanuel et al., 2008). Egleston, Dunbrack, and Hall (2010) examined clinical trial registries for use of language that would exclude lesbians and gay men. Their results indicated that the exclusion of lesbians and gay men from clinical trials in the United States was not uncommon, particularly where sexual function was the topic of study. For example, gay men were found to be excluded in studies on erectile dysfunction. Researchers must be held to a high level of scientific reasoning when they develop exclusion criteria that are based on sexual orientation.

Sex and gender have traditionally been poorly integrated into health research. As a result, the impact on rehabilitation has mostly been overlooked (Colantonio 2016; Mollayeva & Colantonio, 2017). Within the context of rehabilitation and aging, science must seek to understand the mechanisms of health and recovery and the unique and accumulative contributions that sex and gender have on these factors. While it is imperative that sex and gender be considered in rehabilitation and aging, the research on which this care is based is still in an early development phase. In the context of doing more sensitive, precise, and relevant health research, much work has been done to promote sex- and gender-based analysis and critical thinking around the influence of sex and gender around health, health behaviors, and outcomes. Prominent funding agencies have taken a lead in enforcing requirements of research design and analysis to ensure adequate inclusion of women and that investigators provide meaningful analysis by sex and gender. For example, the Canadian Institutes of Health Research has established criteria for the integration of sex and gender at all stages of the research process (CIHR, 2018), based on the Government of Canada's Health Portfolio Sex and Gender-Based Analysis Policy and the Tri-Council Policy Statement on the Ethical Conduct for Research Involving Humans. Both policies underscore the importance of considering sex and gender in health research. In order to enforce this integration, CIHR asks applicants to indicate if sex and/or gender is accounted for in proposed research studies.

Sex and Gender Equity in Research Guidelines

The Sex and Gender Equity in Research (SAGER) guidelines are a comprehensive procedure for the reporting of sex and gender information in study design, data analysis, results, and interpretation of findings (see Table 28.2). The European Association of Science Editors (EASE) established a Gender Policy Committee in 2012, which resulted in the creation of these guidelines. The committee worked over a 3-year period to develop its recommendations and have them reviewed by 36 experts in sex and gender research (Heidari, Babor, Castro, Tort, & Curno, 2016). The SAGER guidelines are designed to promote systematic reporting of sex and gender in research. These guidelines provide researchers and authors with a tool to standardize sex and gender reporting in scientific publication, when appropriate.

Sex- and Gender-Based Analysis (SGBA)

SGBA is an approach to conducting research that systematically examines sex-based (biological) and gender-based (sociocultural) differences among men, women, boys, girls, and gender-diverse people. The purpose of SGBA is to promote rigorous science that is sensitive to sex and gender and, therefore, has the potential to expand our understanding of health determinants for all people. As mentioned earlier, there have been instances in past research that wrongly led to assumptions about care for men and women that either put one at risk or led one to miss the benefits of the therapy because an SGBA approach was not used. The omission of SGBA can have direct and serious consequences for morbidity and mortality (Aulakh & Anand, 2007; Colantonio, 2016; Johnson, Greaves, & Repta, 2007), making the use of an SGBA the most ethical way of conducting health research.

Applying SGBA at various stages of the research process provides a more comprehensive science that can help formulate health research, policies, and programs that are relevant to the diversity of the population. A variety of recommendations for research have been published to help guide SGBA at all stages of the clinical research process and across different fields and disciplines. SGBA is not about adding an extra layer to existing research practices but about enhancing current methodologies. It produces

Table 28.2 SAGER guidelines for research with older adults (adapted from Heidari et al., 2017[a])

General principles
The terms sex and gender should be used carefully by authors carefully in order to avoid confusing both terms
Research should be designed and conducted in a way that can reveal sex-related differences in the results. This should be done even if sex-related differences are not initially expected
Research involving subjects that can also be differentiated by gender (shaped by social and cultural circumstances) should be designed and conducted in a way that can reveal gender-related differences in the results. This should be done even if gender-related differences are not initially expected

Recommendations per section of the article	
Title and abstract	In the case where only one sex is included in the study, or if the results of the study are to be applied to only one sex or gender, the title and the abstract should specify the sex of and gender of human participants
Introduction	Where relevant, authors should report whether sex and/or gender differences should be expected
Methods	Authors should report how sex and gender were taken into account in the design of the study. Adequate representation of males and females should be ensured. Any exclusion of males or females should be justified
Results	Where appropriate, data should be routinely presented disaggregated by sex and gender. Sex- and gender-based analysis should be reported regardless of positive or negative outcome. In clinical trials, data on withdrawals and dropouts should also be reported disaggregated by sex
Discussion	The discussion should include the potential implications of sex and gender on the study results. If a sex and gender analysis was not conducted, the rationale should be given, and the implications of the lack of such an analysis on the interpretation of the results should be provided

data that are not only disaggregated on the basis of sex but also on other important social variables. The traditional research approach that emphasizes single factors, such as age, sex, education, or socioeconomic status, has become the subject of growing scrutiny. This type of research which focuses on single categories does not provide findings that accurately represent communities of individuals with growing diversity. There is no single method for implementing an SGBA framework; instead, there are a number of guiding questions that can assist in the design, undertaking, and analysis of research. These questions may differ depending on the type of research being undertaken (e.g., quantitative, qualitative, or mixed methods).

Review of the Literature

Regardless of the methodology, research should incorporate concepts of sex and gender from the outset. The research process will start with an extensive review of the literature that includes both quantitative and qualitative data where applicable and focuses on developments within the last 5 years. Researchers should also consult, where possible, with stakeholders who have relevant knowledge and expertise in the research area. When using SGBA, it is important to ensure consultations are as inclusive as possible. Once evidence has been gathered, a critical review will elucidate: what is known about the topic of interest as it relates to gender and gender theories; what gaps exist with respect to different populations of women, men, and gender-diverse people; if existing knowledge is objective or perpetuates stereotypes; and what factors and aspects of identity have been taken into account.

Formulate a Research Question

The literature review will provide the foundation and rationale for the research question. The question should consider what is the population being studied; who is the population being compared to; what are gaps in knowledge that consider gender-diverse groups; if the research includes men, women, and gender-diverse people; does the research consider the homogeneity of these groups; and does the question accurately capture the needs of the diverse population. The research question will determine what type of study design is needed (i.e., quantitative, qualitative, or mixed methods). Regardless of which design is chosen, similar considerations will have to be made regarding how to implement an SGBA. These include how gender and other subpopulations will be defined, measured, and investigated; how data will be presented and analyzed; ensuring harmful stereotypes are not perpetuated; inclusion of comparisons of subgroups in the topic of interest; inclusion of traditionally neglected groups; and examination of how gender and other factors (e.g., socioeconomic status, ethnicity, and geography) have combined effects (Cole, 2009; CIHR, 2018).

Asking yourself the following questions when planning a clinical research study is useful and can be applied at any stage of the research process (adapted from CIHR, 2018):

1. Does the research question explicitly state who the research is applicable to, or does it take one sex or gender as the norm? Avoid generalizing the findings to groups other than the one being studied.
2. Does the research question assume sex or gender groups do not have within-group differences? One must consider that there are many possible differences between individuals of the same sex or gender. Findings must acknowledge the differences among different groups (i.e., different groups of women or men).
3. Are sex and gender considered in the literature review? How are sex and gender used in previous work? Are the terms used accurately? How can your study present a more precise representation of sex and gender? Make note of any inaccuracies or omissions in order to avoid making them in your study.
4. Are the selected measures for sex and gender appropriate? The choice of the measures has a great effect on the quality of the results. If any limitations in measure selection exist, make sure to acknowledge this or to modify the measure if possible.
5. How will data be collected, and how will this affect the results?
6. Will analysis account for differences in sex and gender and also within-group differences? Consider how findings can be analyzed to account for these differences.

Gender-Based Research+ (GBA+)

GBA+ is a process for examining how various intersecting identity factors impact the effectiveness of research. It extends beyond SGBA by examining data and considering sex, gender, and social, economic, and cultural conditions and norms. Using GBA+ involves taking a diversity-sensitive approach as part of the research. Thus, GBA+ is meant to be applied within the context of a diversity framework that considers the ways in which social determinants of health, such as ethnicity, socioeconomic status, disability, sexual orientation, migration status, age, and geography, interact with sex and gender to contribute to exposure to various risk factors, disease courses, and outcomes.

How to Conduct SGBA or GBA+: A Guide for Research on Rehabilitation of Older Adults

There are many ways in which to incorporate an SGBA or GBA+ into health research. Integrating sex and gender into a study means more than gender representation in the study design. SGBA and GBA+ both require thoughtfulness of sex and gender at all stages of the research process. Here we discuss three different scenarios that researchers may find themselves in and how an SGBA can be used.

Incorporating SGBA or GBA+ from the Start

The first step in conducting research is identification of a gap in knowledge and, therefore, a need for research. For example, your clinical unit may be interested in the following question: What are the best practices for rehabilitation of older men and women with dementia following hip fracture surgery? Or, are there differences between premenopausal and postmenopausal women's experiences with cardiovascular disease? After a review of the literature, you may find that an answer to this question has not been established, and you would like to conduct a study to answer that question.

A proposed study can incorporate concepts of sex, gender, and diversity from the outset. Studies in this category assume three forms: studies on females/women; comparison studies on females/women and males/men; and multilevel studies that examine multiple layers of sex and gender and diversity, that is, the individual, group, institutional, and cultural layers of sex and gender. Women-only studies help to identify differences among groups of women. Researchers must be careful to ensure their sample is representative of the sample to which they would like to generalize results.

Comparison studies can illuminate differences between and among groups of men and women, and variability in age, ability, socioeconomic status, ethnicity, etc. can be explored. One of the most powerful approaches is to evaluate trends over time to uncover knowledge gaps, similarities, and differences. For example, research has shown that women 50 years of age and over are less likely than men of the same age to be admitted to the intensive care unit (ICU) or to receive potentially lifesaving interventions (such as mechanical ventilation) and are more likely to die when admitted for critical illness (Fowler et al., 2007). Despite similar severity of illness between women and men upon ICU admission, women had shorter stays in the ICU but longer overall stays in the hospital. Research that highlights important disparities such as these can be used to inform targeted interventions and policies to eliminate these disparities.

Multileveled studies can examine multiple layers of sex, gender, and diversity simultaneously. Multileveled studies that take into consideration the interplay of many sex, gender, and diversity variables are useful when exploring whether health outcomes for individuals or groups are correlated. Once the research question has been decided upon, the most appropriate research design will be decided upon. Qualitative research is an "umbrella term" for a number of different approaches (e.g., ethnography, grounded theory, phenomenology) that draw on data collection techniques such as interviews and observations. Qualitative research aims to build an understanding of a phenomenon. Qualitative research is often used for exploratory questions, such as "How?" or "Why?" For example, how does the rehabilitation process differ between older men and older women following hip fracture surgery? Or, how do referral practices for hip fracture surgery by physicians differ depending on the age, sex, and ethnicity of the patient? The goal of qualitative research is to understand the participants' own perspective grounded in a social context. Because qualitative research is contextually based, it does not seek generalizability in the same sense as quantitative research.

A quantitative research approach seeks to explain or identify causation. Quantitative research aims to be more conclusive and answer questions such as "What? When? or Where?" For example, when should postmenopausal women have a bone density test for osteoporosis? Or, what is the relationship between physical activity and quality of life in older adults? A central tenant of the quantitative research method is the research design in which investigators clearly specify in advance what data they will measure and the procedure they will use to obtain the data. The overall goal of quantitative research is prediction, causation, and generalizability.

