CHAPTER 10

Vision Rehabilitation

Highlights

- Patients with visual acuities less than 20/40 or scotomata, field loss, or contrast sensitivity loss will benefit from low vision evaluation and multidisciplinary vision rehabilitation to assist them in achieving their goals and maintaining quality of life despite vision loss.
- An evaluation of visual acuity, contrast sensitivity, location and size of scotomata relative to fixation, and extent of mid-peripheral and peripheral field loss allows clinicians to appreciate the impact of vision loss on patients' functioning and informs effective rehabilitation interventions.
- Multidisciplinary vision rehabilitation addresses reading (eg, magnification requirements), daily activities (eg, cell phone accessibility or doing kitchen tasks), safety (eg, fall prevention or ability to take medications), participation (eg, driving), and psychosocial well-being (eg, adjustment to vision loss or depression).
- The range of devices from which patients can benefit includes optical devices, such as reading adds and illuminated magnifiers; electronic devices, such as smartphones, e-readers, video magnifiers, and audio books; and nonoptical devices, such as large-format telephones or television remote controls.
- Patients with any level of vision loss may experience vivid, recurrent visual hallucinations, such as seeing patterns, faces, flowers, or people where there are none. When patients have full insight that these images are not real, and no other neurological symptoms or diagnosis to explain the hallucinations, this is attributed to Charles Bonnet syndrome.

Glossary

Bioptic telescope A spectacle-mounted telescope that is typically placed above the visual axis for spotting distance targets, such as traffic lights, in jurisdictions where bioptic driving is allowed.

Charles Bonnet syndrome A condition in individuals who have some degree of vision loss that is characterized by vivid, recurrent hallucinations and insight that what is being seen is not real. Individuals may see patterns or images, such as people, faces, or landscapes. The degree of vision loss may be moderate or severe, and the vision loss can be acuity loss or visual field loss due to ocular or neurologic disease.

Eccentric fixation Use of nonfoveal fixation to view the object of regard.

Legal blindness A level of vision loss at which patients are entitled to certain concessions or services in various jurisdictions. Legal blindness is defined in the United States as best-corrected visual acuity less than or equal to 20/200 (if measured using a chart such as an ETDRS chart, one cannot read any letters on the 20/100 line) or a central visual field of equal to or less than 20° in diameter.

Low vision Vision loss that cannot be corrected by standard eyeglasses or by medical or surgical treatment. The cause may be ocular or neurologic disease.

Macular microperimeter A perimetry device that images the retina during visual field testing. Eyetracking facilitates reliable perimetry evaluation of patients with unstable fixation or eccentric fixation. The retina can be imaged with a camera or scanning laser ophthalmoscopy. Macular microperimetry is also called *fundus-related perimetry* or *macular perimetry.*

Preferred retinal locus The area of nonfoveal retina that a patient repeatedly uses for fixation when the foveal area is impaired.

Scanning training Training to enhance compensatory visual searching into nonseeing areas of the visual field, such as with hemianopic field loss. Methods of training include performance of search tasks on devices that can be programmed with displays of lights, computer training programs, and scanning training practice typically implemented by occupational therapists.

Video magnifiers Devices that combine digital cameras with electronic screens in handheld, desk, or head-mounted formats. They have also been referred to as closed-circuit televisions (CCTVs).

Vision rehabilitation A multidisciplinary clinical process aimed at enabling individuals with vision loss to reach their goals for visual tasks and improve quality of life. Comprehensive vision rehabilitation assesses and addresses 5 areas: reading, daily life activities, safety, continued participation despite vision loss, and psychosocial well-being.

Visual prosthesis A device to provide vision substitution for individuals who are blind. Devices currently available or under development stimulate the retina (epiretinal, subretinal, or suprachoroidal implants) or stimulate the visual cortex. A device that places an electrode array on the tongue is also available.

Introduction

Ophthalmologists see patients with vision impairment in their offices every day. Those patients may have difficulty reading appointment notices, finding the clinic, or navigating in the office. Simple measures such as knowing how to assist a patient to the examination room with sighted-guide techniques or offering referral to vision rehabilitation services can be valuable. In this chapter we provide an overview of vision rehabilitation so that ophthalmologists may better appreciate the wide range of vision rehabilitation interventions, from smart speakers to support groups, that can assist their patients.

CLINICAL PEARL

Instructions and videos about sighted-guide techniques and how to offer your arm and verbal instructions to a patient who wishes assistance are available online.

In 2015, 3.22 million Americans older than 40 years were estimated to have visual impairment (with best-corrected visual acuity less than 20/40), and 1.02 million were estimated to have legal blindness. Most of these individuals were elderly, as prevalence of vision loss increases with age. Vision loss impacts patient safety, independence, quality of life, and psychosocial well-being. Seniors with vision loss are at risk for falls, injuries, medication errors, nutritional decline, social isolation, and depression at far higher rates than are reported for sighted individuals.

