15 Visual Disability in the Elderly: Implications for Visual Rehabilitation

Robert W. Massof, Maureen G. Maguire, Duane R. Geruschat, James T. Deremeik, Judith E. Goldstein, Mary Warren, Ann-Margret Ervin, Joan A. Stelmack, Pradeep Y. Ramulu, Barbara S. Hawkins, and Kevin D. Frick

15.1 Introduction

When visual system disorders result in bilateral visual impairments, patients have difficulty performing their customary activities and experience a diminished quality of life (West et al. 2002). Visual impairments increase patients' risk of falling (Ivers et al. 1998), injury (Salive et al. 1994), poor general health (Crews and Campbell 2001), depression (Casten et al. 2004), and even death (Pedula et al. 2006). Activity-limiting chronic visual impairments, collectively called "low vision," most often are caused by age-related visual system disorders, with age-related macular degeneration, glaucoma, diabetic retinopathy, and cataract leading the list (Congdon et al. 2004). Some visual system disorders, such as diabetic retinopathy, are manifestations of more general disorders that frequently produce co-disabilities. But most low vision patients are elderly, so comorbidities and co-disabilities from diseases unrelated to their visual system disorders are common (Ahmadian and Massof 2008). Thus, for a large portion of the low vision population, activity limitations from visual impairments are superimposed on and worsen activity limitations from comorbidities (Langelaan et al. 2009).

The prevalence of low vision in the USA is estimated to be greater than 3.5 million people (Congdon et al. 2004; Massof 2002). Eighty percent of those with low vision are over age 65 years. The prevalence of moderate and severe cases of low vision is 1.5 million Americans and the annual incidence in the USA is 240,000 (Massof 2002). In recent years, there have been dramatic advances in treatments of the diseases that cause low vision. Nevertheless, successful treatments typically result in chronic visual impairments, albeit not as severe as they would be without treatment (Chang et al. 2007; Bressler et al. 2010). Consequently, the

R.W. Massof, PhD (✉) • J.T. Deremeik, MA, CLVT
J.E. Goldstein, OD • P.Y. Ramulu, MD, MHS, PhD
B.S. Hawkins, PhD
Department of Ophthalmology, Wilmer Eye Institute, Johns Hopkins University
School of Medicine, Baltimore, MD, USA
e-mail: bmassof@jhmi.edu

M.G. Maguire, PhD
Department of Ophthalmology, Wilmer Eye Institute, University of Pennsylvania
School of Medicine, Philadelphia, PA, USA

D.R. Geruschat, PhD, COMS, CLVT
Department of Graduate Studies in Vision Impairment, College of Education and Rehabilitation, Salus University, Elkins Park, PA, USA

M. Warren, PhD, OTR/L, SCLV
Department of Occupational Therapy, University of Alabama at Birmingham, Birmingham, AL, USA

A.-M. Ervin, PhD, MPH
Department of Epidemiology, Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD, USA

J.A. Stelmack, OD, MPH
Blind Rehabilitation Center, Hines VA Medical Center, Hines, IL, USA

K.D. Frick, PhD
Department of Health Policy and Management, Johns Hopkins University Bloomberg
School of Public Health, Baltimore, MD, USA

H.P.N. Scholl et al. (eds.), *Ophthalmology and the Ageing Society*, Essentials in Ophthalmology,
DOI 10.1007/978-3-642-36324-5_15, © Springer-Verlag Berlin Heidelberg 2013

prevalence and incidence of low vision is projected to double over the next 20 years as our population ages (Congdon et al. 2004; Massof 2002).

By definition, low vision is a chronic condition. To overcome activity limitations, low vision patients must learn to compensate for their chronic visual impairments and cope with the challenges they encounter in their daily lives, both within and outside their homes. Low vision rehabilitation and orientation and mobility instruction (LOVROM) aim to help patients live with low vision by providing tools and teaching strategies that will enable them to regain the ability to perform necessary daily activities, participate in society, and enjoy their lives. Existing LOVROM services employ four major approaches to intervention: (1) vision enhancement (e.g., magnification, illumination control, contrast stretching); (2) visual skills training (e.g., fixation or eccentric viewing training, visual awareness training, training in how to interpret visual information); (3) adaptations and accommodations (e.g., sensory substitution, environmental modifications, problem-solving strategies); and (4) patient and family education (e.g., coping strategies, accessing social and community services).

Our current system of LOVROM is an extension of a system developed more than 60 years ago to serve blind children in need of education and blind adults wanting to return to work. But the demographics of low vision and blindness have changed, with eight out of ten cases now over age 65. Consequently, the greatest demand for rehabilitation of the blind and visually impaired has shifted from the education and social service systems to the healthcare system, and the demand for services is now driven much more by low vision than it is by functional blindness. Over the past 15 years, LOVROM has been undergoing a gradual paradigm shift (Massof et al. 1995). Low vision rehabilitation (LVR) is now formally recognized as a healthcare service within the professions of ophthalmology (American Academy of Ophthalmology Vision Rehabilitation Committee 2007), optometry (American Optometric Association Consensus Panel on Care of the Patient with Low Vision 2007), and occupational therapy (Warren 2008). Nationwide coverage of LVR services by Medicare dates back only to 2002 (Centers for Medicare and Medicaid Services 2002). Coverage of services provided by orientation and mobility (O&M) specialists was included in the Medicare Low Vision Rehabilitation Demonstration Project (Bishop et al. 2010), but is not yet Medicare policy. And Medicare still explicitly excludes coverage of vision assistive equipment (VAE) for low vision patients (Morse et al. 2010).

Past studies agree that LVR and O&M services provided in the USA and other developed countries are minimally effective (Scott et al. 1999; Wolffsohn and Cochrane 2000; McCabe et al. 2000; Reeves et al. 2004; LaGrow 2004; Smith et al. 2005; Stelmack et al. 2006; de Boer et al. 2006; Hinds et al. 2007; Lamoureux et al. 2007; Walter et al. 2007; Court et al. 2011; Pierce et al. 2011). This conclusion does not mean that current LOVROM methods and VAE are not efficacious – there can be many reasons why efficacious interventions fail to be effective. For example, recent studies have reported high VAE abandonment rates (Dougherty et al. 2011) and poor rates of completion of LVR programs (Matt et al. 2011) by low vision patients, factors that could contribute to the observed failures of the effectiveness of LOVROM. LOVROM services provided by Blind Rehabilitation Centers (BRC) in the Veterans Health Administration (VA) produce large improvements in patients' functional ability (Stelmack et al. 2006). The BRCs provide low vision and blind rehabilitation services through intensive 1- to 6-week inpatient programs that include visual skills training, activities of daily living training, O&M instruction, communication skills instruction, manual skills training, computer access training, physical conditioning and recreation, and patient and family education and counseling (Maino 2001). These services are provided by a team of rehabilitation and healthcare professionals who work with the patient in 50-min sessions, 8 times/day, 5 days/week. The VA classifies VAE as prosthetic devices and covers the costs of all prescribed equipment for BRC patients. Typically, BRCs serve self-selected low vision patients who are highly motivated veterans with more severe visual impairments (e.g., visual acuity <20/100 in the better eye). Observational outcome studies at a VA BRC show with patient-reported outcome measures that the BRC's services are highly effective (Stelmack et al. 2006).