Altering an Existing Research Study

Another approach for incorporating SGBA or GBA+ is to alter an existing study. Researchers can add additional measures or samples to their study in order to allow a more rigorous analysis of how sex, gender, and diversity-related factors help explain a certain issue. When altering an existing research study, investigators may also choose to use a mixed-method approach; that is, make use of both quantitative and qualitative methods. Altering an existing study is most appropriate in the initial stages of the research when alterations are realistic. One way to alter an existing study is to divide the sample of a women-only study or to add a sample of women to a study with only men. Adding a sample or dividing a sample allows for researchers to report more precise information about the data, for example, dividing a group of women into pre- and postmenopausal or dividing a sample of older adults into older men and older women.

Another way to alter an existing study is to add a measure of gender. There are numerous measures that may be added to a study, and some examples will be given later in the chapter. While research often uses measures of quality of life, emotional well-being, and other factors, researchers often neglect to include the measure of gender. Measures of gender may look at gender identity, gender relations, or institutionalized gender.

Revisit an Existing Study

This involves revisiting existing research data from a completed study and then reanalyzing the findings to see how sex and gender are relevant to, or explain, the results. Revisiting an existing study does not involve any changes to the original research question. This approach may involve performing a secondary analysis or asking additional questions about the data that have already been collected; for example, asking how gender roles might explain differences in the data. Even when investigating a phenomenon where gender seems irrelevant, researchers must still consider an SGBA or GBA+.

Performing a secondary analysis is one way researchers can incorporate sex and gender into an existing study. A secondary analysis involves redirecting the focus of the data, such that it can be compared with data from other studies. Secondary analysis is often completed by a different researcher from the original study in order to answer a new research question. This is made possible by the fact that data sets are often not fully explored, and rarely does a study explore all aspects of the data. This is due to time and budget constraints (Payne & Payne, 2004). A secondary analysis allows for re-examination of data from studies that previously did not consider SGBA or GBA+ concepts (Johnson et al., 2007). This can also be applied to reanalyses of systematic reviews (Cancelliere, Donovan, & Cassidy, 2016). Clearly, there are many ways in which investigators can incorporate an SGBA or GBA+ into research on rehabilitation of older adults.

Measuring Sex and Gender

An important part of the research process is operationalizing sex and gender. It is imperative that the measures are valid, sufficiently sensitive, and not gender-biased. A number of measures of sex and gender are available for consideration when deciding the most appropriate measure for the research question.

Measures of Sex

Measures of sex are objective and include those discussed in the beginning of this chapter: anatomy, physiology, and genetics. Anatomical measures of sex include reproductive organs and secondary sex characteristics. Physiological measures of sex include levels of hormones, such as sex steroids in the body (i.e., estrogen, androgens, progestogens). Lastly, genetic measures of sex include chromosomes, such as XX, XY, and XXY (Johnson et al., 2007).

Measures of Gender

Measuring gender requires consideration of multiple intersecting elements of gender. Three components of gender that researchers may want to measure include gender identity, gender relations, and institutional gender (Johnson et al., 2007). Gender identity refers to how we perceive ourselves on the continuum of masculinity and femininity. There is a large body of measures to choose from with varying reliability and validity. It must also be noted that, when deciding upon a measure, gender roles and norms may change with time or between cultures. This has implications for older adults who may have gender ideologies that differ from individuals 50 years younger. Measures that may be used when looking at gender identity include the *Bem Sex-Role Inventory* (BSRI), the *Personal Attributes Questionnaire* (PAQ), and the *Male Role Norms Scale* (MRNS). The BSRI (Bem, 1981) is a 40-item scale that measures gender-role perceptions. It assesses traditional gender roles and links gender, personality, and ideology. The BSRI has been criticized for oversimplifying femininity and masculinity and not being able to capture the complex nature of each concept. This measure is often used in research; however, its validity may be weakening for female- and male-gender-role perceptions in North American/Western cultures (Johnson et al., 2007). The PAQ (Spence & Helmreich, 1978) is a 16-item scale that measures positive instrumental and expressive personality characteristics and assesses internalization of gender-typed traits. Similar to the BSRI (Bem, 1981), this questionnaire has been criticized for oversimplifying femininity and masculinity. Finally, the MRNS is a 26-item self-report scale that uses a 7-point very strongly disagree to very strongly agree format. The MRNS assesses traditional masculine ideology and gender-related attitudes (Thompson, Pleck, & Ferrera, 1992). It is based on the masculinity ideology identified by Brannon (1976) and by three dimensions that underpin the male-role norm: status norms, toughness norms, and antifemininity norms (Thompson et al., 1992).

Gender relations refer to how individuals respond to socially constructed roles, rights, and responsibilities, as well as how gender informs sexual, emotional, and relational expressions (Johnson et al., 2007). Examples of measures that may be used when assessing gender relations include the *Gender Role Beliefs Scale* (GRBS; Kerr & Holden, 1996) and the *Gender Relations Scale* (GRS; Stephenson, Bartel, & Rubardt, 2012). The GRBS is a 20-item scale that measures gender-role ideology about appropriate behavior for men and women. The GRS is a measure of equity and power in relationships. It is a 23-item scale that measures attitudes toward gender roles and expectations, decision-making around sex and reproduction, household decision-making, violence, and communication.

Institutional gender refers to how institutions respond to individuals based on their gender, the connections between gender and power, opportunities afforded to different genders, and how gender relates to positions in society (Johnson et al., 2007). Using the *Global Gender Gap Report* is one way of examining institutional gender. This report benchmarks 144 countries on their progress to gender equality across 4 thematic dimensions: economic participation and opportunity, educational attainment, health and survival, and political empowerment. This report quantifies the magnitude of gender-based disparities and tracks them over time. Similar to measures of gender relations and gender identity, no single measure can capture the complete picture of institutionalized gender. Therefore, researchers must examine different measures and find the most appropriate ones for the specific research question.

Case Example: Considering Sex and Aging After Traumatic Brain Injury (TBI)

Although we will focus primarily on TBI in presenting the *Case Example*, it should be noted that many of the issues raised are comparable for a wide range of other illnesses in the aging population, from musculoskeletal and pain, to cardiovascular disease, to mental health issues (all of which are covered in other chapters of this Handbook). TBI is a good example which "pulls together" many of the factors/dimensions reviewed earlier in this chapter.

Case Example A local outpatient rehabilitation center sees a number of older individuals aging with TBI. Clinicians working on the unit begin to see a pattern that when these individuals have a history of TBI, they present with a number of comorbidities, and of particular interest to the unit are those related to the musculoskeletal system. The clinical educator embarks on answering the following question: *What research exists regarding sex and gender differences in long-term musculoskeletal complaints in aged indi-*

viduals with TBI? In line with the SGBA guideline, as a first step, an extensive review of the literature is completed.

Literature Review

Indeed, recently there has been a call to view TBI as a disease process and not an isolated event (Masel & DeWitt, 2010). Internationally, the need to explore sex and gender differences in outcomes following TBI has been recognized as a priority area of research (Harris et al., 2012). Individuals with TBI are complex patients that may develop a number of comorbidities over time. These comorbidities vary by sex and age, with older females experiencing more comorbidities than older males. This is particularly true for comorbidities and re-hospitalizations related to the musculoskeletal system (Chan et al., 2017; Saverino et al., 2016). Older adults over 75 years of age have the highest rates for TBI-related hospitalizations (Colantonio et al., 2010). In addition, adults over 85 years of age are among the highest to have reported episodes of care for TBI with women outnumbering men (Colantonio et al., 2010; Dams-O'Connor, 2013). Falls are the leading cause of TBI for older adults (41.6%; Colantonio et al., 2010), which may result in simultaneous injuries to the musculoskeletal system.

While many patients survive a TBI, a chronic disease process is often initiated and persists for many years and even decades. In addition, older age is known to negatively influence outcome after TBI. Following a TBI, individuals may experience impacts on multiple organ systems, some that are distant from the site of injury. While it is currently unknown what impairments specifically put individuals at risk for particular long-term impacts, unresolved neuromuscular impairments potentially underlie an increased risk for musculoskeletal-related injuries and complaints (Martini et al., 2011). Altered movement patterns following TBI may be due to poor motor planning (Hesdorffer, Rauch, & Tamminga, 2009), which can cause dysfunction in walking and movement that persist long after TBI rehabilitation is complete. How these changes evolve, with considerations of sex and gender differences, has significance for therapists providing rehabilitation to older individuals following TBI (Bhatia, Bejarano, & Novo, 2013; Mushtaq et al., 2011).

Although literature on long-term musculoskeletal outcomes following TBI is limited, a small number of studies suggest that musculoskeletal complaints, including joint pain and arthritis, are more common in this population (Brown, Colantonio, Beaton, & Hawker, 2011; Colantonio et al., 2004; Hibbard, Uysal, Sliwinski, & Gordon, 1998; Jourdan et al., 2016; Ocampo, Colantonio, Dawson, Badley, & Ratcliff, 2014). While most research has not explored sex and gender differences in these comorbidities, some data exists suggesting that women experience significant unfavorable outcomes 3 or more years following mild TBI in the frequency of self-reported neck pain, lumbar back pain, and thoracic back pain when compared to men (Styrke, Sojka, Björnstig, Bylund, & Stålnacke, 2013). The prevalence of self-reported arthritis in community-dwelling adults is greater in those who have sustained a TBI, compared to the rate of self-reported arthritis in the general population in Canada and the United States (PHAC, 2014). Compared to men aging with TBI, women aging with TBI may be at increased risk for arthritis; however, research suggests that, in the general population, women are also at a greater risk to develop arthritis compared to men (Statistics Canada, 2016), indicating further research is needed.

Many possible mechanisms have been postulated for the high rate of musculoskeletal complaints. Recent literature has suggested that an injury to the brain may have a more systemic effect, developing in the weeks and months following the initial impact that affects the immune system (Balu, 2014). An increased immune response has implications for global inflammation, as well as more specific conditions affecting the joints, such as arthritis and gout. In addition, many TBI survivors sustain other injuries at the time of the initial injury. These injuries may have different patterns when considering sex and gender. Participants injured in motor vehicle crashes may have multiple injuries, particularly in the joints, that could lead to arthritic changes. Heterotopic ossification is known to occur after severe TBI (Cipriano, Pill, & Keenan, 2009) and could possibly lead to long-term musculoskeletal pain and abnormal pressure on joints. Altered postural alignment and asymmetry in motor control may predispose persons to arthritic changes. In addition, prolonged gait deviation, including changes in speed, cadence, width of base, and stance time on each leg, has been found to occur in individuals post-TBI (Williams, Morris, Schache, & McCrory, 2009). This may contribute to painful joints and degeneration of cartilage. It is important to document the extent to which these initial injuries may evolve into long-term musculoskeletal issues.

Summary of Literature Review

Literature on sex differences in aged individuals with TBI remains a huge gap. Therefore, the assessment of long-term health conditions after TBI needs to be conceived very broadly to include conditions for which few summaries exist of the long-term effects, such as arthritis and musculoskeletal conditions. Conditions that evolve over time have proven disabling effects that may be different depending on sex and gender. A detailed investigation of long-term survivors that does not solely rely on self-report, but also includes physical examination of musculoskeletal changes, may shed light on these processes and ways to prevent further disability from occurring. More longitudinal research with the use of a control group is needed to determine if TBI plays a role in accelerated development of arthritis or musculoskeletal complaints in women and men, relative to women and men who have not sustained a TBI. Additionally, how sex and/or gender is measured is important in the design of the study and reporting of results. Existing literature on long-term outcomes following TBI that systematically includes sex and gender differences is still emerging.

New Direction for Future Research

Considering the findings of the literature review, the need for further systematic, long-term comprehensive evaluation over the life course after a TBI, particularly if moderate to severe, is identified. The next step in conducting an SGBA study is to develop a research question to fill this gap. A variety of research questions can be developed.