Ophthalmologists should be aware of societal disparities that may have contributed to their patients' vision loss and that can present challenges to its management. For instance, if language differences prevent clear communication between the ophthalmologist and patient, the ophthalmologist should engage the help of an interpreter. If financial circumstances are a barrier to obtaining the services and technology that would allow the patient to improve their quality of life, the ophthalmologist can be ready with low-cost resources. Agencies, services, and technologies that can aid patients with vision rehabilitation are discussed throughout this chapter.

The ophthalmologist is in a unique position to support patients with vision loss by **"recognizing and responding"**: recognizing that vision loss, even moderate vision loss, impacts patients' ability to successfully accomplish the things they need and want to do, and responding by facilitating access to vision rehabilitation services. Appreciation of the strategies and options in the vision rehabilitation "toolbox" allows you to understand why referring patients to such services is important and beneficial and to provide specific examples to your patients of what vision rehabilitation can offer. In addition, your empathy in recognizing a patient's reaction to vision loss, whether it be fear, anger, or sadness, and conveying that you understand the connection of their emotion to their loss, can be a brief but important step in the continuum of care, from diagnosis to rehabilitation.

Any patient with eye disease that cannot be improved with medical or surgical treatment and who is not able to successfully accomplish necessary visual tasks is a candidate for vision rehabilitation. Rehabilitation can be very important even for patients with good acuity and eye disease that is associated with scotomata or with reduced contrast perception, such as patients receiving injections for exudative macular degeneration.

CLINICAL PEARL

The Academy's *Vision Rehabilitation Preferred Practice Pattern* Guidelines recommend that patients with acuity less than 20/40, contrast sensitivity loss, and peripheral or central field loss be referred for vision rehabilitation.

Patients whose only difficulty is reading fine print can usually be assisted by routine eye-care services; however, when vision impairment impacts activities beyond the ability to read fine print, the many practical options of vision rehabilitation are useful.

Vision rehabilitation begins with a low vision evaluation and is followed, as indicated, by training and referral to resources and specialized services. In contrast to an ophthalmic examination, in which visual function and ocular status are evaluated with the intent to diagnose and treat, vision rehabilitation aims to assess and address the whole person by considering five areas: reading and access to text, valued daily life activities, patient safety, continued participation in activities despite vision loss, and psychosocial well-being.

Low Vision Evaluation: History

Patients' Goals

Patients' goals and values help direct and prioritize rehabilitation efforts. Tasks may still be difficult after rehabilitation, but patients highly value success in accomplishing tasks that are important to them. The examiner should ask patients about difficulties with the following 5 areas and encourage them to describe their rehabilitation priorities.

- *Reading tasks,* such as reading newspapers, mail, books, and handwritten notes.
- *Daily life activities,* such as shopping, cooking, using a cell phone or computer, shaving, and watching television. What does the patient do for fun?
- *Safety,* for instance, falls, difficulty reading medications, and kitchen safety.
- *Barriers to participation,* including driving status, transportation alternatives, and isolation.
- *Well-being,* for instance, anxieties, including worry about visual hallucinations experienced; depressive symptoms; and concerns about responsibilities, such as financial or caregiving responsibilities.

Ocular History

The disease, rate of progression, and previous ocular treatments will typically correlate with the patient's functional concerns. For example, patients with macular degeneration would be anticipated to have reading difficulty, whereas a patient with glaucoma may have difficulty with ambulation, but be able to read.

General History

Current living arrangements, responsibilities, employment, hobbies, illnesses, and use of glasses, devices, cell phones, and computers are all relevant issues in the history. Systemic diseases can impact rehabilitation interventions, such as when arthritis or tremors impair a patient's ability to hold a book or magnifier. As in other areas of health care, social determinants of health such as living situation, education, income, social supports, health literacy, social inclusion, and access to services can impact an individual's ability to access rehabilitation.

Charles Bonnet Syndrome

Patients with Charles Bonnet syndrome see images of objects that are not real. The condition affects up to one-third of visually impaired persons. Patients are often relieved to discuss their hallucinations. They may see vivid, recurrent images of patterns, such as wallpaper or barbed wire, or images of people or landscapes. Many patients are puzzled by this symptom. Some are anxious, as they do not understand what they are experiencing, and a small proportion are very upset. Most patients will not report the hallucinations unless the clinician inquires, for fear of being labeled as mentally unwell.

CLINICAL PEARL

A diagnosis of Charles Bonnet syndrome can be made if the patient has 4 clinical characteristics: (1) vivid recurrent visual hallucinations; (2) some degree of vision loss; (3) insight into the unreality of the images, when it is explained to them; and (4) no other neurologic or psychiatric diagnosis to explain the hallucinations.

Charles Bonnet syndrome is a diagnosis of exclusion, and patients should be referred for neurologic or psychiatric evaluation if they have any other neurologic signs or symptoms (see BCSC Section 5, *Neuro-Ophthalmology*). Strategies such as eye movement, blinking, and increasing lighting or activity can decrease hallucinations for some patients.