The VA Low Vision Intervention Trial (LOVIT) tested the effectiveness of an intensive outpatient LVR program that provided services modeled after the inpatient services in the BRC (Stelmack et al. 2008a). The participants were visually impaired veterans (visual acuity <20/100 to >20/500) who were eligible for BRC services and were on the BRC wait list. LOVIT participants were given 10–12 h of outpatient LVR services, provided mostly in the clinic over a period of 6 weeks (one session was provided in the patient's home), and homework assignments to complete between sessions (Stelmack et al. 2008b). As done for BRC patients, the VA covered the costs of all VAE prescribed to LOVIT participants. To prevent interruptions in the LVR schedule, free transportation was provided to participants who needed it. With these optimized conditions for LVR service delivery, participants in the LOVIT treatment group exhibited a large improvement in self-reported functional ability.

A census of private and state-sponsored LOVROM in the USA concluded that at the end of 2007, there were 1,228 private practices, agencies, or other non-VA entities, serving American low vision patients (Owsley et al. 2009). Generalizing from the responses to a survey of these services (50 % response rate), 43 % are in private optometry practices, 17 % in private ophthalmology practices, 4 % in university-based ophthalmology practices, 3 % in university-based optometry practices, 4 % in other healthcare settings, 11 % in private agencies, 8 % in state agencies, and the remaining 8 % are other non-healthcare system private entities. Overall, 96 % of low vision services provided in the private healthcare system report that they offer training in the use of VAE, 50 % say they offer eccentric viewing training, 33 % say they offer scanning training, 23 % report they sometimes make visits to the patients' homes, and 18 % say that O&M instruction is available.

Over the past decade, findings from observational outcome studies of private outpatient programs in several different countries concur that the effects of LOVROM are disappointingly small (Scott et al. 1999; Wolffsohn and Cochrane 2000; McCabe et al. 2000; Reeves et al. 2004; LaGrow 2004; Smith et al. 2005; Stelmack et al. 2006; de Boer et al. 2006; Hinds et al. 2007; Lamoureux et al. 2007; Walter et al. 2007; Court et al. 2011). All the LVR outcome studies, including the VA LOVIT, employed patient-reported outcome measures (PROM). But studies varied widely in their choice of PROM instruments and none, except LOVIT, employed an untreated control group. To compare studies, we converted their reported effects of intervention to Cohen's effect size (i.e., $d = \Delta\mu/\sigma$). Figure 15.1 illustrates effect sizes for different studies and different groups within studies. Three of the studies compared primary care outcomes to comprehensive care outcomes. Effects were small to medium for both types of LVR, and none of the studies saw any difference between the two types of care (Reeves et al. 2004; Court et al. 2011; Pierce et al. 2011). In the most direct comparison of private service outcomes to VA BRC outcomes, Stelmack et al. reported that one private practice-based and one university practice-based low vision service in the USA had effects of intervention that were one-fifth the size of the intervention effect for the VA BRC (Stelmack et al. 2006) (all three outcomes were estimated using the VA LV VFQ (Stemack et al. 2004)).

The obvious differences between VA and private healthcare system services that likely explain much of the large differences in outcomes include:

1. The VA pays all costs of prescribed VAE; in the private healthcare system, patients must pay 100 % of VAE costs. Consequently many patients do not acquire prescribed VAE.
2. The VA programs are comprehensive and intensive; the private healthcare system programs concentrate on low vision device training.
3. Service delivery in VA programs is consistent and complete; programs in the private healthcare system are inconsistently attended and often not completed by patients. Typical BRC patients are admitted as VA hospital inpatients for 4 weeks and stay focused exclusively on the rehabilitation program. LOVIT patients

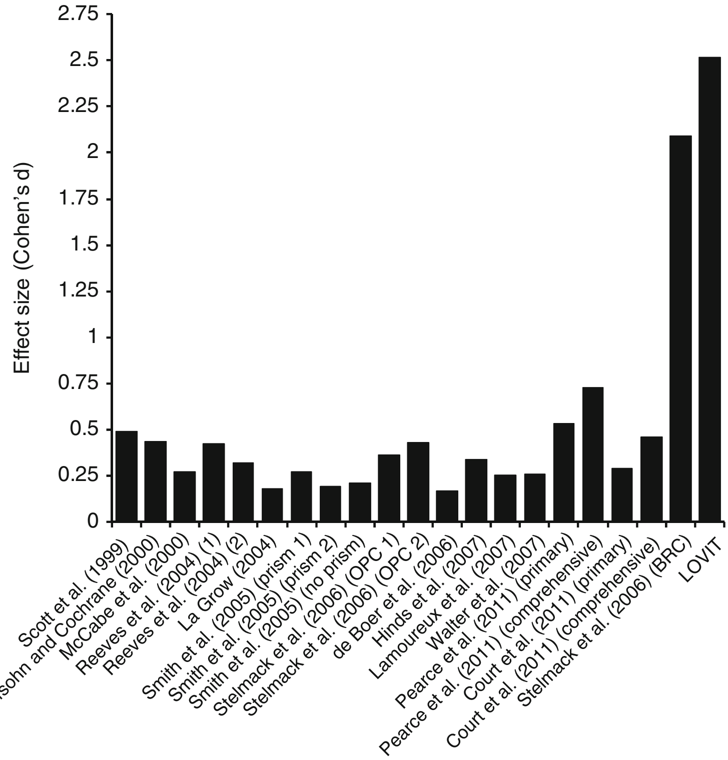

Fig. 15.1 LVR effect sizes for different clinical outcome studies and groups within studies

had transportation services provided so that they did not miss their rehabilitation sessions in the clinic, were required to complete homework exercises between sessions to stay focused on their therapy, and had a home visit. In the private healthcare system, patients must provide their own transportation to the outpatient clinic for rehabilitation sessions (which is difficult because most patients cannot drive, appointments frequently are missed, and the dropout rate is very high), and services provided in the patient's home are rare, so inconsistent and incomplete services are common.

4. The VA BRC routinely provides O&M instruction; O&M instruction is rare in the private healthcare system.

Given these differences, it is reasonable to propose that private outpatient low vision services would be more effective if the services were comprehensive, intensive, well targeted to the patients' needs, and made consistent by accommodating physical constraints imposed on patients by their health, mobility, and availability of assistance.