Exercise:

1. Write a research question that would begin to fill this gap.
2. How sex and gender will be measured to answer the research question?
3. How will data be collected?
4. How will data be analyzed?

Clinical Implications of Literature Review

Despite the need for more research, clearly, clinicians in both neurological fields and physical rehabilitation must be on alert for comorbid conditions as these influence the course and outcomes of rehabilitation. All healthcare practitioners must be aware of the increased probability for musculoskeletal changes in the long-term aftermath of TBI, especially in females, and screen for them. Close attention to confounding variables, such as obesity, gait imbalances, sex, and a history of fractures, will further help in the elucidation of the mechanism of the development of musculoskeletal pain and arthritis following TBI. Knowledge of cultural differences in the reporting of pain, such as the belief in “no pain, no gain,” or “pain is a normal part of aging,” will also help clinicians when assessing older adults and creating appropriate plans for rehabilitation. Awareness of comorbid conditions provides an opportunity for planning and prevention which would influence activities of daily living and quality of life in aging individuals following TBI.

Research to Practice Implications

Knowledge translation is a moving and iterative process that includes synthesis, dissemination, exchange, and ethically sound application of knowledge to improve the health of older adults (CIHR, 2018). When developing a project, knowledge translation should be considered from the outset. Knowledge-translation plans should consider sex and gender, as well as how they intersect with diversity factors. When translating research findings into practice, health practitioners working with older adults should consider the following (CIHR, 2018):

- What is the makeup of the audience? Might the problem differ depending on their age and gender and other diversity factors?
- Adapt the knowledge to the local context, for example, in patient or outpatient rehabilitation.
- Consider gender differences in communication. Might these influence how information is received?
- Assess any barriers to knowledge use, given the different gender roles in society and any barriers that may prevent knowledge use by gender.
- Review the evidence that exists regarding sex and gender differences in the field and what works for who and in what context.
- Different people have different ideas of what success looks like. Have sex and gender differences in the definition of success been considered?
- Identify any differences that exist in motivation by sex, gender, and other diversity factors.

Future Directions for Research and Practice

As sex- and gender-based health research is still in its infancy, healthcare professionals and researchers particularly in the rehab field have a huge opportunity to engage in relevant and ethically sound research. Research from the young adult population suggests that gender differences exist in the transition from pediatric to adult care in relational factors, such as communication, family involvement, and social support (Lindsay, Hartman, & Fellin, 2016). Similar research is needed to elucidate any sex or gender similarities or differences in the transition from care as an adult to older adulthood. In addition, research on sex- and gender-specific counseling practices for older adults is virtually nonexistent, and this needs to be addressed to promote mental health in this growing population.

Healthcare professionals working in rehabilitation of older adults must consider sex and gender when planning care. Healthcare practitioners must review the literature not only on best practices for rehabilitation and gender differences in rehabilitation protocols but also in areas that will affect care planning. For example, men may respond better to problem-solving and micro-skill training to achieve a specific outcome (Bedi & Richards, 2011). In addition, clinical educators can use their role to educate groups of healthcare professionals and embed concepts of sex and gender within the curricula. For example, there is extensive research suggesting men and women differ in their responses to pain (Bartley & Fillingim, 2013). Women have been found to have increased pain sensitivity and more likely to suffer from chronic pain. Women are also more likely to report pain than men (Fillingim, King, Ribeiro-Dasilva, Rahim-Williams, & Riley, 2009). The communication and reporting of pain of older adult men and women has implications for rehabilitation planning and progression.

Healthcare practitioners must critically examine gender stereotypes, because they stand in the way of effective rehabilitation. For example, in the case of nutritional interventions to help with cardiac rehabilitation, while women traditionally have been responsible for meal preparation, sex and gender roles have changed over time, and both men and women are involved in the preparation and purchase of food (Lee Anne, Bisakha, Kilgore, & Locher, 2014; Smith, Ng, & Popkin, 2013; Wang, Naidoo, Ferzacca, Reddy, & Van Dam, 2014). Community integration measures scoring women higher than men may be influenced by the fact that women have been socialized to take more responsibility for "home integration" that influence scoring on those measures (Mollayeva et al., 2017).

It is often difficult to compare studies in rehabilitation of older adults as they are based on populations with different ethnic, socioeconomic, and demographic characteristics, different geographic and ethnic groups, different illnesses and health conditions, or different symptoms of these illnesses and conditions. Moreover, these interrelationships may change over time with, for example, changes in social and economic conditions. As a result, clinicians must review the literature and critically appraise which research is applicable to their patient population. In addition, because in-depth analysis of sex and gender in studies on older adults is still very few, a systematic approach to studies in this area is needed to provide a useful basis for the development of policy, planning, and health services.

Conclusion

Sex and gender are not monolithic variables. Instead, they influence each other, as well as interact with ethnicity, culture, class, sexual orientation, and sexual identity. Sex and gender clearly play a role in the determinants and consequences of the health of older adults, and it can no longer be assumed that a male model for health also applies to women. The way in which gender affects these determinants and consequences may vary according to the conditions selected and according to the characteristics of the population studied. Taking these variables into account in research and practice is necessary to understand the experience of health and to create evidence-based rehabilitation plans for older adults. Much of the literature does not address this, especially as it pertains to older adults. To reduce disparities in health outcomes between older men and older women, it is essential for clinicians to consider sex and gender differences as one of the underlying mechanisms of illness and rehabilitation. A greater focus on sex and gender in research will lead to improvements in human health, illness, and rehabilitation outcomes, as well as influence the frequency and magnitude of adverse events. To accomplish this goal, researchers must conduct research using an SGBA or GBA+ approach. This presents a great opportunity for healthcare practitioners to engage in sound, relevant, clinically based research that focuses on rehabilitation outcomes in older adults, and with a "sex and gender lens." This research will continue to form the basis for advancing more appropriate, personalized medicine.

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What Is AARP and Other Nonprofit Organizations that Can Help Older Adults

29

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Today, there are many nonprofit organizations that have been established centered around recognizing and supporting the social and physical health needs of the aging population. According to the Population Reference Bureau (2016), the number of Americans aged 65+ is substantially increasing and will reach more than double the current number of 46 million by 2060. Along with these growing numbers, there has been an increase in social and health challenges, including increased obesity rates, economic disparities, rise in mental health disorders, and isolation issues, all of which collectively create a lower quality of living for this particular age group. Because of this, there has been, and will continue to be, a growth spurt of nonprofit organizations focused on innovatively creating solutions for these national issues. This present chapter will discuss the largest national American nonprofit organization, the *American Association of Retired Persons*, followed by similar organizations that are continually on the rise in executing organizational initiatives.

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The American Association of Retired Persons (AARP)

AARP, previously known as the *American Association of Retired Persons*, is a national nonprofit/nonpartisan social welfare organization that provides a variety of services for individuals over the age of 50. The founder, Dr. Ethel Percy Andrus (a former California principal and educator), established the *National Retired Teachers Association* (NRTA) in 1947 in order to provide retired teachers with health insurance and benefits (International Directory of Company Histories, 1999). Dr. Andrus's passion for community outreach was initially spawned from seeing her fellow retirees struggling, not only to live the lives that they had worked so hard for, but to support their basic needs (Kiger, 2016). With the assistance of a New York insurance broker (Leonard Davis), Dr. Andrus created the *American Association of Retired Persons* in 1958 (USC, 2001). In 1982, Dr. Andrus broadened the outreach of her program by establishing NRTA as a division of the larger AARP. Davis became the head of AARP's insurance coverage by establishing the *Colonial Penn Group* in 1963. Years later in 1979, Prudential became AARP's primary insurer, offering more coverage and less out-of-pocket pay for members (Tierney, 1988).

Dr. Andrus and Davis continued to dedicate their lives to improving and revolutionizing the definition and image of the aging in our society,

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which has ultimately impacted generations today. AARP had been founded on principles committed to promoting the independence, dignity, and purpose of aging individuals, enhancing their quality of life, and encouraging them "to serve, not to be served" (AARP, 2015). Since the establishment of AARP, 7 affiliated organizations have been created, serving approximately 38 million members worldwide. In becoming one of the largest membership-based organizations in the nation, AARP is well known for its advocacy in representing older adults in the US Congress for important financial issues, such as Medicaid and Social Security. AARP publicizes its political policy initiatives that are in line with the organization's mission of "enhancing the quality of life for all as we age" (2016).

The AARP Foundation

The *AARP Foundation* is one of the four nonprofit charitable affiliates of AARP. The affiliation focuses on advocating for mature adults who experience challenges meeting their basic living standards, including isolation, low income/unemployment, housing issues, hunger, and legal disparities (AARP Foundation, 2013). With offices in all 50 states, the *AARP Foundation* partners with local and nationwide organizations to increase the availability and effectiveness of their services, as reviewed below.

Hunger

For years, diet was not officially known for causing or proliferating chronic illnesses. It was not until the year 2010 that the *Global Burden of Disease* started to recognize the need to analyze the impact of our diets on our overall health. With the continual knowledge through health and wellness research, today's standards of optimal nutrition are on the rise. The *AARP Foundation* has created a worldwide initiative specifically on educating society, extending public policy, and elevating collaborative leadership for nutrition and hunger. To achieve such initiatives, the *AARP Foundation* partners with the USDA Center for Nutrition Policy and Promotion and is an active member of the Sustainability Consortium, Alliance to End Hunger, and National Alliance on Nutrition and Activity (AARP Foundation, 2016c; USDA Center for Nutrition Policy & Promotion, 2016). The Root Cause Coalition was created by the *AARP Foundation* and *ProMedica* as a nonprofit, member-driven organization that addresses the impact of preventable chronic diseases associated with hunger and food insecurities. Its collective research initiatives have been abundant in helping everyday people learn about the basics of healthy living and disease management.

In the Spring of 2016, the *AARP Foundation* collaborated with nutrition scientists at Tufts University's Jean Mayer US Department of Agriculture Human Nutrition Research Center on Aging (USDA HNRCA) in establishing an updated version of *MyPlate* for mature adults (Gallagher, 2016). *MyPlate* is a health/nutrition resource created by the USDA Center for Nutrition Policy and Promotion, equipping Americans with updated education on recommended dietary and lifestyle choices (Gallagher, 2016). The current nutrition recommendations for an aging body include 50% fruits and vegetables, 25% whole grains, 25% protein-rich foods, moderate portion of dairy, and the reminder to stay active (all recommendations have been framed around the USDA's *Recommended Dietary Guidelines of 2015–2020*). The update helps older adults establish a balanced diet that caters toward reducing many common chronic diseases, such as type 2 diabetes mellitus and hypertension.

AARP Foundation's 50+ Consumer Survey collected perspectives on what healthy eating means to adults over the age of 50 (AARP Foundation, 2016a). According to the survey, most older adults have the ideal perspective on the definition of healthy living, meaning the consumption of more nutritious foods necessary to obtain physical freedom, independent living, and freedom from disease. Although their ideology is intact, they express different barriers to receiving the nutrients that are required to live a healthy life. These barriers include illiteracy of nutrition labels, inability to afford fresh foods, and convenience factors such as time and preparation.

Income

Many older Americans approaching retirement today struggle with a variety of economic challenges. According to the Board of Governors of the Federal Reserve System, 91% of Americans in 2015, age 60+, reported that their main income after retirement would come from social security, and 55% admitted that they will continue to work (Board of Governors of the Federal Reserve System, 2015; DeNavas-Walt & Proctor, 2015). Unfortunately, the ability for older adults to maintain a consistent income after the age of 50 continues to be a more difficult issue that is paralleled with increasing health disorders, specifically mental health disorders (Meiler, Steil, Wiesten, Wiltfang, & Kis, 2011). The *AARP Foundation* focuses specifically on assisting the older population with different financial and job matching programs and resources.