Low Vision Evaluation: Assessment of Visual Function

Visual Acuity

Accurate visual acuity measurements can be made to very low levels. Charts can be brought to closer-than-standard viewing distances; for example, the ETDRS chart is commonly used at 1 or 2 m (Fig 10-1). For patients with very poor vision, the Berkeley Rudimentary Vision Assessment, a set of 25–cm^2 cards held at 25 cm, is available for quantifying visual acuity as low as 20/16,000.

Figure 10-1 Measuring visual acuity with the ETDRS chart at 1 meter. *(Courtesy of Scott E. Brodie, MD, PhD.)*

Refraction

The goal of refraction for patients with low vision is to check for significant uncorrected refractive errors; however, only about 10% of low vision patients will benefit from alternate refractive correction, as the source of their poor vision is typically ocular disease, not refractive error. The vision rehabilitation clinician must temper unreasonable expectations that patients may have, such as the expectation that new glasses can solve vision problems associated with the eye disease, and ensure that patients do not deplete their financial resources on spectacles that offer little benefit, especially when they could put that money toward other devices that significantly improve function. Purchase of new glasses is often best delayed until the patient can compare the benefit of other rehabilitation options and devices to the benefit of spectacles.

Specific strategies can assist low vision refraction, including using a trial frame, performing retinoscopy at a shorter distance with greater working-distance lens power, using a +1.00/−1.00 cross cylinder for patients with poorer acuity to allow them to appreciate the differences between choices, and using an automated refractor. The vision rehabilitation clinician should check for balance lens corrections in an eye that may now be the better-seeing eye. Full corrections, rather than balance lens corrections, are encouraged. Impact-resistant lens material can be considered for ocular safety.

Contrast Sensitivity

The ability to discern contrast is a visual function separate from visual acuity, and these functions are not directly correlated. Patients with poor contrast sensitivity have difficulty seeing the edges of steps, reading light-colored print, driving in foggy or snowy conditions, and recognizing faces. Contrast sensitivity varies with target size (spatial frequency), and the relationship between contrast threshold and spatial frequency may be displayed as a contrast sensitivity curve (see Chapter 3 in this volume). Formal tests of contrast sensitivity include paper charts and computer tests, the latter allowing greater testing range. Paper charts may test a range of spatial frequencies or a single spatial frequency (Fig 10-2).

Patients whose visual impairment includes loss of contrast sensitivity may benefit from illuminated magnifiers or electronic magnification; nonoptical strategies, such as task lighting; or modification of contrast in tasks, such as using a black felt-tip marker rather than a fine-point pen.

Central Visual Field

Traditional field testing with Goldmann or Humphrey perimeters maps the visual field relative to a central fixation point, which is located at the fovea in patients with normal central field. Patients with disease that affects central field, however, may fixate with eccentric areas of the retina, called preferred retinal loci (PRL) (Fig 10-3). Clues to understanding fixation behavior include head and eye movements, the patient's subjective reports, observation of fixation during ophthalmoscopy, and measured fixation with macular microperimetry, also called *fundus-related perimetry.*

The macular microperimeter monitors fundus location and then determines the patient's direction of gaze before each target is presented. Macular microperimetry documents the

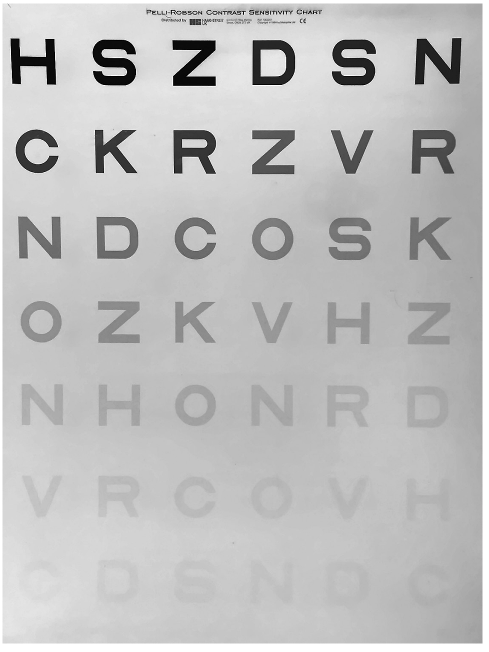

Figure 10-2 Pelli-Robson chart. Contrast of large Sloan letters decreases in groups of 3 from top to bottom and left to right within each line. *(Courtesy of Mary Lou Jackson, MD.)*