15.2 Optimizing Outpatient Low Vision Rehabilitation with a Feasible Service Delivery Model

LVR practitioners in the private healthcare system employ one of three service delivery models. First is the "primary care model," (Nowakowski 1994) in which clinicians dispense VAE, usually magnifiers, and train the patient in the clinic how to use them. This model is described in the American Optometric Association's low vision clinical practice guideline (American Optometric Association Consensus Panel on Care of the Patient with Low Vision 2007) and is the model most commonly employed in optometric practices (Owsley et al. 2009). At the next level of service, eccentric viewing training and other types of visual skills instruction are offered in the clinic, in addition to training the patient to use VAE. Occasionally, some LVR therapists may make visits to some patients' homes in addition to providing in-clinic services. This second LVR service delivery model, which is most commonly employed in private ophthalmology practices, in practices associated with academic institutions, and in practices associated with rehabilitation agencies, often is called the "comprehensive care model" (Markowitz 2006). This model is described in the American Academy of Ophthalmology's Preferred Practice Pattern for LVR (American Academy of Ophthalmology Vision Rehabilitation Committee 2007) and is covered by Medicare part B as long as the LVR services are provided by a trained occupational therapist (OT) (Centers for Medicare and Medicaid Services 2002). The third LVR service delivery model is the "home healthcare model." This model, which rarely is employed, requires low vision patients to be referred by a physician to a licensed home healthcare agency, and all LVR services are provided in the patient's home within a 60-day episode. Services provided under the home healthcare model are covered by Medicare part A for patients who meet the requirements of being homebound (most do because they cannot drive or travel independently) and having at least one systemic disorder diagnosis besides low vision (70–80 % of low vision patients meet this requirement (Medicare Benefits Policy Manual 2011)).

There have been no formal outcome studies performed on the home healthcare model for LVR. At least two companies (Low Vision Works home page; HomeSight home page) have offered consulting services to home healthcare agencies with the aim of adding LVR to the agency's list of specialty services. The consulting companies train their clients' OTs and home healthcare nurses to provide LVR services and assist their clients with marketing LVR services to referring physicians and to the public. The LVR services provided by the agencies target patients with moderate and severe low vision who are homebound and have at least one other systemic disorder and thus meet eligibility requirements for Medicare coverage. All LVR services are provided in the patients' home over a period of 60 days. The agencies must provide their LVR services pursuant to a physician's orders (Goldberg-Dey et al. 2011). The consulting companies and their client agencies claim excellent LVR outcomes, but to date, nothing more than testimonials has been offered as supporting evidence.

There are two compelling reasons why providing LVR services to patients within their home instead of the clinic should be optimal. First, unlike most medical rehabilitation, which is aimed at restoring function to normal levels, LVR focuses on enabling patients to continue engaging in everyday activities despite their chronic visual impairments. Most people with low vision live in their own homes or apartments and are responsible for meeting their daily needs within this specific environment (O'Connor et al. 2008). The type of lighting, contrast, and clutter within the patient's environment can either facilitate or inhibit her/his ability to use remaining vision to perform daily tasks (Haymes and Lee 2006; Brunnstroom et al. 2004; Watson 2001; Wald et al. 1999). Adequate simulation of the specific qualities of the home environment within the artificial confines of the clinic is difficult. Medicare, the main third-party payer of LVR, encourages providing rehabilitation services in the home and covers home services under both parts A and B. A report on LVR completed for the Centers for Medicare and Medicaid Services suggested adoption of the home healthcare model as an appropriate and effective method of providing LVR to Medicare beneficiaries (Bishop et al. 2010).

Second, low vision patients experience unique transportation issues that create barriers to participating in clinic-based rehabilitation programs. The visually impaired person rarely drives because of poor vision (DeCarlo et al. 2003; Massof et al. 2007a), and frequently his or her spouse also does not drive. This situation forces reliance on adult children, friends, or service organizations who often are unable to be a consistent source of transportation because of family and work obligations (Goldstein et al. 2012). Thus, missed appointments and dropping out of LVR service are common. Providing in-home services should improve the likelihood of consistent participation in the LVR services.

The home healthcare model promises to be an optimal approach to LVR in the private sector because it increases the frequency and intensity of service and increases the likelihood the patient will complete the planned LVR. Also, the patient is not required to transfer skills learned in the clinic to a different environment and set of circumstances in the home. All LVR services can be customized to accommodate the unique characteristics of each patient's home environment, and environmental modifications can be made to increase safety and accommodate the patient's needs. The home healthcare model of LVR is feasible because it is supported by Medicare part B, and when implemented through licensed home healthcare agencies, it also is supported by Medicare part A. But, despite all its pluses, the home healthcare model does not address problems the patient has functioning outside the home.

15.3 Providing O&M Instruction to Low Vision Patients as a Healthcare Service

Much of the emphasis of LVR currently is directed at restoring reading function and achieving goals related to activities normally performed inside the home (Markowitz 2006; Bachelda and Harkins 1995). Most activities performed outside the home require the patient to be mobile. In the private healthcare system, O&M instruction typically is not included in the LVR regimen (Owsley et al. 2009). Indeed, OTs consider O&M instruction to be outside their scope of practice (Riddering 2008). But there is strong documentation that people with low vision, even those with moderate visual impairments, experience functional limitations with mobility. (Marron and Bailey 1982; Leat and Lovie-Kitchin 2008) More important, because most low vision patients are elderly (Massof 2002; Owsley et al. 2009), they are at increased risk of injury from falls and accidents and increased risk of physical and mental health problems from reduced activity levels (Salive et al. 1994; Crews and Campbell 2001). The mobility limitations of people with low vision potentially could be ameliorated with O&M instruction. Although most O&M specialists are trained to work with low vision clients, the lay public, third-party payers, and many eye care professionals assume that O&M instruction is needed only by people who are functionally blind and assume that it is not a healthcare service. For example, in a recent poll of 120 optometrists, we asked respondents at what visual acuity they would first consider referring a visually impaired patient for O&M instruction; 93 % responded that they would require the patient to be legally blind.

Improving mobility function is medically necessary for older low vision patients. The Safety of Seniors Act of 2007 has made preventing falls and increasing physical activity levels in the older population high priority health agenda items in the USA (Safety of Seniors Act of 2007). The maintenance of balance and postural stability becomes more difficult with age. Besides an increased prevalence of age-related musculoskeletal disorders, such as arthritis and peripheral artery disease, normal aging results in neurodegenerative changes in muscle and joint somatic receptors that interfere with accurate knowledge of the degree of flexion of the limbs and sense forces on the skin, muscles, and joints (Skinner et al. 1984). Also typical with aging is a degeneration of hair cells in the vestibular organ, which interferes with sensing angular and linear acceleration (Ochs et al. 1985). These losses put a greater demand on the visual system to provide sensory information needed to maintain balance – even moderate visual impairments can lead to increased postural instability (Tobis et al. 1990; Turano et al. 1996). Older people with low vision have slower walking speeds (Patel et al. 2006), abnormal gait, and increased incidence of stumbles and near falls (Spaulding et al. 1994). Epidemiological studies show that even mild visual acuity loss increases the risk of falling (Ivers et al. 1998; Klein et al. 2003; Abdelhafiz and Austin 2003), with fall prevalence ratios (relative to 20/20 visual acuity) of 2 for visual acuity <20/30 in the better eye. Relative to older people with 20/20 acuity, the risk of hip fractures doubles for older people with visual acuity in the 20/30–20/40 range, triples for visual acuity in the 20/50–20/70 range, and quadruples for older people with visual acuity <20/70 (Dargent-Molina et al. 1996). More than 50 % of accidental deaths in the older population are from falls. Relative to people with 20/20 visual acuity, the death rate for older people increases independently of age and comorbidities by 20 % for people with visual acuity of 20/25 in the better eye, 35 % for people with visual acuity of 20/30, and 60 % for people with visual acuity <20/30 (Pedula et al. 2006).