The *AARP Foundation's Tax-Aide* is a unique program that is available to all older Americans. This program allows all persons above the age of 50 years old to acquire free tax preparation help yearlong, with the expertise of IRS-certified volunteers. *AARP Foundation Finances 50+* trained volunteers of all different backgrounds to assist members with setting realistic goals, establishing healthy financial habits, and providing continuous assessment on their progress (AARP Foundation, 2016d). A lack of accountability may contribute to the poor financial decisions that are made throughout a working adult's life. During the 2017 tax season, the *AARP Foundation's Tax-Aide* program completed over 6700 tax returns in the state of Utah alone (Polacheck, 2017).

BACK TO WORK 50+ addresses the issue of financial instability at the root cause: unemployment (AARP Foundation, 2016b). This program encourages community colleges and workforce boards to allow greater opportunities to adults age 50+ in obtaining the appropriate skills and support to enter back into the workforce. Today, thousands of job-seeking Americans have utilized *BACK TO WORK 50+* in various colleges across the country to obtain employment security (AARP).

Previous Colorado Attorney General, Ken Salazar, published *Respecting our Elders: A Statewide Action Plan to Combat Senior Fraud* in 1999, which introduced legislative changes ultimately leading to the beginning of the *AARP Foundation ElderWatch* (Colorado Attorney General's Office, 2016). *ElderWatch Colorado* works to protect older Americans from the abuse of financial fraud and scams. Common financial fraud and scams are disguised as charity programs, lotteries and sweepstakes, tax identity theft, and telephone marketing (USA.gov, 2016). Approximately 180 volunteers every year dedicate their time to the *AARP Foundation ElderWatch Hotline*, the Fraud Fighter Call Center, and the Field Fraud Fighter Program. Among the 2015 volunteers, 40 NRTA (*National Retired Teachers Association*) members completed vetted fraud-watch training, helping to amplify the caution in their communities.

Housing

From incompatible housing infrastructure to insufficient funds to pay mortgages, the *AARP Foundation* has set up many efforts to increase the quality of life for those in need. In 2014, AARP and Harvard's Joint Center for Housing Studies (JCHS) published the report *Housing America's Older Adults: Meeting the Need of An Aging Population* (Baker et al., 2014). This report demonstrated the rapidly increasing demographics of adults over the age of 65 by the year 2040 and the need for continuous progression. With a wide variety of research, AARP and JCHS of Harvard present the importance of increasing housing options for the growing population of older Americans, including improving residential care and alternative travel options. The report specifically presented that the current housing stock will not be able to deliver the independent living necessities for older adults, such as accessibility, social and support services, and affordable pricing. AARP Foundation and JCHS urge private and public agencies to help address the shortage of appropriate housing situations for older adults AARP Foundation (AARP Foundation Housing, 2016). Initiatives may include creation of housing located closer to relevant amenities and services, allow construction of smaller housing units for those who wish to downsize, develop intergenerational compatible housing, create rental housing options within the suburbs, and reduce the financial burden by offering tax breaks and incentives to home owners.

In 2015, AARP launched the *Future of Housing Campaign*, an initiative to spread awareness of the current housing challenges that older Americans face (many addressed in *Housing America's Older Adults: Meeting the Need of An Aging Population* by JHCS and AARP) (Harrell, 2015). The first of their efforts included hosting the *Future of Housing Summit* in Washington, D.C., which invited "movers and shakers" in the housing industry to collaborate in solving the greatest challenges with America's housing (Public Policy Institute, 2015). The *AARP Foundation Prize* (to be discussed later) set aside $50,000 to assist a new innovative start-up company to develop a solution for low-income older adults to live comfortably, safely, and independently in their own homes. In February of 2017, AARP and contributing organizations selected Gruzen Samton from the IBI Group to produce a house with an "ageless design" to support older adults who wish to stay in their homes as they age. The house was built in Memphis, Tennessee, and includes a completely stepless layout, wider doorframes that allow easy wheel chair accessibility, and lower counter tops.

Ultimately, with the increase in aging, there may come a parallel increase in disability, decrease in income, and stagnant, if not increasing, bills and expenses. According to the US Census Bureau, households in 2015 between the ages of 55 and 64 had a median yearly income of $62,802, which dropped substantially to $38,515 for ages 65+ (U.S Census Bureau, 2018). For home owners experiencing difficulty in keeping up with their expenses, the *AARP Foundation's Housing Solutions Center* is represented by HUD (US Department of Housing and Urban Development) and certified counselors who offer counseling to homeowners over the age of 50 that may be in danger of foreclosure (AARP Foundation, 2016e).

Isolation

Finally, an additional service provided by AARP concerns isolation. Considering the challenges associated with chronic illnesses, housing, income, and other life-quality changes for older Americans, there is no surprise in the growth of isolation. Social isolation is considered the distancing of an individual from others, who may be an important part of one's life, through psychosocial and/or physical efforts (Biordi & Nicholson, 2009). The *AARP Foundation* started their first isolation research initiative, ResearchWork's *AARP Foundation Isolation Framework Project*, in 2012 to shed some light on a very unknown issue in this age group (Elder & Retrum, 2012). In fact, social support has been found to have many positive effects, such as decreasing the likelihood of a disease, increasing the speed of recovery from an illness or some treatment, and increasing the compliance and other positive health behaviors (e.g., Taylor, 2015). Thus, social isolation can be very detrimental to the physical and mental well-being of an individual. The *Isolation Framework Project Report* suggests that there are many risk factors inducing isolation, including, but not limited to, living alone, physical immobility, having low income, living in a rural area, having a language barrier, and, surprisingly, being a caregiver. As awareness is spread throughout communities, there is a rise in increasing community interaction initiatives and social programs. AARP's affiliate *Experience Corps* is a great example of bringing the isolated back into the communities of younger generations and giving back personal fulfillment and life purpose.

Other AARP Services

AARP Foundation Litigation

AARP Foundation Litigation (AFL) is a program across the country of legal advocacy and individual rights protection for adults over the age of 50 (AARP Foundation, 2016f; AARP Foundation Legal Advocacy, 2016). With a focus on state and federal litigation, common topics include employee discrimination, health, housing, employee benefits, voting rights, etc. AFL has devoted 15 years into making sure that Americans have a voice in the judicial system and that their struggles through daily life are addressed nationally. Finalized cases can be viewed in the *AARP Foundation Litigation* case activity database (called *Docket*), which can educate Americans on their rights, policies, or laws, while answering any questions involving the preceding. *AARP Foundation Litigation* is unlike the AARP affiliate *Legal Counsel for the Elderly*, which is only available to residents of Washington, D.C.

As reviewed above, the *AARP Foundation* provides direct assistance programs in an effort to help older adults acquire life's essentials (see Table 29.1). Their initiatives partner with a variety of organizations to assist adults with food, income, housing, and social benefits. It is the efforts of the *AARP Foundation* that continue to "fuel the passion" for helping aging adults in the community through nonprofit efforts.

Table 29.1 AARP Foundation's projects and initiatives that impact hunger, income, housing, and isolation for the aging population

Hunger
Root Cause Coalition
MyPlate
Income
AARP Foundation's Tax-Aide
AARP Foundation's Finances 50+
BACK TO WORK 50+
AARP Foundation Elder Watch (Colorado)
Housing
AARP Foundation's Housing Solutions Center
Isolation
Experience Corps
Other
AARP Foundation Litigation

Other Related Institutes/Affiliates

AARP Public Policy Institute

AARP's participation to public debate and policy research is governed by the nonpartisan *AARP Public Policy Institute* (PPI) (AARP Public Policy Institute, 2016a). The Institute focuses on providing a larger voice for mature adults in the many issues involving social security, Medicare, work and retirement, etc. For example, during the 2016 Presidential Election, AARP launched the *Take a Stand* campaign to urge the 2016 presidential candidates to propose a plan for securing social security and preserving the issue as a main priority for the Americans who are affected most (AARP, 2016b; Hishta, 2016). By March 2016, 140,000 AARP members signed the *Take a Stand* petition and received almost immediate responses from the presidential candidates.

The main categories of concern for older adults discussed in the initiatives of the *AARP Foundation* can be difficult problems to solve but even more so to measure. PPI created the *Livability Index* for residents and policy makers to access the housing, neighborhood, transportation, environment, health, engagement, and opportunity scores in areas throughout the United States (AARP Public Policy Institute, 2016b). Each category's score is based on the average percentage score of affordability, access, and quality of subcategories. Scores are determined based on 40 metrics and 20 policies that are developed/reviewed by the experienced experts at the PPI, ICF International, and the University of Utah's Metropolitan Research Center. Online access to data for specific neighborhoods can help older adults assess the livability of their community, as well as assess if that area can serve their specific needs. It is these scores that can urge older adults to acknowledge the strength of supporting services in their communities and encourage policyholders to make progressive changes for society. AARP PPI publishes opinions on recent public policy and political issues in order to keep members up to date on policies that directly affect maturing adults.

Similar to AARP Foundation's *BACK TO WORK 50+*, the *AARP Public Policy Institute* created *Future of Work@50+*, an initiative to further study policy analyses, the rapidly changing workforce, and resources to help older adults acquire training and opportunity for good-quality professions. *Future of Work@50+* continues to educate all ages about the many discrepancies within the workforce (e.g., age discrimination, disability, etc.) through various publications of the latest research and surveys. In December of 2014, *Future of Work@50+* held a conference on "Social Insurance and Lifecycle Events Among Older Americans," with experts speaking on research topics such as *Trends in Retirement and Claiming in the SSA Administrative Data* (Pattinson, 2014) and *Marital Biography, Social Security Receipt and Economic Well-Being* (Lin, Brown, & Hammersmith, 2014).

Legal Counsel for the Elderly

In 1975, AARP created a nonprofit, volunteer-based affiliation that would help hundreds of elderly a year with a variety of legal situations. AARP's *Legal Counsel for the Elderly* (LCE) provides legal counseling and casework to the citizens of Washington, D.C., 60 years of age and older (AARP D.C's Legal Counsel for the Elderly, 2013; Legal Counsel for the Elderly, 2016). For 40 years, LCE has been providing resources to aid in civil-legal cases and additional advocate programs. In 1977, LCE created one of the first community outreach programs that provide pro bono attorneys from private law firms with the opportunity to volunteer in assisting elderly low-income residents with a variety of legal situations. A few major LCE programs include the Long-Term Care Ombudsman, Senior Medicare Patrol, and a variety of home- and community-based services, to be reviewed next.

Long-Term Care Ombudsman

This provides advocates to resolve complaints from long-term care residents in nursing homes, community resident facilities, and assisted living facilities. Additional services include evaluating complaints in order to promote changes in state and national laws.

Senior Medicare Patrol

This involves the recruiting of approximately 5700 volunteers a year to assist Medicaid and Medicare beneficiaries in the regulation of fraud within the user community (AARP Legal Counsel for the Elderly, 2016b).

Homebound Elderly Law Project (HELP)

This is a team of pro bono lawyers, professional staff and volunteers, and a full-time attorney to assist patients, who are not able to leave their homes, due to physical or physiological impairment, with legal documentation, housing situations, and benefit accrual (AARP Legal Counsel for the Elderly, 2016a).

In addition to the programs listed above, AARP LCE delivers assistance in an abundance of unique legal cases for older adults in the D.C. area. The District of Columbia Office on Aging assists in funding LCE which, in turn, helps continue the availability of the resource to D.C. residents. An estimated 1200 civil lawsuits were completed in 2015 from Social Security and Medicaid to house foreclosures and financial fraud.