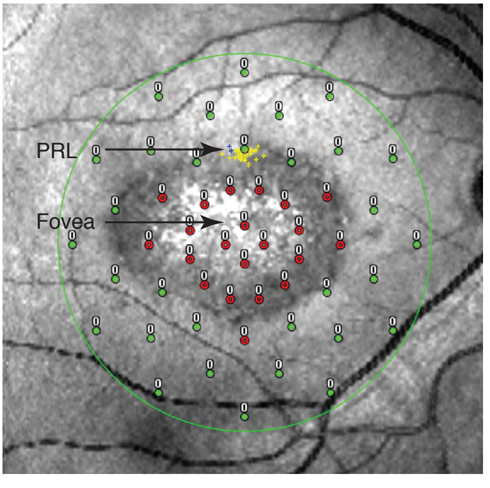

Figure 10-3 The patient has eccentric fixation and uses a preferred retinal locus (PRL) superior to the fovea. *(Courtesy of Mary Lou Jackson, MD.)*

patient's retinal point of fixation, identifies scotomata, and documents the relationship of the fixation to the scotomata. Other nonautomated testing methods, such as Amsler grids, cannot assess fixation and will not detect approximately half of central or paracentral scotomata due to perceptual completion, or "filling in" of visual field defects. Although most patients with central scotomata spontaneously develop eccentric fixation, they may have poor oculomotor control at the eccentric area or PRL. They may use multiple PRLs, change fixation depending on target size or illumination, or develop a sense of "straight ahead" related to their PRL rather than their fovea.

The vision rehabilitation clinician needs to appreciate the nature of the patient's fixation (foveal or eccentric), the presence and nature of scotomata (central or paracentral), and the relationship of fixation and scotoma. Scotomata can vary widely in size, shape, number, and density, and they may not correspond to the fundus appearance of atrophy, scarring, or pigment alteration. For example, a scotoma may be right of fixation and obscure next words, or be left of fixation and make it difficult to carry out an accurate saccade to the beginning of the next line of print. It is not uncommon that patients with macular disease have very small areas of foveal retina surrounded by dense scotomata, called foveal-sparing scotomata (Fig 10-4A). Such scotomata are seen in both dry and treated wet macular degeneration, Stargardt disease, and other macular diseases. Patients with foveal-sparing scotomata may be unable to read the larger letters on a visual acuity chart, causing the examiner to abandon the testing and record very low acuity. More careful testing, or testing at a closer distance, however, may reveal that the patients can in fact discern smaller letters when they are able to align the limited central field with the targets on the eye chart (Fig 10-4B). Scotomata that surround seeing retina may interfere with the recognition of large objects, fluent reading, or using magnification, depending on the size of the central seeing field.

Crossland MD, Culham LE, Kabanarou SA, Rubin GS. Preferred retinal locus development in patients with macular disease. *Ophthalmology*. 2005;112(9):1579–1585.

Crossland MD, Jackson ML, Seiple WH. Microperimetry: a review of fundus related perimetry. *Optom Rep*. 2012;2:11–15.

Peripheral Visual Field

Peripheral visual field defects cause patients to bump into objects or people, trip over objects and curbs, and lose their orientation, particularly in unfamiliar areas. Goldmann fields, automated peripheral fields, and carefully conducted confrontational fields can be informative in the setting of patients with glaucoma, peripheral retinal disease, or optic nerve or neurologic disease that affects visual pathways.

Assessment of Other Visual Functions

Glare, color vision (discussed in BCSC Section 5, *Neuro-Ophthalmology* and in Section 12, *Retina and Vitreous*), binocularity, eye movements, and accommodation (see BCSC Section 6, *Pediatric Ophthalmology and Strabismus*) may be considered in some situations. Patients may describe discomfort from glare or impairment of vision caused by scattered light (mainly Mie-type scattering in the forward direction; see Chapter 2). Patients with reduced contrast sensitivity often require increased illumination, which may, in turn, exacerbate glare, necessitating a balance between lighting recommendations and glare management strategies.

As in ophthalmology in general, visual acuity is an important and common measure of visual function in vision rehabilitation; however, other measures of visual function are also important and in vision rehabilitation can be equally important. As Figures 10-5, 10-6, and 10-7 illustrate, there is a range of visual function not only for visual acuity, but