Approximately one-third of the older population reports a fear of falling (Tinetti et al. 1994; Arfen et al. 1994; Vellas et al. 1997), and about 10 % report an intense fear of falling (Howland et al. 1998). Fear of falling is associated with decreased activity levels due to self-limitations (Howland et al. 1998; Li et al. 2003; Scheffer et al. 2008). Older people with low vision are 3.7 times more likely to report a strong fear of falling than do normally sighted people in the same age group (Arfen et al. 1994). Relative to people with 20/20 visual acuity, the prevalence of physical limitations on activities (assessed with walking tests, balance tests, and stair climbing tests) ranges from 30 % greater in people with mild visual impairments, to twice as great in people with severe visual impairments (West et al. 2002).

Recently, our group monitored physical activity levels in visually impaired AMD patients and normally sighted age-matched AMD patients. A 0.1 log MAR decrement in visual acuity was associated with a 6.1 % decrease in daily steps. AMD patients were 3.5 times more likely not to leave their home in a day and took 43 % fewer steps per day than controls (Chan et al. 2011).

O&M instruction long has been identified with teaching blind people how to travel independently using a long white cane. But the field of O&M instruction has advanced considerably over the past 70 years to include a wide array of approaches to increasing mobility (Wiener and Siffermann 2010). In the late 1960s, O&M instruction was extended from solely adults to blind children through schools for the blind. Beginning in the mid-1970s, O&M instruction was offered to people with severe low vision. Instruction methods evolved as the served population expanded and diversified; with the addition of low vision clients, techniques were developed to optimize the use of remaining vision and interpret visual information in the scene. From a health perspective, by improving mobility function, the O&M specialist explicitly addresses the healthcare aims of increased safety, increased physical activity, and increased socialization and community integration.

Low vision patients need to improve their mobility, but evidence of the effectiveness of O&M instruction is contradictory and based on studies with weak methodology and/or very small numbers:

1. Geruschat and De l'Aune compared outcomes of O&M instruction for three groups of VA Blind Rehabilitation Center (BRC) patients: those who used vision alone to travel (10 participants), those who used vision and cane to travel (7 participants), and those who used cane alone to travel (2 participants) (Geruschat and De l'Aune 1989). Outcome measures consisted of instructors' scores of errors participants made on a mobility course. The investigators observed a significant improvement in scores post-rehabilitation for all groups combined.
2. Straw et al. performed the only randomized controlled trial of O&M instruction. The first part of the study looked at 35 legally blind (low vision) participants (mean age 76) who were assigned to a treatment or control group. The treatment group received 10–12 weeks of 90 min/week O&M instruction targeting the areas of orientation, independent mobility, and sighted guide mobility. The comparison group received fitness exercises as placebo training. The outcome measure consisted of performance scores in each training area that were assigned by an expert O&M instructor (Straw et al. 1991). The study was repeated with 32 functionally blind participants (mean age = 77) (Straw and Harley 1991). The baseline scores were lower for the functionally blind group than for the low vision group. A significant improvement in the overall O&M score was seen for the functionally blind group, but not for the low vision group.

3. Soong et al. conducted a study that compared a group of low vision patients (19) who received O&M instruction, including how to use the long cane, to another group of patients (18) who received no training (Soong et al. 2001). The outcome measures were walking speed and counts of mobility errors on a course. These investigators saw no effect of training.
4. Ramsey et al. looked at the effects of mobility training on gait and balance in an uncontrolled study (Ramsey et al. 2003). Six VA BRC patients, who were approximately 70 years old and had visual acuity of 20/200 or less in the better eye, were participants. Baseline data were collected within 1 week of admission to the BRC, and follow-up data were collected at discharge. The investigators employed six performance measures (gait velocity, stride length, stride rate, double stance time, the Berg Balance test, and hand-grip strength). They also used a self-report questionnaire, the Fall Efficiency Scale (FES), to estimate fear of falling. The investigators concluded that O&M instruction had no effect on any of the measures.
5. Kuyk et al. employed Turano's independent mobility questionnaire (Turano et al. 2002) to estimate the effects of O&M instruction on 128 VA Blind Rehabilitation Center patients, more than half of whom had age-related macular degeneration (Kuyk et al. 2004). The investigators reported significant improvements in average response rank scores for each item. The investigators also saw an increase in patient-reported confidence with travel ability, a decrease in the percentage of patients who had fallen, and a decrease in the average number of falls among those who had fallen previously, but no change in the prevalence of fear of falling.

The indisputable fact is that the ever-growing low vision population has substantial functional problems due to limitations in mobility. While O&M instruction appears to be an obvious solution, perceptions by physicians and patients that O&M services are meant only for blind children and for blind adults seeking employment, the absence of a feasible reimbursement system, as well as the absence of definitive evidence of the effectiveness of this type of rehabilitation have resulted in little utilization of O&M services. The literature strongly supports the thesis that low vision patients have a medical need for the professional services of an O&M specialist, which are distinctly different from the services offered by OTs and other low vision rehabilitation professionals. O&M instruction provided to low vision patients by an O&M specialist should improve their mobility function and balance. Potential downstream benefits include decreased risk of injury, decreased fear of falling, and increased levels of physical activity, which ultimately could lead to decreased morbidity and mortality and increased life space and community integration. Overall, the functional gains from O&M services have the potential to improve the lives of low vision patients, which would manifest as measurable gains in quality of life that could inform health policy decisions. Past studies of O&M instruction outcomes produced equivocal results, so there is true equipoise with respect to evidence, even though there are individuals with strong personal opinions for and against the value of O&M instruction for low vision patients. Previous studies had weak designs and were grossly underpowered (Vigili and Rubin 2003). Nevertheless, the results were encouraging, especially the results of the Kuyk et al. (2004) study, which used a self-report measure.

15.4 Approaches to Measuring the Effectiveness of LOVROM

There are many measurement strategies from which to choose:

1. Performance measures in the clinic such as reading speed (Legge et al. 1989), reading comprehension (Watson and Wright 1996), walking speed (Geruschat et al. 1998), navigation accuracy (Turano et al. 2004), and accuracy/speed of performing visual motor tasks (Owsley et al. 2001)
2. Real-world performance measures (e.g., physical activity levels in the home environment by accelerometers) (Chan et al. 2011)

3. Rating of patient performance by clinicians (Babcock-Parziale et al. 2005), as more commonly done in occupational and physical therapy with instruments such as the Functional Independence Measure (FIM) (Granger et al. 1998) and the Assessment of Motor and Process Skills (AMPS) (Park et al. 1994)
4. Patient self-report instruments such as visual function (Massof 2007) and quality of life (Wolffsohn and Cochrane 2000) rating scale questionnaires

The limitation suffered by most clinic-based performance measures and ratings by expert judges is that they constitute observations of what the patient can do on surrogate tasks at that moment, under artificial conditions; they do not measure what the patient actually does in everyday life. Consequently, the most common performance measures and clinician ratings can be used to measure the efficacy of an intervention (how well an intervention works under ideal circumstances), but cannot be used to measure its effectiveness (how well an intervention works in "real-world" settings).