AARP Experience Corps

The *AARP Foundation Experience Corps* (EC) is a unique program that gives adults over the age of 50 the opportunity to increase their mental, social, and physical health by volunteering to help kindergarten through third-grade children improve their literacy skills (AARP Foundation Experience Corps, 2016). This high-commitment volunteer experience requires approximately 10 h per week of in-class service. Volunteering tasks include assisting the teacher with in-class activities and stimulating academic and learning readiness and behavioral management (Fried et al., 2013). As of 2016, there have been 3000 highly trained volunteers over the age of 50 contributing their services in more than 17 different cities across the country. *Experience Corps* primarily focuses on locations within the states that have low-income and low-education trends in the hope of breaking the cycle of illiteracy. This has been beneficial for the volunteers. Indeed, a recent study performed on select schools within the Baltimore City Public School District had shown significant results in the positive health benefits for EC volunteers (Fried et al., 2013). Results suggested that there was a decrease in physical immobility, falls, and memory loss in these volunteers. Furthermore, there was a surprising preservation in balance, strength, and physical and mental ability. The social interactions and mental exercises utilized by the volunteers have shown considerable progress in increasing quality-of-life and mental function. In addition, studies have shown substantial uprising in student scores throughout the first year of implementation of this program in schools (Parisi et al., 2015).

AARP's Experience Corps are in the established service network of *AmeriCorps*, an organization serving thousands of nonprofit organizations through education among other areas. In 2011, EC was awarded the "Service Impact Reward of the Year," through the AmeriCorps national service network.

Electronic Initiatives

As of July 2016, there are a reported 200 million Internet users in America, making up about 89% of America's population (Internet Live Stats, 2016). AARP has one of the largest online resource centers for all ages, focusing primarily on those over the age of 50. AARP.org provides access to AARP Bulletin, AARP Magazine, member benefits, and a wealth of opportunities and information through webinars and AARP held events. These are detailed below.

AARP Bulletin

This is an online bulletin board for older Americans to stay up to date on topics that influence their everyday life. AARP Bulletin mainly focuses on financial, health, Medicare, and Social Security matters.

AARP Magazine

AARP Magazine focuses on lifestyle topics, celebrity advocates, entertainment, and aging conversations for adults 50+.

Staying Sharp

AARP has partnered with the *Global Council on Brain Health* to educate older adults on having a healthy brain with *Staying Sharp* (AARP, 2016a). *Staying Sharp* has a scientifically designed assessment that informs participants how "healthy their brain is." Based on the results, valuable information on relaxing, discovering, connecting, nourishing, and moving is presented in order to sharpen each individual's brain functioning in order to improve their everyday lives (Staying Sharp, 2016).

Global Council on Brain Health (GCBH)

This is an independent group of vetted healthcare professionals and policy experts created by AARP and Age UK. Their focus is to study and share practical and scientific information on brain health and its importance in hopes of creating healthier individuals. Their main initiative is *Staying Sharp*, an online portal of information for older adults and their brains.

A Future in Aging

AARP Foundation Prize

The "AARP Foundation Prize" is a charitable contribution from the *AARP Foundation* in hopes of finding the most innovative solutions to the many challenges in housing, hunger, income, and isolation that the aging population face today (AARP Foundation Prize, 2016). The AARP Foundation Prize seeks out start-up businesses and entrepreneurs that focus on helping adults aged 50+ with an income of less than $40,000 a year. Universities across the country such as Duke University, Tufts University, and the University of Minnesota have created business plan competitions within their academic programs in order to assist in promoting innovative initiatives that express the qualifications of the AARP Foundation Prize.

Life Reimagined

The *Life Reimagined Institute* is a program intended to help individuals get back "on track" after a wide variety of life-altering personal developmental challenges (Life Reimagined, 2016). AARP created *Life Reimagined* in 2009, which has since grown a community of more than 1,890,000 participants. Expert advisors on life, aging, and personal development create community activities, events, and online initiatives, such as *LifeMap*, in order to help individuals across the country with finding their purpose.

AARP Driver Smart Safety

This is a well-developed *AARP Driver Smart Safety* course, specially catered toward adults over the age of 50, in order to ensure that all drivers are up to date on new traffic laws, regulations, and healthy driving habits. The *AARP Driver Smart Safety* course is available in classroom for select states, as well as online.

Disrupt Aging

AARP CEO Jo Ann Jenkins initiated the conversation on what aging looks like by writing the book *Disrupt Aging* (Disrupt Aging, 2015). *Disrupt Aging* is a reality-based initiative focused on understanding ourselves and others in the process of aging. She encourages embracing everything age has to offer and accepting your true self in the process. Many adults find support by reading and contribution to the stories, problems/solutions, and ideas on the *Disrupt Aging* online platform. All 100% of book sales contribute to the AARP Foundation.

AARP Community

AARP is a membership-based organization that not only impacts the community with an array of free services and education but also helps the older population with discounts and benefits that only cardholders receive. Because the AARP community has reached approximately 38 million members, AARP has nationally recognized partnerships with health, car, and life insurance companies. The AARP community can also benefit from discounts on restaurants, movies, apparel, travel, and electronics to make every day life more affordable.

Other Nonprofit Organizations

With the rapid increase of aging adults around the world, there is no "one-size-fits-all" solution to every financial, health, and social challenge. AARP is one of the many nonprofit organizations dedicated to creating a better quality of life for the aging population. Many of the additional nonprofit organizations have established a variety of services and platforms, similar to AARP, while others work to that impact the community with a particular focus. The following nonprofit organizations/coalitions have all developed dedicated programs to increase the quality of life in older adults through healthcare services, quality of healthcare professionals, health and wellness education, availability of housing infrastructure, and government advocacy.

American Geriatric Society

The American Geriatrics Society (AGS) is a nonprofit organization founded in June 1942 by physicians, among whom was Dr. Ignatz Nascher, who coined the term "geriatrics" (American Geriatric Society, 2016b). AGS is now a society established around 6000 healthcare professionals working toward creating the optimal quality of life for older adults (American Geriatric Society, 2016a, 2016c). Their strategy consists of educating professionals and the aging population in order "to encourage and promote the study of geriatrics." Although their initiatives are not as successful in producing community-based events such as the *AARP Foundation*, they acknowledge the importance of quality healthcare professionals who ultimately affect a patient's physiological/physical outcome. AGS has nine branching committees, established to ensure the quality of care for older Americans is at an all-time high. These committees represent topics of education, clinical practice, ethics, ethnogeriatrics, health systems, public policy, and research. Within the participation of the members are Special Interests Groups (SIGs). Each SIG is an established area of care (e.g., acute, cancer, veterans' health, etc.) that is represented by a leader in the American Geriatric Society community. Each year, AGS encourages leaders of such groups to continue the conversation of specific health needs through proposals and projects. Recent projects, including the Health in Aging Foundation, are briefly reviewed below.

Geriatric Emergency Department Collaborative

In January of 2016, AGS received funding from the *John A. Hartford Foundation* and the West Health Institute to fund the *Geriatric Emergency Department Collaborative* (GDCE). The GDCE was created in hopes of educating more healthcare professionals about guideline-based care in order to improve the quality of life for older adults.

Older Driver Traffic Safety

This is a professional and public education initiative to help physicians "assess and council older drivers."

Geriatrics-Orthopedics Co-managing Planning Project

A project funded in 2015 by the *John A. Hartford Foundation*, in support of creating a strong foundation in support of an interdisciplinary geriatric-orthopedic management approach, was developed at the University of Rochester in New York.

Geriatric Workforce Enhancement Program

This is an initiative funded in 2016 by the *John A. Hartford Foundation* to provide different services that enhance the impact of geriatric initiatives. These services include local and national meetings, professional mentor programs, an array of education resources for professionals and patients regarding geriatric studies, and expert consultations.

Health in Aging Foundation (HiAF)

In 1999, the American Geriatric Society created the *Health in Aging Foundation* in order to impact older adults with a more communal approach (American Geriatric Society, 2016d, 2016e). HiAF's main initiative is creating educational resources with the help of AGS members to ensure that aging adults are "up to date" on recent health and wellness tips and tools. Their online resource center, *HealthinAging.org*, is filled with descriptions and treatment options for over 60 common conditions of the aging population.

The American Geriatric Society (along with HiAF) is constantly creating new resources for education and awareness into clinical practice, board certifications throughout multiple disciplines, practice managements, and research. The American Geriatric Society's first publication was the *Journal of the American Geriatric Society (1953)*, a monthly updated reference related to clinical geriatric issues and clinical research. AGS's *GeriatricsCareOnline.org* is an online library that stores an abundance of AGS's clinical research, publications, product portfolios, and a variety of other resources that help educate older adults and healthcare professionals on the refining world of geriatric care.

Aging Life Care Association

The *Aging Life Care Association* (ALCA) is a nonprofit organization that was formerly developed as the "National Association of Professional Geriatric Care Managers" (1985) and the "National Academy of Certified Care Managers" (1996). Since the beginning, there have been nine regional chapters of ALCA that were functioning as separate nonprofit organizations. In 2016, five out of nine of the separate nonprofits merged with the national association, ALCA, in order to assist in creating more benefits and services for their members. ALCA's most valuable services are through professionals who assist families and persons with disabilities by guiding, educating, and providing other resources and tools to ensure that the families and their loved ones are being cared for. The Aging Life Care Association provides older adults with experts in housing, local resources, finances, health and disabilities, advocacy, legal advice, crisis intervention, care support for families, and more depending on the individual's situation. Aging Life Care professionals offer continual support services at any time for individuals with chronic illnesses, brain injuries, mental disabilities, and other health challenges that make living more difficult for the older adult.

Alzheimer's Association

Among the many diseases acquired by the older population, Alzheimer's disease is at the forefront, affecting approximately 5.4 million Americans today. Alzheimer's disease, a form of dementia, usually is associated with memory loss, challenges in thinking, and behavioral issues (Alzheimer's Association, 2016b). Fortunately, the National Institute of Aging was approached by Jerome H. Stone and colleagues in 1979, who stimulated the idea of creating a nonprofit organization centered around the disease. In 1980, the *Alzheimer's Association* was created, dedicating its services to assist people of all ages who suffer with Alzheimer's disease (Alzheimer's Association, 2016a). The *Alzheimer's Association* is the largest association dedicated to this specific cause. In fact, the organization was among the few primary advocates for the *National Alzheimer's Project Act*, a legislation ensuring that a national plan for Alzheimer's initiatives would be developed annually, which was passed by the Congress in 2010 (Alzheimer's Association, 2016f; Alzheimer's Association, 2016g). The organization represents millions of individuals and their families across the country, through 75 localized chapters, and globally with an abundance of donor support. Their initiatives include events focused toward awareness, education, prevention, social support, and research. Some of these are briefly discussed next.

Walk to End Alzheimer's

Walk to End Alzheimer's is an annual, nationwide fundraising event that brings together individuals within 600 communities to promote Alzheimer's awareness, support, and research (Alzheimer's Association, 2016i). The Alzheimer's Association encourages members within each community to start a fundraising team prior to the event. Teams are then qualified to participate in the *National Incentive Program*, which provides various incentives for raising certain amounts of funds (Alzheimer's Association, 2016j). In select communities, individuals' fundraising over $500+ can qualify for the Alzheimer's Association Champions and Grand Champions Club, which rewards qualifiers with special products and recognitions. During the *Walk to End Alzheimer's* of 2016 in Tulsa, over $330,000 was raised, making it the most funds accrued by one event in that year (Alzheimer's Association, 2016l). Seventy-eight percent of all funds raised contribute to Alzheimer's disease initiatives. 16% of funds raised "cycle back" into fundraising, and 6% of funds raised are distributed among the Alzheimer's Association Administration (Alzheimer's Association, 2016k).