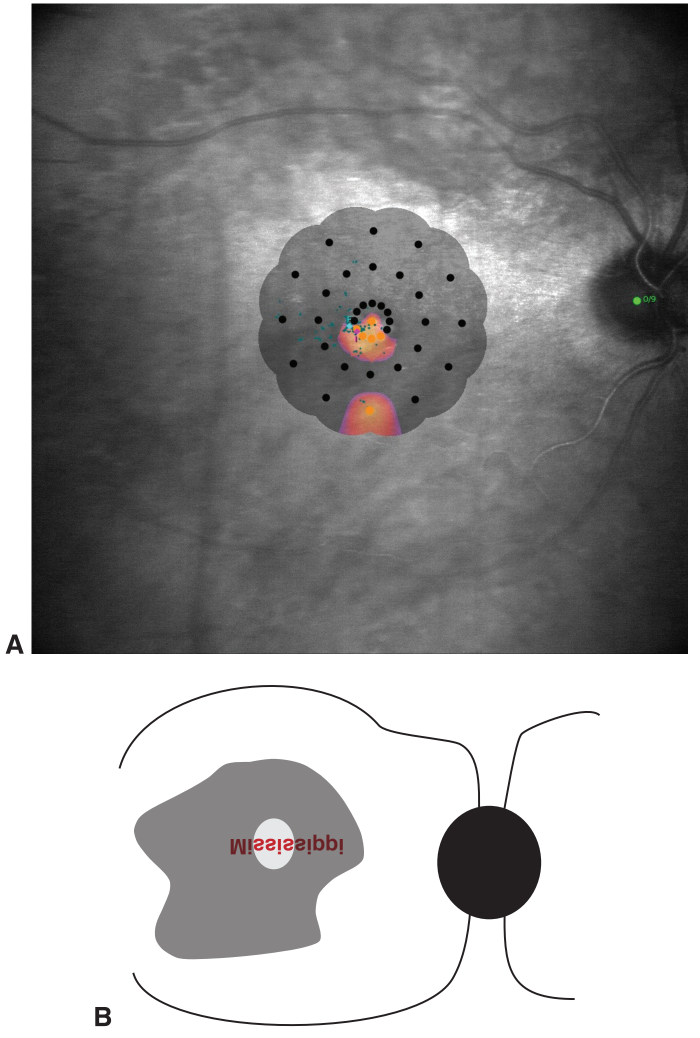

Figure 10-4 Foveal-sparing scotoma. **A,** Fixation is in an area of remaining central field that extends only a few degrees and is surrounded by a dense paracentral scotoma. **B,** Effect of a foveal-sparing scotoma on visualization of text. *(Part A courtesy of Mary Lou Jackson, MD, and part B courtesy of Mary Lou Jackson, MD, and the American Academy of Ophthalmology/Vision Rehabilitation Committee.)*

also for contrast sensitivity and for visual field, both central and peripheral. A composite of visual function, together with patient variables and goals, determines the most effective rehabilitation strategies for that patient.

Performance of Visual Tasks

A practitioner can assess patients' current success with visual tasks by observing them doing such things as reading, using their cell phone or computer, writing, or ambulating. Difficulties, successes, and adaptive strategies may be apparent. Reading tests vary and

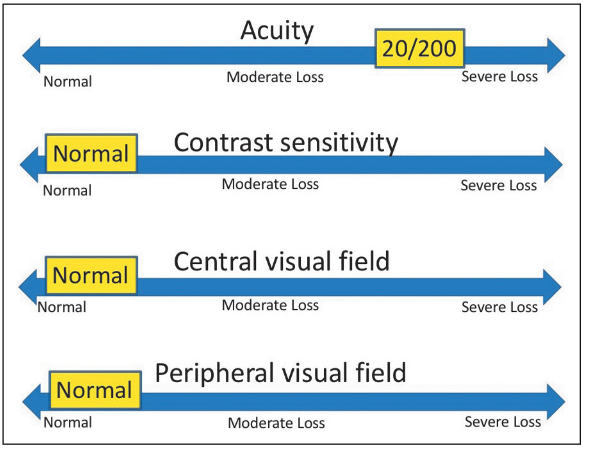

Figure 10-5 Test results of a 65-year-old patient diagnosed to have albinism. This patient has poor visual acuity and will benefit from magnification. Given the excellent contrast sensitivity and central visual field, optical magnification will likely be very successful. The patient is entitled to legal blindness concessions. *(Courtesy of Mary Lou Jackson, MD.)*

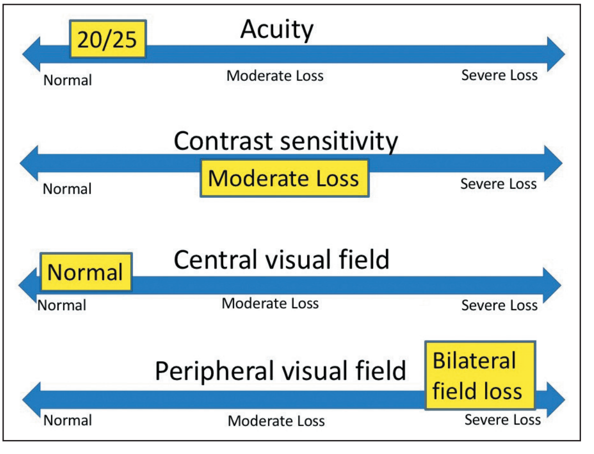

Figure 10-6 Test results of a 65-year-old patient diagnosed to have moderately severe glaucoma. This patient has near-normal visual acuity and moderate loss of contrast sensitivity, but significant loss of bilateral peripheral visual field. He is not legally able to drive and will benefit from orientation and mobility training with a white cane to ambulate safely, particularly in unfamiliar settings. He does not require magnification and can read fluently with a moderate increase in reading add. *(Courtesy of Mary Lou Jackson, MD.)*