When choosing an outcome measure for visual rehabilitation, one must keep in mind that, with the exception of improved refractive error correction, LOVROM services and VAE do not change the patient's vision. Unlike medical and surgical procedures, which can improve visual acuity in some conditions, such as cataract, and have a positive effect on many aspects of the patient's life, the effects of LVR are activity-specific (e.g., a table top CCTV magnifier may improve the patient's ability to perform the activity of reading mail, but have no effect on the patient's ability to perform the activity of reading price tags in a store). Consequently, outcome measures must have content that is chosen carefully to be relevant and responsive to the effects of LOVROM. Also, VAE, adaptations, visual skills training, and patient education require patients to participate, not simply comply, and they require the patient to compromise (e.g., magnification is accomplished at the expense of field of view and/or working distance; adaptations and visual skills training require the patient to give up familiar routines and develop new habits). Consequently, LOVROM outcome measures also must be sensitive to individual patient preferences and willingness to change because those factors will affect the importance and relevance of the measurement instrument's content. Finally, patients may be capable of performing activities but do not do so because they lack confidence or are fearful. Successful interventions, particularly O&M instruction, may achieve their effects, at least in part, by building the patient's confidence and reducing fear. Thus, the optimal outcome measure also must be responsive to changes in psychological variables that contribute to the patient's activity limitations.

When evaluating patients, LVR therapists and O&M instructors do not simply assess functional abilities. Rather, they identify activities that are important to the patient and are difficult or impossible for the patient to perform with the current approach to performing the activity. Instead of intervening to restore a standard array of functional abilities, many of which may have limited or no relevance to a specific patient, LVR therapists and O&M instructors are goal directed; they employ individualized intervention strategies based on vision enhancement, adaptations, and accommodations to make targeted activities easier to perform despite the patient's limited functional capabilities. For accurate assessment of the effects of services provided under goal-directed intervention, an approach that can capture improvement in attaining goals is required.

Measuring the effectiveness of goal-directed rehabilitation requires an adaptive patient-centered approach. Goals are the reasons for performing activities. Goals are attained by completing a set of specific cognitive and motor tasks (Massof 1995). For a given goal, the specific tasks that must be completed may vary among patients. For example, to attain the goal of cooking daily meals may require one patient to read recipes, cut or chop food, measure ingredients, set stove and oven controls, pour liquids without spilling, and judge when the food has finished cooking. For another patient, cooking daily meals may require only finding the correct package in the freezer, reading the cooking instructions, and setting the controls on the microwave. For either example, if the individual tasks cannot be performed, the goal cannot be attained. The LVR therapist may train the first patient to use a magnifier to read recipes, advise the patient to buy precut or pre-chopped food, mark measuring spoons with colored tape, use Velcro tape or Hi-Marks to label common stove and oven settings, show the patient how to use a funnel to pour liquids, and teach the patient how to use a large print timer and/or talking food thermometer to judge when the food has finished cooking. Such task adaptations, or accommodations in the case of cutting or chopping food, make the component tasks easier to perform, or obviate them, so that the parent goal can be attained. For the second patient, the intervention is much simpler – organize the freezer and mark the packages with large print labels, teach the patient to use a magnifier to read the cooking instructions, and mark the microwave controls with Hi-Marks or other markers. In both cases, successful rehabilitation means that the patient can attain the goal of cooking daily meals; but in neither case have the patient's functional capabilities, which are traits of the patient, been improved.

The Activity Inventory (AI) (Massof et al. 2005a, b; 2007b) is an adaptively administered patient-reported outcome measure of the effects of goal-directed interventions. The AI has an item bank with 50 goals and a total of 460 tasks nested under the goals. The patient is presented with a goal and asked to rate its importance (not important, slightly important, moderately important, or very important). Whenever a patient responds that the goal is not important, the interviewer moves on to the next goal; otherwise the patient is asked to judge the difficulty of attaining the goal, and an ease of performance rank score is assigned to the response (4, not difficult; 3, somewhat difficult; 2, moderately difficult; 1, very difficult; or 0, impossible). Whenever a patient responds that the goal is not difficult, the interviewer moves on to the next goal; otherwise the patient is asked to rate the difficulty of each task nested under the goal (using the same five response categories) or respond that the task is "not applicable." After all of the tasks under the goal have been rated, the interviewer moves on to the next goal. The AI is well validated and well studied and is or has been used as the primary outcome measure in four clinical trials (Pierce et al. 2011; Rovner et al. 2011; U.S. National Institutes of Health 2009; U.S. National Institutes of Health 2006) and in prospective clinical outcome studies in the UK; (Tabrett and Latham 2011) a Dutch version (D-AI) is being validated to be used as a clinical outcome measure in the Netherlands (Bruijning et al. 2010).

Item responses are interpreted with a general scaling theory, and measures are constructed from responses to sets of AI items using Rasch analysis. At the time of the baseline assessment, each low vision patient has some amount of functional ability. Depending on the visual requirements, each goal and task in the AI item bank demands of the person some minimum amount of functional ability in order to be performed with a criterion level of ease. When the patient is asked to rate the difficulty of an item, the patient judges the difference between his/her functional ability and the functional ability required to perform the goal or task described by that item. This difference is called "functional reserve" (Massof 1998).

Interventions can have three possible effects that manifest as increases in functional reserve for a given patient (Massof 2013). First, there could be an increase in the patient's functional ability (e.g., due to correction of refractive error). Second, there could be a systematic reduction in the patient's response criteria (e.g., due to an increase in the patient's confidence or reduction in the patient's fear). Third, because of adaptations and/or vision enhancement, there could be a decrease in the functional ability demanded of the patient by selected items. Vision enhancement and task adaptations are expected to decrease functional ability demands of targeted tasks, resulting in an overall increase in average functional reserve across tasks; accommodations are expected to reduce the number of difficult or impossible tasks involved in a targeted goal by making obviated tasks "not applicable," which also increases average functional reserve across tasks (Massof 2013).

Because LVR and O&M instruction address different goals, they require different outcome measures. Some goals such as cooking daily meals, managing personal finances, and dressing typically are performed inside the home. Other goals such as shopping, attending church, and attending meetings are performed outside the home. Inside-the-home goal activities depend heavily on patients' reading, visual information processing, and visual motor function and depend to a lesser extent on patients' mobility. Outside-the-home goal activities depend heavily on mobility but also on the other functions that are limited by visual impairments. The LVR therapist addresses goal activities that normally are performed in the patient's home; the O&M specialist addresses goal activities that normally are performed outside the home. Ideally, outcome measures of both types of services would be on the same scale but selectively responsive to the attainment of respective inside-the-home or outside-the-home goals that are indentified by the individual patient.