Alzheimer's and Dementia Caregiving Center

The Alzheimer's Association has created a "caregiving community" that offers individuals with Alzheimer's or their family members' information on each stage of disease development (Alzheimer's Association, 2016c). Their initiatives include offering a 24-h support, a community resource finder and message boards, and an abundance of information through their online resource center. *The Alzheimer's Navigator©* guides caregivers through different topics needed to develop the best-quality support in caring for individuals with Alzheimer's (Alzheimer's Association, 2016e).

Alzheimer's Association TrialMatch

The Alzheimer's Association's *TrialMatch* is a matching service available to the public that pairs individuals to over 250 current clinical trials and studies focused on Alzheimer's disease (Alzheimer's Association, 2016h).

MedicAlert© + Alzheimer's Association Safe Return©

MedicAlert© + Alzheimer's Association Safe Return© is a nationally recognized emergency response service that partners with law enforcement and the Alzheimer's Association's local chapters. Their 24-h services ensure that, if an individual with Alzheimer's disease or dementia becomes lost, caregivers and family members will be able to find them with an efficient system.

Alzheimer's Association's International Society to Advance Alzheimer's Research and Treatment

The Alzheimer's Association not only focuses on the community of individuals affected by Alzheimer's disease but also on health professionals, such as physicians and scientists, dedicated to finding improvements in research for Alzheimer's. This community of professionals work within the *Alzheimer's Association's International Society to Advance Alzheimer's Research and Treatment*, also recognized as ISTAART (Alzheimer's Association, 2016d). The group contributes articles/information to *Alzheimer's & Dementia: The Journal of the Alzheimer's Association*, which provides material on the latest research, clinical trials, detection and prevention information, etc. ISTAART holds numerous meetings and conferences every year in order to promote the initiatives of the Alzheimer's Association and collaborative action among professional advocates.

Meals on Wheels Association of America

Meals on Wheels is a nonprofit organization created to help solve the issue of hunger in America's older population (Meals on Wheels America, 2016a). Their solution involves providing nutritious meals to seniors in an environment suitable for socializing with other seniors and for developing the wellness needed to increase their quality of life. *Meals on Wheels* has developed over 5000 programs across the country, serving approximately 2.4 million adults each year with the assistance of local businesses and organizations that see where the need is. For older adults who have difficulty leaving their own homes to join the community programs, *Meals on Wheels* makes special accommodations to ensure even those who are limited will receive the nutrients they deserve. Not only do older adults benefit from wellness but also from the social interactions within the community that are created by the program. Because lack of wellness and isolation are serious conditions that increase for older adults who are unable to leave their homes (AARP, 2015), *Meals on Wheels* delivers nutrition, companionship, and safety precautions (in the event of an emergency) to the homes of older adults. For areas with additional needs, *Meals on Wheels* is taking the initiative to provide older adults with additional essential services, such as transportation to doctor appointments, delivery of pet food, home repair services, etc. *America, Let's Do Lunch* is the *Meals on Wheels* Association of America's most recent advocacy campaign focused on recruiting more volunteers to help grow the movement of reducing hunger in America (Meals on Wheels America, 2016b, 2016c).

National Osteoporosis Foundation

In 1984, the first nonprofit organization solely focused on osteoporosis and bone health was developed. The *National Osteoporosis Foundation* (NOF) focuses on the education, awareness, and prevention methods needed to strengthen the bones of aging adults (National Osteoporosis Foundation, 2016a, 2016d). Since the beginning, NOF has been a major advocate of providing America with the tools to develop healthier bones by aiding in the passage of the *Revitalization Act* in the 1990s. The *Revitalization Act* allowed the National Institutes of Health (NIH) to establish a clearinghouse of bone health and osteoporosis information (NIH Osteoporosis and Related Bone Diseases National Resource Center) that would be available to the public. The *National Osteoporosis Foundation's* most recent initiative for educating professionals and the general public is the *2Million2Many Campaign*. NOF data suggest that 2 million bones break due to osteoporosis yearly in the United States (2Million2Many, 2016; National Osteoporosis Foundation, 2016e). *2Million2Many* urges adults over the age of 50 to take personal initiative in prevention and treatment, as well as their healthcare professionals. The *National Osteoporosis Foundation* is one of 54 members of the *National Bone Health Alliance*, a coalition launched in 2010 dedicated to changing the public's view on bone health (National Bone Health Alliance, 2016).

Bone Source®

This is the *National Osteoporosis Foundation's* program for healthcare professionals to receive the latest information and research on bone health. *Bone Source*® provides resources and education to help professionals advance their understanding of osteoporosis by providing clinical care manuals, prevention methods, diagnosing tactics, and treatment options (National Osteoporosis Foundation, 2016b).

American Public Health Association

In 1872, the *American Public Health Association* (APHA) was founded, creating a nonprofit organization centered around increasing the health of US residents (American Public Health Association, 2016a, 2016c, 2016d). With the success of APHA, the organization has established impactful affiliations with 54 state and local health-oriented associations (American Public Health Association, 2016e). Throughout the years, APHA has taken the initiative as a public health organization to educate the US population about the prevalent outbreaks to date, such as tuberculosis (1893), influenza (1918), and childhood obesity (2001) (American Public Health Association, 2016b). Their initiatives are well known throughout the country, with the help of the *American Journal of Public Health*, a journal dedicated to sharing public health issues through education, awareness, and prevention, with a history of over 100 years of publication. APHA has also been a strong advocate for governmental support with each development of health issues in America. In fact, the *Nation's Health* newspaper, created by the *American Public Health Association*, was created specifically for healthcare professionals, participants in legislation, and policy makers to help them stay current with recent topics of interest in America's health and wellness initiatives. In 1974, APHA held an annual meeting that presented the issue of the lack of programs on healthy aging. Soon after, the *American Public Health Association* established the *Aging and Public Health Section* of APHA. Since then, they have devoted more and more time and research to educating the public on improving the lives of aging adults.

Lifetime Arts

Lifetime Arts is a nonprofit organization that works with other organizations in establishing professionally developed art courses for older adults. Their major focus is on creating positive artful events for older adults through community fine art programs, such as dance, music, painting, etc (Lifetime Arts, 2016a). *Lifetime Arts* works to increase the quality of life for older adults by sharpening their physical, psychosocial, and emotional well-being (Cohen, 2006). Since its development in 2008, *Lifetime Arts* has established affiliations with libraries, government agencies, art organizations, senior centers, and independent art instructors in approximately 22 cities throughout the country (Lifetime Arts, 2016b). Their affiliations undergo standards of creative aging requirements and training in order to strengthen their focus in creative aging and to increase their professionalism to assist the older adult (Lifetime Arts, 2016c, 2016d).

Volunteers of America

Volunteers of America is a nonprofit organization established in 1896, with the goal of helping many underserved Americans through various volunteer efforts (Volunteers of America, 2016a). Today, *Volunteers of America* has established volunteer programs and services in over 46 states, impacting tens of millions of individuals. Along with a focus on underserved women, children, and homeless individuals, *Volunteers of America* has a specific focus on different services for older adults. Their volunteers work to increase the quality of life in older adults by providing services and assistance for seniors with disabilities or who are homebound. These assistance programs are reviewed below.

Senior Action Network (SAN)

The *Senior Action Network* is *Volunteers of America*'s way of advocating and impacting older adults on a larger scale at Capitol Hill. Currently, the *Senior Action Network* is representing underserved seniors throughout the country, with the goal to receive increased affordable housing options that preserve quality living and care for seniors and more access to Medicare and Medicaid programs when specialized care gets more prevalent with aging (Volunteers of America, 2016e). *Seniors Action Network* is an advocacy program of *Volunteers of America* and the *LeadingAge* organization.

Quality Care for Seniors

Older adults have many options for living, including location, level of independence, housing infrastructure, etc. Regardless of the situation, *Volunteers of America* offers programs and professionals to help achieve the maximum quality of living (Volunteers of America, 2016c). Their healthcare programs engage older adults in receiving additional monetary support, behavioral health, rehabilitation, and licensed professionals to provide additional or specialized care.

Meal Programs

Volunteers of America also recognizes the need for a more nutritious meal plan in older-adult households and provides nutrition counseling and meal-delivery programs (Volunteers of America, 2016d). Some volunteers assisting with *Volunteers of America*'s meal programs are the exclusive source for nutritious food to the older adults who are served.

Aging with Options™

Volunteers of America's Aging with Options™ is a chance to give adults of all ages and all stages of health the opportunity to live with assistance throughout every aspect of their lives (Volunteers of America, 2016b). *Aging with Options*™ volunteers or professional organizations offer assistance through three categories, delineated below.

1. **Community Engagement Programs**

Aging with Options™ *Community Engagement Programs* assist older adults in living the most independent lives possible. Many older adults enjoy living in the homes they are most comfortable in and are not quite ready to make a transition to assisted living. Community Engagement Programs do their best to honor the independence seekers. Volunteers or professional organizations provide everyday services, such as trips to the grocery store, meal preparation, or at-home visits.

2. **Home- and Community-Based Services**

Aging with Options™ *Home- and Community-Based Services* focuses on the medical needs of adults living independently. Volunteers and professional organizations help with daily monitoring, medication and medical equipment assistance, and other tasks to preserve independent living situations.

3. **Program of All Inclusive Care for Elderly (PACE)**

The PACE program connects older adults with a network of specialized nurses, social workers, doctors, and counselors dedicated to achieving maximum health and independent living. Benefits include one collectively driven set of specialists who have consistent knowledge of their patients throughout their disciplines. *Volunteer of America's Aging with Options*™ has also worked to achieve affordable care, without co-pays or deductibles, in order to ensure that every individual, no matter what the situation, can receive the care they deserve. If their comes the time in older adults' lives where independent living is no longer in their best interest, PACE organizes the best options of assisted living for adults closer to their families.

Partnership for Health in Aging

In June of 2008, the *Partnership for Health in Aging (PHA) Coalition* was created by 21 organizations focusing on strengthening geriatric care and its professionals in preparation for the upcoming years. All organizations recognized within PHA have created a practice that serves the community through health promotion and safety, evaluation and assessment, care planning and coordination across the spectrum of care, interdisciplinary and team care, caregiver support, and healthcare system and benefits. The coalition consists of some of the top governing bodies in the medical industry, including/but not limited to the American Geriatric Society, American Association for Geriatric Psychiatry, American Association of Colleges of Pharmacy, and a number of Geriatric Nursing Organizations. PHA's recent development strived to ensure quality healthcare for older adults through the *Position Statement on Interdisciplinary Team Training in Geriatrics: An Essential Component of Quality Health Care for Older Adults* (2014).

LeadingAge

LeadingAge, previously known as the *American Association of Homes and Services for the Aging*, is a nonprofit organization created in 1961 by the National Council of Aging to support the collaboration between 6000+ nonprofits, members, businesses, and states with the same mission while using each other as a learning tool, support system, and collective advocacy (Leading Age, 2016a). *LeadingAge*'s prime initiatives are focused around nonprofit advocacy, quality care and services for all members of the community, and creating and supporting innovative ways to educate society on the aging process (Leading Age, 2014). Throughout the years, the *LeadingAge* Center for Applied Research has devoted their time to improve long-term care/nursing home quality, workforce, and best practices (Leading Age, 2016b). The Center's goal is to create improved "end-of-life" care and focus not only the health and wellness of the older adult but also on their just as impactful living situations. From 2003 to 2008, *LeadingAge* (known as the American Association of Homes and Services for the Aging, during that time period) had the opportunity to be the leading game-changer in *Better Jobs Better Care*, a research project funded by Robert Wood Johnson Foundation and Atlantic Philanthropies that aimed at changing the high turnover rates and job quality of long-term care centers (Leading Age, 2016c). Their political advocacy is one with *Volunteers of America's Senior Action Network* (discussed above), working to increase the stock of affordable and compatible housing for older adults.