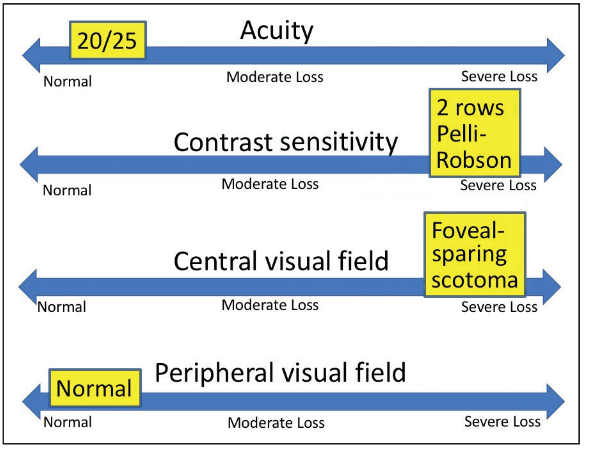

Figure 10-7 Test results of a 65-year-old patient diagnosed to have macular degeneration. This patient has near-normal visual acuity and both significant loss of contrast sensitivity and dense encircling paracentral field loss in the better-seeing eye. He can spot-read and use minimal magnification, but cannot read continuous print fluently due to the limited horizontal span around the fovea. He will benefit from reading with audio books, addressing contrast and lighting in daily tasks such as cooking, and applying fall-prevention strategies. Seeing faces, using a computer, or driving a car may be impacted by the encircling foveal-sparing scotoma. Given the normal peripheral visual field, he does not report difficulty with ambulation. *(Courtesy of Mary Lou Jackson, MD.)*

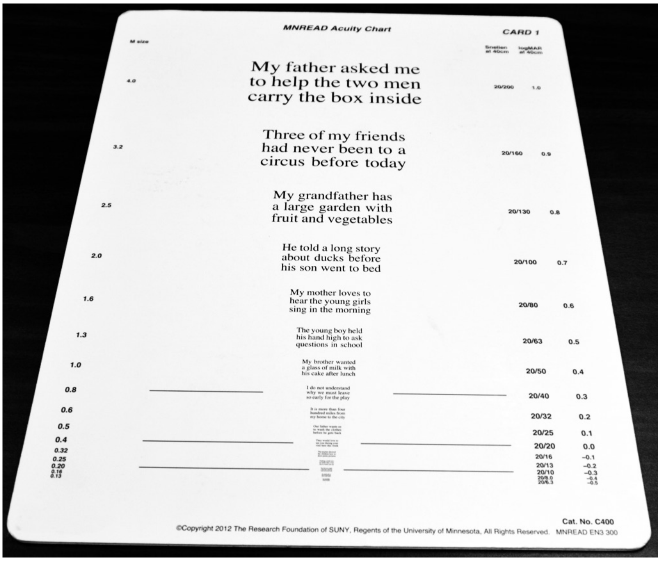

Figure 10-8 The Minnesota Low-Vision Reading Test has a range of text sizes. Patients with a limited area of central seeing retina may have difficulty reading the larger text, yet find it easier to read smaller text. *(Courtesy of Mary Lou Jackson, MD.)*

include tests to assess reading single numbers or words (spot reading), paragraphs (continuous print reading; eg, the International Reading Speed Texts [iReST]), or sentences with decreasing size of text (eg, the Minnesota Low-Vision Reading Test [MNREAD], Fig 10-8). Useful variables include the minimum size of print that can be read with the patient's current glasses or devices (reading acuity), reading errors, and the optimal size text for reading fluency (critical print size). The last variable can inform magnification goals. It is important to note that because different powers of reading add will change reading acuity, reading add power used should always be documented when near vision is measured.

Observing a patient ambulate provides valuable insight into the need for orientation and mobility training, white-cane or support-cane use, or scanning training.

Many different questionnaires have been used to elicit patient reports of difficulties with visual tasks.

Interventions

There is a wide range of vision rehabilitation interventions, including electronic devices, optical devices, nonoptical devices, practical alternate strategies to accomplish tasks, strategies to enhance safety (such as fall prevention strategies), and programs to support adjustment to vision loss, such as peer support groups.

Technology and Electronic Devices

Smartphones and tablets are now increasingly important as devices that allow patients with vision impairment not only to make phone calls, but also magnify text and images and use audio options to send texts, send emails, read books and newspapers, identify colors, read bar codes, navigate in unfamiliar areas, and search the internet. Cell phone cameras can be used to magnify. Smart speakers and virtual assistants also can be very useful for individuals with vision impairment. A variety of applications (Table 10-1) and devices (Table 10-2) are available.

Audio books, most often in Digital Accessible Information System (DAISY) format, are used widely by patients with vision loss and are available free through the Library of Congress in the United States, the Center for Equitable Library Access in Canada, and from online libraries such as Bookshare. These are extensive libraries. The Bookshare accessible library, for example, has more than 1 million titles that can be accessed via audio, by listening while seeing highlighted text, by using digital braille, and by converting standard text to large print or paper braille format.