Conclusions

The Western world's population is aging and both the incidence and prevalence of vision disabilities from age-related eye diseases will double over the next 20 years. Studies show that low vision not only results in reduced functional capabilities and reduced quality of life but also increases the risk of premature morbidity and mortality. Although the Low Vision Intervention Trial demonstrated that under optimal conditions low vision rehabilitation can restore the patient's ability to function in daily life, other studies conclude that the effectiveness of current low vision rehabilitation practices is weak outside the US VA healthcare system. Furthermore, the supply of low vision rehabilitation services and qualified service providers is inadequate to meet the current demand and third-party payment policies discourage growth in supply. The authors advocate a service delivery model that emphasizes the provision of low vision rehabilitation and orientation and mobility instruction in the patient's home and in the patient's community. It will be necessary to conduct rigorous clinical research to prove the effectiveness and value of such a service delivery model and effect changes in healthcare policies. But future studies will have to accommodate the individualized nature of LOVROM and very carefully choose outcome measures that are responsive to the achievement of the individual rehabilitation goals for each patient.

Acknowledgments Conflict of interest: none; Ethical standards: Informed consent – not applicable: Animal rights – not applicable

References

Abdelhafiz AH, Austin CA (2003) Visual factors should be assessed in older people presenting with falls or hip fracture. Age Ageing 32:26–30

Ahmadian L, Massof RW (2008) Impact of general health status on validity of visual impairment measurement. Ophthalmic Epidemiol 15:345–355

American Academy of Ophthalmology Vision Rehabilitation Committee (2007) Preferred Practice Pattern: vision rehabilitation for adults. American Academy of Ophthalmology, San Francisco

American Optometric Association Consensus Panel on Care of the Patient with Low Vision (2007) Optometric clinical practice guideline: care of the patient with visual impairment (low vision rehabilitation). American Optometric Association, St. Louis

Arfen CL, Lach HW, Birge SJ, Miller JP (1994) The prevalence and correlates of fear of falling in elderly persons living in the community. Am J Public Health 84:565–570

Babcock-Parziale J, McKnight PE, Head DN (2005) Evaluating psychometric properties of a clinical and a self-report blind rehabilitation outcome measure. J Rehabil Res Dev 42:487–498

Bachelda JM, Harkins D Jr (1995) Do occupational therapists have a primary role in low vision rehabilitation? Am J Occup Ther 49:927–930

Bishop C, Perloff J, Meagher J, Ritter G, Leutz W (2010) Evaluation of the low vision rehabilitation demonstration. Claims analysis. Final Report, CMS Contract No. 500-00-0031. Web access: http://www.cms.gov/Reports/Downloads/Bishop_LowVisiDemoClaims_2010.pdf. Accessed on Mar 18, 2013

Bressler NM, Chang TS, Suner U et al (2010) Vision-related function after ranibizumab by better or worse-seeing eye: clinical trial results from MARINA and ANCHOR. Ophthalmology 117:747–756

Bruijning JE, van Nispen RM, van Rens GH (2010) Feasibility of the Dutch ICF Activity Inventory: a pilot study. BMC Health Serv Res 10:318

Brunnstroom G, Sorensen S, Alsterstad K, Sjostrand J (2004) Quality of light and quality of life – the effect of lighting adaptation among people with low vision. Ophthalmic Physiol Opt 24:274–280

Casten RJ, Rovner BW, Tasman W (2004) Age-related macular degeneration and depression: a review of recent research. Curr Opin Ophthalmol 15:181–183

Centers for Medicare and Medicaid Services (CMS) (2002) Provider education article: medicare coverage of rehabilitation services for beneficiaries with vision impairment. Program Memorandum AB-02-078, 29 May 2002

Chan ES, Hochberg C, Maul E, Ferrucci L, Friedman DS, Ramulu P (2011) Objective quantification of physical activity and travel outside the home in age-related macular degeneration. Invest Ophthalmol Vis Sci 52:E-abstract 1911

Chang TS, Bressler NM, Fine JT, Dolan CM, Ward J, Klesert TR (2007) Improved vision-related function after ranibizumab treatment of neovascular age-related macular degeneration. Arch Ophthalmol 125: 1460–1469

Congdon N, O'Colmain B, Klaver CC, Klein R, Munoz B, Friedman DS, Kempen J, Taylor HR, Mitchell P (2004) Causes and prevalence of visual impairment among adults in the United States. Arch Ophthalmol 122(4):477–485

Court H, Ryan B, Bunce C, Margrain TH (2011) How effective is the new community-based Welsh low vision service? Br J Ophthalmol 95:178–184

Crews JE, Campbell VA (2001) Health conditions, activity limitations, and participation restrictions among older people with visual impairments. J Vis Impair Blind 95:453–467

Dargent-Molina P, Favier F, Grandjean H, Baudoin C, Schott AM, Hausherr E, Meunier PJ, Breart G et al (1996) Fall-related factors and risk of hip fracture: the EPIDOS prospective study. Lancet 348:145–149

de Boer MR, Twisk J, Moll AC et al (2006) Outcomes of low-vision services using optometric and multidisciplinary approaches: a non-randomized comparison. Ophthalmic Physiol Opt 26:535–544

DeCarlo DK, Scilley K, Wells J, Owsley C (2003) Driving habits and health-related quality of life in patients with age-related maculopathy. Optom Vis Sci 90:207–213

Dougherty BE, Kehler KB, Jamara R et al (2011) Abandonment of low vision devices in an outpatient population. Optom Vis Sci 88:1283–1287

Geruschat DR, De l'Aune W (1989) Reliability and validity of O&M instructor observations. J Vis Impair Blind 83:457–460

Geruschat DR, Turano KA, Stahl JW (1998) Traditional measures of mobility performance and retinitis pigmentosa. Optom Vis Sci 75:525–537

Goldberg-Dey J, Johnson M, Pajerowski W, Tanamor M, Ward A (2011) Home Health Study Report. Report to CMS HHSM-500-2010-00072C

Goldstein JE, Massof RW, Deremeik JT, Braudway S, Jackson ML, Kehler KB, Primo SA, Sunness JS, LOVRNET Study Group (2012) Baseline traits of low vision patients served by private outpatient clinical centers in the United States. Arch Ophthalmol 130:1028–1037

Granger CV, Deutsch PC, Linn RT (1998) Rasch analysis of the Functional Independence Measure (FIM) Mastery Test. Arch Phys Med Rehabil 79:52–57

Haymes SA, Lee J (2006) Effects of task lighting on visual function in age-related macular degeneration. Ophthalmic Physiol Opt 26:169–179

Hinds A, Sinclair A, Park J et al (2007) Impact of an interdisciplinary low vision service on the quality of life of low vision patients. Br J Ophthalmol 87:1391–1396

HomeSight home page. http://www.homesight.biz/. Accessed on Mar 18, 2013

Howland J, Lachman ME, Peterson EW, Cote J, Kasten L, Jette A (1998) Covariates of fear of falling and associated activity curtailment. Gerontologist 38:549–555