The Gerontological Society of America

Since 1945, the *Gerontological Society of America (GSA)* has been one of the largest organizations devoting their research and advocacy toward advancing knowledge and awareness in needed areas of aging in America. With the collaboration of many other organizations dedicated to health and wellness, GSA has been able to educate health professionals and their patients on the importance of various topics: the effects of having an animal companion on healthy aging, signs of malnutrition, vaccination education and awareness, safety of over-the-counter medications in gaining adults, pain management, the importance of caregivers, and increasing effective communication with older adults. In the following section, we will discuss a few of the topics listed in more detail.

Human Animal Interaction and Healthy Aging

In 2017, Dr. Dawn Carr and Dr. Natalie Sachs-Ericsson (both from Florida State University) were awarded funding by the *Gerontological Society of America* and Mars *Petcare/WALTHAM*™ to study the beneficial effects of having/interacting with an animal companion as associated with healthy aging (Gerontological Society of America, 2017b). Dr. Carr and Dr. Sachs-Ericsson will be using the Health and Retirement Survey created by the Institute of Social Research at the University of Michigan in Ann Arbor. The study will identify the many factors that contribute to picking a companion, the social process utilized in order to establish relation between the companion and aging, and consider the impact companions may have on socially isolated adults (defined previously in AARP Foundation: Isolation).

National Adult Vaccination Program

The *Gerontological Society of America* created the *National Adult Vaccination Program* to increase awareness and education of the importance of vaccinations for healthy aging and disease prevention through research and advocacy (Gerontological Society of America, 2017c). Through an abundance of stakeholders, including the previously mentioned American Geriatrics Society, the National Adult Vaccination Program has great influence in the direction of national policy in efforts to ensure improvement of the current US vaccination rates.

OTC Medication Behavior of Older Adults

The *Gerontological Society of America* and various organizations gather and evaluate research focusing on over-the-counter medication use in older adults (Gerontological Society of America, 2017d). Their initiatives focus on safe and effective uses of medications, influences supporting optimal behavior with medication use, and effective training of health professionals and caregivers assisting the medication use. The GSA and the *Consumer Healthcare Products Association* published "Over-the-counter Medication Behaviors of Older Adults: Research is needed to better understand and promote safe and effective use," a white paper emphasizing the importance of medication safety and efficacy in aging individuals (Gerontological Society of America and Consumer Healthcare Products Association, 2017).

Communicating with Older Adults

Communication is critical when in relation to ensuring the safety and efficacy of medication

Table 29.2 A list of discussed non-profit organizations with their corresponding email addresses

Organization	Email address
The American Association of Retired Persons (AARP)	member@aarp.org
The AARP Foundation	giving@aarp.org
Legal Counsel For The Elderly	lce@aarp.org
American Geriatric Society	info.amger@americangeriatrics.org
Aging Life Care Association	No Email Found
Alzheimer's Association	info@alz.or
Meals on Wheels Association of America	info@mealsonwheelsamerica.org
National Osteoporosis Foundation	info@nof.org
American Public Health Association	membership.mail@apha.org
Lifetime Arts	info@lifetimearts.org
Volunteers of America	info@voa.org
LeadingAge	info@leadingage.org
Gerontological Society of America	geron@geron.org

use. The *Gerontological Society of America* has developed Silver Market Training Modules, a tool for health professionals and supporting staff to improve communication with knowledge on many critical topics such as medication adherence, communication with patients with cognitive impairment, over-the-counter medication reconciliation, and medication safety (Gerontological Society of America, 2017a).

Finally, Table 29.2 provides a listing of the various aforementioned nonprofit organizations that we have reviewed.

Research to Practice Implications

With the abundance of organizations working to assist in the social, economic, and financial needs of older adults, it is critical that these resources are utilized and encouraged. From housing infrastructure to psychological wellness, these dedicated organizations can support aging adults as they face these growing challenges that occur in conjunction with the many clinical concerns discussed in the earlier chapters. As health professionals and caregivers, we must be knowledgeable in the tools that can help older adults with the very difficult processes of aging. Many of these organizations host annual meetings or continuing education opportunities, which allow them to share their most recent initiatives and strategies and to seek out community involvement. New initiatives are also shared via electronic newsletters, social media, and monthly magazines. The US Administration on Aging created the *Eldercare Locator* database to assist in finding appropriate programs for aging adults in their areas (Department of Health and Human Services, 2018). Specific programs include topics such as health insurance, financial assistance, housing options, transportation, legal assistance, etc. Coleman, Whitelaw, and Schreiber (2014) published an article which outlines important considerations that physicians should take into account when learning more about community-based organizations and when referring patients to those organizations in hopes of creating an all-encompassing illness-state management plan. It is in our best interest to become familiar with the many databases and organizations that provide these services and to integrate education of these resources into our standard practices.

Future Directions in Practice and Research

As health professionals and researchers continue to learn more about the unique health challenges of the aging population, there will always be a need for additional tools and resources that assist with these findings. Although there is an abundance of already-established organizations fueling the aging populations of larger areas, such as the Baltimore-Washington metropolitan area, a major challenge is providing these services to the many rural areas that already have limited access to basic healthcare. *Rural Health Information Hub* (RHIhub) is an online guide provided by the Health Resources and Services Administration of the US Department of Health and Human Services that identifies the obstacles an aging rural community may face (Rural Health Information Hub, 2017a). For instance, RHIhub developed the Health Professional Shortage Areas for Primary Care map of the United States in 2017 (Rural Health Information Hub, 2017b). This map represents areas within each State (nonmetropolitan and metropolitan) that have a greater need for primary care providers. Other maps include Health Professional Shortage Areas pertaining to mental health and dental care (Rural Health Information Hub, 2017c). While many older adults may not live in an area of healthcare shortage, there is still the issue of proper transportation and access to those facilities. *Transportation for America* studied this issue in various metropolitan areas such as Los Angeles, Chicago, and Minneapolis, by evaluating the transit quality available for aging adults comparing the years of 2000–2015 (Degood, 2015). Their evaluation also includes information on the best practices of implementing transportation for older adults and the need to utilize federal and local organizations.

Finally, with a rise in the aging population and the growth of novel techniques used for illness-state management (smart medical technology and gender-specific care), more education of supporting organizations for health professionals, caregivers, and patients become necessary to optimize patient health.

Summary and Conclusions

According to the Centers for Disease Control healthy aging data for 2015, as age increases from 50 to 65+, the percentages of individuals who claim "fair" or "poor" health rises as well (Centers for Disease Control and Prevention, 2017). With an estimated rise to 98 million individuals over the age of 65 by the year of 2060, there is a substantial need for an increase in programs focused on the aging process and disability assistance. Along with issues in housing, financial stability, nutrition, employment, social struggles, and challenges in living with chronic illnesses, there are more programs that have yet to be developed fully, such as reliable country-wide transportation services affordable for all seniors. As seen above, there are many national organizations currently focusing on improving the quality of life of the aging population through patient programs and their healthcare providers. With the constant rise in innovation and technology, it appears promising that more nonprofit organizations will become available for every aspect of independent living for older adults and that aging will no longer be a burden for individuals or their families.

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30 Functional Rehabilitation in Older Adults: Where Are We Now and Where Should We Be Going?

Robert J. Gatchel, Izabela Z. Schultz, Christopher T. Ray, Marena Hanna, and Jin Y. Choi

There is no doubt that the general population is rapidly aging. As has been noted throughout this present handbook, the older adult population is growing at a very fast pace, with the US Census Bureau estimating older adults will comprise 20% of the overall population by 2020. Now, more than ever, we need to "parse out" differences within this population in order to target their specific needs, especially concerning potential chronic illnesses and disabilities. Indeed, older adults face unique challenges related to their ability to best manage chronic illnesses, multiple comorbidities, medication use, decreased physical and functional ability, occupational concerns, decreased quality of life, and end-of-life challenges. Valuable insights into the possible rehabilitation and other intervention approaches and techniques that are available to them have been presented.

Also, with aging, there is a concurrent accelerated rise in chronic illnesses (as highlighted in Chap. 1). For more information on the various diseases of the geriatric population, the reader is referred to Nagaratnam et al. (2018). In addition, the aging population is creating significant challenges to the management of human resources in organizations that no longer have as many workers to select from (e.g., Segura-Camacho, Rodríguez-Cifuentes, Sáenz De la Torre, & Topa, 2018). The present chapter will review the current status of how we can best handle the rehabilitation of the older adults in our population, as well as future directions that are needed to "stem the tide" of being overwhelmed by the plethora of aging-related issues that will continue to rise in the future. Recognition of both the "gray tsunami" and this "rising tide" can be seen in many recent announcements, such as the American Psychological Association's "Exploring Careers in Aging Roadmap" (http://www.apa.org/pi/aging/resources/careers/index.aspx). This Roadmap provides guidance to psychologists, as well as students, in finding a career working with older adults, which is highlighted as a "thriving spe-

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cialty area rich in opportunities…." There are now also routine calls from funding agencies, such as the National Institutes of Health (NIH), on topics such as "…recommendations to accelerate therapy development for Alzheimer's disease" (NIH, 2018).

Where Are We Now?

From all the epidemiological research which has been conducted, we now know the relative prevalence of the various chronic illnesses and related problems in older adults. However, we are seriously lagging behind in developing the most comprehensive and effective rehabilitation and other intervention programs for them. For example, there are many alterations in the body composition and metabolism of older adults that can lead to altered medication effects. Thus, basic medical symptom management can be quite complicated because many of the medications frequently used for such symptoms cannot be recommended for older adults (Bevers & Gatchel, 2017). Indeed, with the "coming of age" of *precision medicine* (e.g., Ashley, 2015), we now need to know about "what drug, at what dosage, and for what particular patient?" This is now recognized as an especially important need for patients. This need is even more urgent for older adults.

Also, as pointed out in the chapter by Stephens and colleagues, many medical researchers still follow an overly reductionistic biomedical approach and simply evaluate the physical symptoms and mechanisms of a "disease." For example, the *National Cancer Institute* still often conducts medical research looking exclusively at the nature and course of the disease. However, the now more heuristic *biopsychosocial model* of illnesses focuses on the complex interactions among the influential *bio*, *psychological*, and *social* factors involved in chronic *illnesses*. This "illness model" has replaced the older biomedical "curative model" because science is at a point where many "diseases" (often with unknown or complex pathophysiological underpinnings) cannot be cured, but merely better managed. Such a biopsychosocial management approach needs to be adopted for all illnesses and disabilities, especially for older adults who usually have many psychosocial issues associated with the aging process. This is beginning to happen, with investigators looking at how lifestyle variables contribute to various illnesses, such as dementia (Carrillo, 2018) and multiple sclerosis (Rensel, 2018).

We also now know that older Americans are sicker and also face more financial barriers to healthcare than their counterparts in other countries (Osborn, Doty, Moulds, Sarnak, & Shah, 2017). This was found to be especially true for "high-need" older adults who have multiple chronic illnesses and functional limitations. In the chapter by Brindle and Gatchel, a review was provided about the American Association of Retired Persons (AARP) and their nonprofit organization that can help older adults. However, many more financial services are needed. In addition, new Internet technologies are being developed to provide health information to the elderly in order to decrease the number of office visits to physicians for minor medical issues (Shim, Ailshire, Zelinski, & Crimmins, 2018). This is certainly one small step to keep medical costs down. However, expanding the technology via other *telehealth* innovations is still needed.