A variety of video magnifier devices (Fig 10-9) combine cameras and screens to allow not only magnification, but also modification of contrast and color. Both electronic devices that are designed for individuals with low vision (such as video magnifiers) and electronic devices such as computers, tablets, and cell phones that have accessibility features are commonly used by patients with vision impairment. The major difficulties with electronic devices are cost and training requirements; however, in some jurisdictions, and for certain individuals, devices are provided gratis or at reduced cost. For example, devices are provided by some state societies and are also provided to veterans.

Optical Devices

High adds

Ophthalmologists are strongly encouraged to consider +4.00 adds or simple over-the-counter readers, such as +4.00 readers, as long as patients can learn to maintain the closer

Table 10-1 Examples of Smartphone Accessibility Features and Free Applications Used by Individuals With Vision Impairment

iOS operating system
- Siri for phone calls, texts, email, calendars, etc.
- Speak Screen and Speak Selection screen reading options
- VoiceOver screen reader in operating system
- Soundscape app (3D audio cues for navigation)
- Seeing AI app (reads printed text aloud; identifies handwriting, colors, currency, people, landscapes)

Android operating system
- TalkBack (spoken, audible and vibration feedback)
- Select to Speak (screen reading)
- iVision app (optical character recognition [OCR] reader)

Android and iOS operating systems
- Be My Eyes app (connects to volunteers by video call to identify objects and help with other tasks
- TapTapSee app (identifies objects)
- Libby app by Overdrive (plays ebooks and audio books from public libraries)
- Magnifier app with flashlight

Table 10-2 Technology Used by Individuals With Vision Impairment

Electronic Magnification Devices

Advantages
- Greatest range of magnification
- Excellent contrast, reverse contrast, different colors, and brightness
- Allows comfortable position and binocularity
- Can be portable
- Digital devices provide magnification for many tasks (email, internet searching, etc.)

Disadvantages
- Cost
- Must be charged
- Requires some training

Type	*Cost*
Portable video magnifiers	$400–$1,500
Desk video magnifiers	$1,500–$4,000
Head-worn video magnifiers	$3000–$8,000
Tablets, eReaders, computers, cell phones	$500–$4,000

Audio Devices

Advantages
- Allow fluent reading
- Access to more than 1 million books
- Audio books can be played on a device from library, cell phone, eReader, or computer
- Can be portable
- Text-to-speech function is part of many desk video magnifiers
- Audio can be used for texts, phone calls, email, searching the internet, home control, etc.

Disadvantages
- May require practice to become comfortable with synthetic voice
- Devices require training
- May require internet

Type	*Cost*
Audio books	free from public library or subscription
Audio book players	loaned–$500
Smartphone with apps	variable cost of phones
Text-to-speech in video magnifiers	$3,000–$4,000
Text-to-speech apps	free–$125
Head-worn text-to-speech	$5,000–$7,000
Smart speakers (eg, Echo, Google Home)	$50–$300

focal distance and use supplemental lighting if beneficial. This can be recommended prior to referral for comprehensive vision rehabilitation. Patients will often use readers in powers from +6.00 D to +12.00 D with appropriate base-in prism and focal distance.

CLINICAL PEARL

A +10.00 D reading add will require a reading distance at the focal point of the lens, which will be 1/10 m (ie, 10 cm, or 4 in).

Figure 10-9 Portable handheld video magnifiers. *(Courtesy of Mary Lou Jackson, MD.)*

CLINICAL PEARL

In binocular patients, prism is required to assist convergence and relax accommodation. The recommended prism strength is 2 prism diopters (Δ) more base-in (BI) than the numerical add power, in each eye. For example, if the distance prescription is plano OU and the appropriate add power for reading is +8.00 D, then the prescription should read as follows: OD: +8.00 sphere with 10Δ BI; OS: +8.00 sphere with 10Δ BI. Prism is not required in adds up to +4.00 D.

Historically an add was calculated as the inverse of the visual acuity (Kestenbaum rule: the inverse of the visual acuity fraction is the add power, in diopters, to read 1M type—about 8 points, corresponding to the 20/50 line on a standard near-vision card calibrated for use at 14 inches), and this calculation may provide a general starting point. However, it is now appreciated that many other factors also influence reading fluency, such as fixation location, scotomata, perceptual span, crowding, and contrast sensitivity. The Kestenbaum rule would estimate that a patient with 20/200 acuity would require 200/20, or 10.00 D of add. For fluent reading, patients with 20/200 acuity may actually require a higher add than calculated.

Computer glasses with the intermediate power in the upper segment of the bifocal can be useful.

Magnifiers

A wide range of optical magnifiers are available with and without illumination (Fig 10-10 and Table 10-3). There are 2 methods of calculating the magnification of magnifiers, which can lead to confusion. Simple or nominal magnification is defined as the dioptric power

Figure 10-10 Handheld and stand magnifiers. *(Courtesy of Mary Lou Jackson, MD.)*

divided by 4 and assumes that the object is held at the anterior focal point of the magnifier. For example, the power of a +24.00 D magnifier is 6× (24.00 D / 4.00 D). Commercially available magnifiers are often labeled with a "trade magnification" power calculated as (the diopter power of the hand magnifier)/4 + 1, so the trade magnification of +4.00 D handheld lens is 2×. In practical settings, the amount of magnification depends on the dioptric power and how the lens is used. (Magnification is discussed in Chapter 1).