Ivers RQ, Cumming RG, Mitchell P, Attebo K (1998) Visual impairment and falls in older adults: the blue Mountains Eye Study. J Am Geriatr Soc 46:58–64

Klein BE, Moss SE, Klein R, Lee KE, Cruickshanks KJ (2003) Associations of visual function with physical outcomes and limitations 5 years later in an older population: the Beaver Dam Eye Study. Ophthalmology 110:644–650

Kuyk T, Elliott JL, Wesley J, Scilley K, McIntosh E, Mitchell S, Owsley C (2004) Mobility function in older veterans improves after blind rehabilitation. J Rehabil Res Dev 41:337–346

LaGrow SJ (2004) The effectiveness of comprehensive low vision services for older persons with visual impairments in New Zealand. J Vis Impair Blind 98:679–692

Lamoureux EL, Pallant JF, Pesudovs K et al (2007) The effectiveness of low-vision rehabilitation on participation in daily living and quality of life. Invest Ophthalmol Vis Sci 48:1476–1482

Langelaan M, de Boer MR, van Nispen RMA, Wouters B, Moll AC, van Rens GHMB (2009) Change in quality of life after rehabilitation: prognostic factors for visually impaired adults. Int J Rehabil Res 32:12–19

Leat SJ, Lovie-Kitchin JE (2008) Visual function, visual attention, and mobility performance in low vision. Optom Vis Sci 85:1049–1056

Legge GE, Ross JA, Luebker A, LaMay JM (1989) Psychophysics of reading. VIII. The Minnesota low-vision reading test. Optom Vis Sci 66:843–853

Li F, Fisher J, Harmer P, McAuley E, Wilson NL (2003) Fear of falling in elderly persons: association with falls, functional ability, and quality of life. J Gerontol B Psychol Sci Soc Sci 58:P283–P290

Low Vision Works home page. http://www.lowvisionworks.com/. Accessed on Mar 18, 2013

Maino JH (2001) Low vision and blindness rehabilitation in the VA: inpatient rehabilitation. In: Massof RW, Lidoff L (eds) Issues in low vision rehabilitation: service delivery, policy, and funding. AFB Press, New York

Markowitz SN (2006) Principles of modern low vision rehabilitation. Can J Ophthalmol 41:289–312

Marron JA, Bailey IL (1982) Visual factors and orientation-mobility performance. Am J Optom Physiol Opt 59:413–426

Massof RW (1995) A systems model for low vision rehabilitation. 1. Basic concepts. Optom Vis Sci 72: 725–736
Massof RW (1998) A systems model for low vision rehabilitation. II. Measurement of vision disabilities. Optom Vis Sci 75:349–373
Massof RW (2002) A model of the prevalence and incidence of low vision and blindness among adults in the U.S. Optom Vis Sci 79:31–38
Massof RW (2007) An interval-scaled scoring algorithm for visual function questionnaires. Optom Vis Sci 84:689–704
Massof RW (2013) A general theoretical framework for interpreting patient-reported outcomes estimated from ordinally scaled item responses. Stat Methods Med Res. Feb 19. [Epub ahead of print] doi:10.1177/0962280213476380
Massof RW, Dagnelie G, Deremeik JT, DeRose JL, Alibhai SS, Glasner NM (1995) Low vision rehabilitation in the U.S. health care system. J Vis Rehabil 9:3–31 [Massof RW, Lidoff L (eds) (2001) Reprinted in low vision rehabilitation: service delivery, policy, and funding. AFB Press, New York, pp 267–306]
Massof RW, Hsu CT, Baker FH, Barnett GD, Park WL, Deremeik JT, Rainey C, Epstein C (2005a) Visual disability variables. I. The importance and difficulty of activity goals for a sample of low vision patients. Arch Phys Med Rehabil 86:946–953
Massof RW, Hsu CT, Baker FH, Barnett GD, Park WL, Deremeik JT, Rainey C, Epstein C (2005b) Visual disability variables. II. The difficulty of tasks for a sample of low vision patients. Arch Phys Med Rehabil 86:954–967
Massof RW, Deremeik JT, Park WL, Grover LL (2007a) Self-reported importance and difficulty of driving in a low vision clinic population. Invest Ophthalmol Vis Sci 48:4955–4962
Massof RW, Ahmadian L, Grover LL, Deremeik JT, Goldstein JE, Rainey C, Epstein C, Barnett GD (2007b) The Activity Inventory (AI): an adaptive visual function questionnaire. Optom Vis Sci 84:763–774
Matt AI, Pesudovs K, Daly A, Brown M, Chen CS (2011) Access to low vision rehabilitation services: barriers and enablers. Clin Exp Optom 94:181–186
McCabe P, Nason F, Demers-Turco P et al (2000) Evaluating the effectiveness of a vision rehabilitation intervention using an objective and subjective measure of functional performance. Ophthalmic Epidemiol 7: 259–270
Medicare benefits policy manual (2011) Chapter 7, CMS http://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/Internet-Only-Manuals-IOMs-Items/CMS012673.html; accessed May 2, 2013.
Morse AR, Massof RW, Cole RG, Mogk LG, O'Hearn AM, Hsu YP, Faye EE, Wainapel SF, Jackson ML (2010) Medicare coverage for vision assistive equipment. Arch Ophthalmol 128:1350–1357
Nowakowski RW (1994) Primary low vision care. Appleton and Lange, Norwalk
O'Connor PM, Lamoureux EL, Keeffe JE (2008) Predicting the need for low vision rehabilitation services. Br J Ophthalmol 92:252–255
Ochs AL, Newberry J, Lenhardt M, Harkins SW (1985) Neural and vestibular aging associated with falls. In: Birren JE, Schaie KW (eds) Handbook of the psychology of aging, 2nd edn. Van Nostrand Reinhold, New York
Owsley C, McGwin G, Sloane ME et al (2001) Timed instrumental activities of daily living tasks: relationship to visual function in older adults. Optom Vis Sci 78:350–359
Owsley C, McGwinn G Jr, Lee PP, Wasserman N, Searcey K (2009) Characteristics of low vision rehabilitation services in the United States. Arch Ophthalmol 127: 681–689
Park S, Fisher AG, Velozo CA (1994) Using the assessment of motor and process skills to compare occupational performance between clinic and home settings. Am J Occup Ther 48:697–709
Patel H, Turano KA, Broman AT, Bandeen-Roche K, Munoz B, West SK (2006) Measures of visual function and percentage of preferred walking speed in older adults: the Salisbury Eye Evaluation Project. Invest Ophthalmol Vis Sci 47:65–71
Pedula KL, Coleman AL, Hillier TA, Ensrud KE, Nevitt MC, Hochberg MC, Mangione CM (2006) Visual acuity, contrast sensitivity, and mortality in older women: study of osteoporotic fractures. J Am Geriatr Soc 54:1871–1877
Pearce E, Crossland MD, Rubin GS (2011) The efficacy of low vision device training in a hospital-based low vision clinic. Br J Ophthalmol 95:105–108
Ramsey VK, Blasch BB, Kita A (2003) Effects of mobility training on gait and balance. J Vis Impair Blind 97:720–726
Reeves BC, Harper RA, Russell WB (2004) Enhanced low vision rehabilitation for people with age related macular degeneration: a randomized controlled trial. Br J Ophthalmol 88:1443–1449
Riddering A (2008) Evaluation and intervention for deficits in home and community mobility. In: Warren M (ed) Low vision: occupational therapy evaluation and intervention with the older adult. Revised edition. American Occupational Therapy Association, Bethesda, pp 131–157
Rovner BW, Casten RJ, Hegel MT, Massof RW, Leiby BE, Tasman WS (2011) Improving function in age-related macular degeneration: design and methods of a randomized clinical trial. Contemp Clin Trials 32:196–203
Safety of Seniors Act of 2007, Public Law 110–202. Web access: http://thomas.loc.gov/cgi-bin/bdquery/z?d110:SN00845:@@@L&summ2=m&. Accessed 23 Apr 2008
Salive ME, Guralnik J, Glynn RJ, Christen W, Wallace RB, Ostfield AM (1994) Association of visual impairment with mobility and physical function. J Am Geriatr Soc 42:287–292
Scheffer AC, Schuurmans MJ, van Dijk N, van der Hooft T, de Rooij SE (2008) Fear of falling: measurement