Another important psychosocial issue faced by older adults is the often low degree of social contact and interactions with increasing social isolation and loneliness. We know that *social support* is a strong mediator which helps to "buffer" individuals from the full impact of a major stressor (Taylor, 2006) which may lead to problems with depression in the elderly (e.g., Zis et al., 2017). In fact, Gerino, Rollè, Sechi, and Brustia (2017), in a structural equation model, confirmed the importance of the support received from social relationships and that the reduction of loneliness can be targeted in the primary prevention or recovery process of mental distress. This goal would be paralleled by the increase in resilience and self-efficacy, as well as loneliness dissatisfaction. Therefore, more effort needs to be expended to increase social support networks in the elderly. Also, innovative methods, such as pet ownership, should be employed. Indeed, Gee, Mueller, and Curl (2017) have delineated the beneficial effects of human-animal interaction in older adults.

In addition, another important issue which we know is that, in general, the elderly exhibit a higher incidence of chronic and neuropathic pain conditions, relative to their younger counterparts (Bevers & Gatchel, 2017; Paladini, Fusco, Coaccioli, Skaper, & Varrassi, 2015). Therefore, more comprehensive pain management programs, such as interdisciplinary pain management, as well as more sophisticated pharmacological methods specifically tailored for the elderly, are needed (Bevers & Gatchel, 2017; Polatin, Bevers, & Gatchel, 2017). For example, Delle Fave et al. (2018) conducted longitudinal research which evaluated the mental well-being among aging adults (age 67–85) who were involved in two Adapted Physical Activity (APA) training programs. Results highlighted that, besides the physical benefits, participants reported significantly more adaptive emotion-regulation strategies after both programs. Overall, these results support the view of old age as a stage of competent development and adaptive adjustment, rather than a stage of merely psychophysiological decline.

Finally, as highlighted in one of the earlier chapters by Stephens and colleagues, the World Health Organization (2015) has strongly recommended the importance of the continued advance of clinical research on both the quantification <u>and</u> qualifications of healthy aging. Such research is now being conducted on behalf of WHO – the *Study of Global AGEing* (SAGE). However, this study needs to be expanded to address new models to better understand important issues, such as longevity-improvement processes and the significance of a good quality of life. For example, there have been recent investigations of the role of vitamin D in cognitive disorders in older adults (Gold, Shoaib, Gorthy, & Gorossberg, 2018) that require additional studies, as well as that of other supplements. Also, the use of B vitamins for the lowering of homocysteine may be beneficial for stroke prevention (Spence, 2018).

Where Should We Be Going?

More Funds Needed for the Better Understanding of All Illnesses and Disabilities in the Aging Population

As noted in an earlier chapter of this *handbook* (Stephens et al.), there are certain "high-profile" diseases, such as cardiovascular diseases and cancer, for which the majority of the expenditures by NIH focuses on in terms of the biological nature and course of these ailments, and not specifically on the effects of aging. Even the *National Institute of Aging* focuses nearly one-half of its expenditures on a single, clearly aging-related disease: Alzheimer's disease (Kaeberlein, Rabinovitch, & Martin, 2015). This situation, in turn, reduces funding for the many other aging-related illnesses reviewed in this *handbook*, such as Parkinson's disease, brain injuries, cardiovascular disorders, spinal cord injury, as well as mental health and cognitive disorders.

The Importance of Engaging in a Work Environment

Miklashevsky and Fischer (2017) have argued against retirement because it has negative implications for healthy aging. Moreover, a study by Guglielmi et al. (2016) concluded that, although age matters in some workplaces: "…greater consideration should be devoted to age difference in order to design appropriate human resource practices that foster work engagement and satisfaction" (p. 7). This comment speaks to the importance of the organizational climate needed for successful aging (Zacher & Yang, 2016). They conducted an investigation of the construct of *OCSA* (organizational climate for successful aging) and how it can serve as a "buffer" to the negative relationship between employee age and the focus on opportunities (i.e., the beliefs about future goals and possibilities at work). The most important findings were that the negative association between age and focus on opportunities was weakened by a high OCSA; a focus on opportunities was positively associated with employee attitudes; and OCSA is an important contextual resource for successful aging in the organizational and work context.

The above results are important because, in developed countries, the aging population presents a growing challenge for the management of human resources in large organizations (Ince Yenilmez, 2015). As noted by Lytle et al. (2015), many organizations find themselves "between a rock and a hard place." They must take into account the age-related physical and cognitive changes that older workers are undergoing. If they do not, they cannot allow themselves to lose these workers, who have accumulated a high degree of implicit knowledge and experience needed for the most successful and efficient completion of jobs. Thus, as echoed by Ekici and Koydemir (2016), from both an organizational and older-worker viewpoint, it is essential to study/better understand the adjustment to aging and individuals' adaptation strategies to age-related cognitive and physical changes, as well as other psychosocial factors at work. Thus, job accommodations for the aging worker are an important area for future clinical research.

"Caring for the Caregiver"

Caregivers of the elderly have long been overlooked, even though their burden is great (e.g., Harris, 2009). Fortunately, the AARP has provided a platform to discuss some of the common issues experienced by caregivers. Nevertheless, a great deal of additional attention needs to be given to the potential stress-related overload and general health of these caregivers.

Future Problems

Etkind et al. (2017) have examined the projected needs for palliative care in the future (2040), using mortality statistics for England and Wales (between 2006 and 2014). They found that the annual deaths in England and Wales are projected to rise by 25.4% and the number of people who will need palliative care will grow by 25.0%. In addition, the estimated costs of care during the last year of life in England are expected to grow by 25% by the year 2030. Much of the cost of this palliative care will have to be absorbed by society. Therefore, long-term plans need to be developed for this "oncoming onslaught" of palliative care and its associated high societal and individual costs. Otherwise, social and economic pressures on the vulnerable elderly to consent to assisted suicide, especially in the context of loneliness and depression, are likely to increase. Noteworthy is the recent Canadian survey of over 300 caregivers of individuals with dementia, which showed that the majority of them favor assisted suicide for incompetent patients (Bravo et al., 2017).

However, there is still some hope to somewhat "ebb this tide." In a cover story appearing in the *Monitor on Psychology*, Clay (2017) delineated a number of findings that show promise in "slowing down" the negative consequences of the aging process, as delineated below.

- Older athletes have "…described the psychological benefits of exercise, the social network of fellow athletes and the physical benefits, including weight loss" (p. 48).
- "A growing body of neuroscience research suggests that intense activity may also help to delay cognitive aging" (p.48).
- "…participation in sports gives older people a sense of competence, enjoyment, and new social relationships and a more positive identity in addition to a cognitive boost" (p. 91).

It should be kept in mind, though, that the above findings were gleaned from observational studies. Indeed, it was noted that more controlled research is needed in this emerging field.

Conclusions: Toward Expanding Geroscience

As we grow older, we are more likely to be diagnosed with one or more chronic ailments. These ailments include life-threatening diseases such as

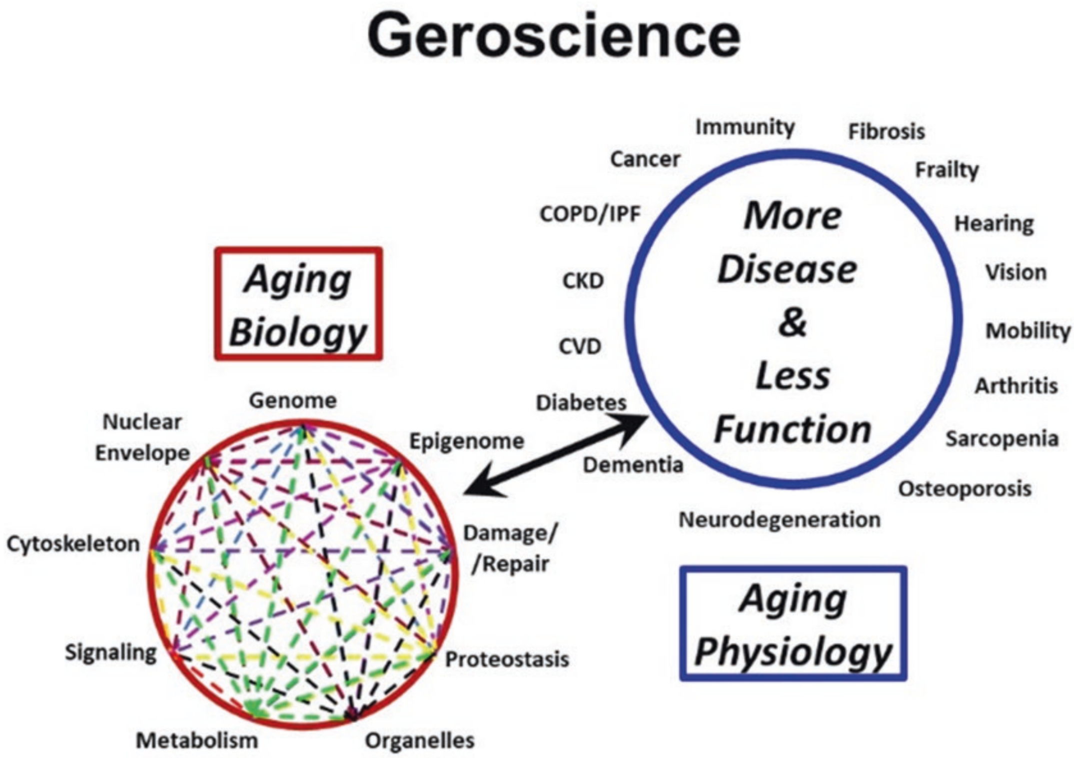

Fig. 30.1 Geroscience accelerates research into the basic biological mechanisms driving aging, which could lead to improved clinical interventions for the diseases and conditions experienced by many older people (National Institute on Aging, 2014)

> cardiovascular disease, diabetes, and cancer, as well as debilitating conditions like arthritis, fatigue, and frailty. These ailments rob us of our quality of life. The question is: How does the aging process affect the disease process and susceptibility – and vice versa?

This quote is from a recent *National Institute of Aging* Report (Kennedy et al., 2014), entitled "Geroscience: The Intersection of Basic Aging Biology, Chronic Disease, and Health." This Report highlights the fact that, in the past, although investigators who studied the basic science of aging in an attempt to highlight these above complex questions, they did not evaluate it in any integrative, comprehensive manner across the major issues. In contrast, *geroscience* now takes a different approach: "…seeking to understand the genetic, molecular, and cellular mechanisms that make aging a major risk factor and drive the common conditions and diseases of older people" (Kennedy et al., 2014). The ultimate goal is to accelerate coordinated research across multiple scientific disciplines in order to improve clinical interventions. Figure 30.1 presents some of the various disciplines/issues that will need to be addressed in a coordinated manner. Basically, this is the *bio* component of the biopsychosocial model of aging. Earlier in the chapter, we reviewed many of the *psycho* and *social* issues of this more comprehensive biopsychosocial model.

As also noted in this same Report was the fact that, as a result of this new geroscience approach, a large summit was held on the NIH campus: *Advances in Geroscience: Impact on Healthspan and Chronic Disease*. A great number of well-known researchers from various interdisciplinary fields then developed important topics that need to be addressed in aging and chronic disease. These topics have become known as "…the Pillars of Geroscience: inflammation, minority, adaptation to stress, epigenetics, metabolism, macromolecular damage, proteostasis, and senescence" (p. 710). However, geroscience, as presently conceptualized and advanced, represents a somewhat reductionistic and medicalized approach to aging. It needs to be expanded to include integrated social, behavioral, cultural, gender, and anthropological aspects of aging, together with attitudinal changes regarding aging. Tackling complex and difficult end-of-life issues for public awareness, as well as ethical and professional perspectives, is also paramount to minimize the impact of economic, family, and healthcare pressures on vulnerable older adults.

> Age is an issue of mind over matter. If you don't mind, it doesn't matter. (Mark Twain)

> Old age is like everything else. To make a success of it, you've got to start young. (Theodore Roosevelt)

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