strategy, prevalence, risk factors and consequences among older persons. Age Ageing 37:19–24

Scott I, Smiddy W, Schiffman J et al (1999) Quality of life of patients with low vision and the impact of low-vision services. Am J Ophthalmol 128:54–62

Skinner HB, Barrack RL, Cook SD (1984) Age-related decline in proprioception. Clin Orthop Relat Res 184:208–211

Smith HJ, Dickinson CM, Cacho I et al (2005) A randomized controlled trial to determine the effectiveness of prism spectacles for patients with age-related macular degeneration. Arch Ophthalmol 123:1042–1050

Soong GP, Lovie-Kitchin JE, Brown B (2001) Does mobility performance of visually impaired adults improve immediately after orientation and mobility training? Optom Vis Sci 78:657–666

Spaulding SJ, Patla AE, Elliott DB, Flanagan J, Rietdyk S, Brown S (1994) Waterloo vision and mobility study: gait adaptations to altered surfaces in individuals with age-related maculopathy. Optom Vis Sci 71:770–777

Stelmack JA, Szlyk JP, Stelmack TR et al (2006) Measuring outcomes of low vision rehabilitation with the Veterans Affairs Low Vision Visual Functioning Questionnaire (VA LV VFQ-48). Invest Ophthalmol Vis Sci 47:3253–3261

Stelmack JA, Tang C, Reda DJ et al (2008a) Outcomes of the Veterans Affairs Low Vision Intervention Trial (LOVIT). Arch Ophthalmol 126:608–617

Stelmack JA, Rinne S, Mancil RM, Dean D, Moran D, Tang XC, Cummings R, Massof RW (2008b) Successful outcomes from a structured curriculum used in the Veterans Affairs Low Vision Intervention Trial. J Vis Impair Blind 102:636–648

Stemack JA, Szlyk JP, Stelmack TR, Demers-Turco P, Williams RT, Moran D, Massof RW (2004) Psychometric properties of the Veterans Affairs Low-Vision Visual Functioning Questionnaire. Invest Ophthalmol Vis Sci 45:3919–3928

Straw LB, Harley RK (1991) Assessment and training in orientation and mobility for older persons: program developing and testing. J Vis Impair Blind 85:291–296

Straw LB, Harley RK, Zimmermann GJ (1991) A program in orientation and mobility for visually impaired persons over age 60. J Vis Impair Blind 85:108–113

Tabrett DR, Latham K (2011) Factors influencing self-reported vision-related activity limitations in the visually impaired. Invest Ophthalmol Vis Sci 52:5293–5302

Tinetti ME, Mendes de-Leon CF, Doucette JT, Baker DI (1994) Fear of falling and fall-related efficacy in relationship to functioning among community-living elders. J Gerontol 49:M140–M147

Tobis JS, Block M, Steinhaus-Donham C, Reinsch S, Tamaru K, Weil D (1990) Falling among the sensorially impaired elderly. Arch Phys Med Rehabil 71:144–147

Turano KA, Dagnelie G, Herdman SJ (1996) Visual stabilization of posture in persons with central visual field loss. Invest Ophthalmol Vis Sci 37:1483–1491

Turano KA, Massof RW, Quigley HA (2002) A self-assessment instrument designed for measuring independent mobility in RP patients: generalizability to glaucoma patients. Invest Ophthalmol Vis Sci 43:2874–2881

Turano KA, Broman AT, Bandeen-Roche K et al (2004) Association of visual field loss and mobility performance in older adults: Salisbury Eye Evaluation Study. Optom Vis Sci 81:298–307

U.S. National Institutes of Health (2006) Feasibility study of a chronic retinal stimulator in retinitis pigmentosa. ClinicalTrials.gov. ID NCT00279500, http://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/bp102c07.pdf. Accessed on Mar 18, 2013

U.S. National Institutes of Health (2009) Low vision depression prevention trial for age related macular degeneration (VITAL). ClinicalTrials.gov. ID NCT00769015, http://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/bp102c07.pdf. Accessed on Mar 18, 2013

Vellas BJ, Wayne SJ, Romero LJ, Baumgartner RN, Garry PJ (1997) Fear of falling and restriction of mobility in elders. Age Ageing 26:189–193

Vigili G, Rubin G (2003) Orientation and mobility training for adults with low vision. Cochrane Database Syst Rev (4):CD003925

Wald HW, Oswald F, Zimprich D (1999) Everyday competence in visually impaired older adults: a case for person-environment perspectives. Gerontologist 39:140–149

Walter C, Althouse R, Humble H, Smith W, Odom JV (2007) Vision rehabilitation: recipient's perceived efficacy of rehabilitation. Ophthalmic Epidemiol 14:103–111

Warren M (ed) (2008) Low vision: occupational therapy evaluation and intervention with the older adult. Revised edition. American Occupational Therapy Association, Bethesda

Watson GR (2001) Low vision in the geriatric population: rehabilitation and management. J Am Geriatr Soc 49:317–330

Watson GR, Wright V (1996) A low vision reading comprehension test. J Vis Impair Blind 90:486–494

West SK, Rubin GS, Broman AT, Munoz B, Bandeen-Roche K, Turano K (2002) How does visual impairment affect performance on tasks of everyday life? The SEE Project. Salisbury Eye Evaluation. Arch Ophthalmol 120:774–780

Wiener WR, Siffermann E (2010) The history and progression of the profession of O&M. In: Wiener W, Welsh R, Blasch B (eds) Foundation of orientation and mobility, vol I. American Foundation for the Blind, New York

Wolffsohn JS, Cochrane AL (2000) Design of the low vision quality-of-life questionnaire (LVQOL) and measuring the outcome of low vision rehabilitation. Am J Ophthalmol 130:793–802