Telescopes

There are 2 types of telescopes: astronomical (also called Keplerian) telescopes and Galilean telescopes. (Optics of telescopes are discussed in Chapter 1). Telescopes are much less commonly used than magnifiers due to their various limitations (Table 10-3) and also because tasks that require magnification for distance viewing are less common than those that require magnification for near viewing (Fig 10-11).

Bioptic telescopes are spectacle-mounted telescopes set to focus at distance; they are mounted in the upper portion of the spectacle lens. In some states drivers can use a bioptic to briefly read signs or look into the distance. The rest of the time, the individual drives while looking through the regular prescription portion of their spectacles. Driving with a bioptic telescope requires prescription of the device as well as device training, driver training, and, in some states, on-road evaluation. Patients with good contrast sensitivity and intact central field are optimal candidates for bioptic driving.

CLINICAL PEARL

State-by-state driving licensing requirement including vision requirements and status for bioptic driving is outlined in the Physician's Guide to Assessing and Counseling Older Drivers, which can be accessed at: https://www.nhtsa.gov/sites/nhtsa.gov/files/812228_cliniciansguidetoolderdrivers.pdf

Table 10-3 Optical Devices Used by Individuals With Vision Impairment

High-Add Readers

Advantages
- Glasses are a familiar device format
- Allow a wide field of view
- Leave hands free
- Portable

Disadvantage
- Closer focal distance, depending on power

Type	*Cost*
Readers without prism, +4.00 D to +6.00 D	\$20–\$50
Readers with prism, +6.00 D to +14.00 D	\$125–\$200
Monocular aspheric, +6.00 D to +32.00 D (used less often)	\$150–\$200

Handheld Optical Magnifiers

Advantages
- Available with and without illumination
- Low-powered (5.00 D to 12.00 D) version with light-emitting-diode illumination is popular
- Easy to carry
- Ideal for brief spot reading, such as checking prices
- Can be used by some for continuous print reading, ideally with the material on a reading stand

Disadvantages
- Have to be held steady and moved along line of text
- Limited field of view; with power higher than 20.00 D, the field of view is very limited

Type	*Cost*
Handheld, 6.00 D to 32.00 D	\$30–\$150 (LED illuminated frequently used)
Pocket magnifiers, 10.00 D to 20.00 D	\$20–\$100 (frequently used device)

Stand Optical Magnifiers

Advantages
- Magnifier sits on page, eliminating the need to hold it at the proper distance
- Available with and without illumination
- Useful for individuals with a tremor
- Best used with a reading stand and a reading add
- Some types allow writing under the magnifier

Disadvantages
- Higher-power magnifiers are less comfortable for extended print reading, such as reading books
- Larger and less portable
- Often require reading stand to preserve posture

Types	*Cost*
Stand, 8.00 D to 40.00 D	\$40–\$200
Dome, 4.00 D to 20.00 D	\$30–\$250

Table 10-3 *(continued)*

Other Hands-Free Optical Magnifiers

Advantage
- Allow distance from the magnifier to the hands (for writing, sewing, etc.)

Disadvantages
- Distance of object must be maintained
- Easiest to use in lower powers
- Best for stationary tasks

Type	*Cost*
Magnifier on a flexible stand, 3.00 D to 16.00 D	\$75–\$150
Around-the-neck craft magnifier, 4.00 D to 8.00 D	\$50–\$75
Head-worn magnifying visor, 3.00 D to 20.00 D	\$100–\$125

Telescopes

Advantages
- Available for magnification at distance or near focus
- Hands-free
- Close-focus telescopes (loupes) have greater working distance than high-adds
- Astronomical telescopes have a greater focusing range and better image quality
- Galilean telescopes have a wider field of view and are smaller and lighter

Disadvantages
- Reduced field of view
- Decreased contrast
- Narrow depth of field

Type	*Cost*
Handheld monoculars	\$40–\$350
Handheld binoculars	\$50–\$500
Spectacle-mounted, bioptic	\$400–\$3000
Simple telescopic spectacle without casing	\$200–\$250 (frequently used device)

A

B


Figures 10-11 Telescopic devices. **A,** The range of telescopic devices includes monocular and binocular telescopes. **B,** This binocular spectacle telescope is lightweight and can be used for stationary distance viewing such as watching television. *(Courtesy of Mary Lou Jackson, MD.)*

Nonoptical Aids and Alternative Strategies

An armamentarium of tools is available to assist patients with impaired vision, and it extends beyond electronic, optical, and audio devices. Simple, practical devices include large-format watches, telephones, remote controls, playing cards, and checks. Bold-lettered computer keyboards, needle threaders, dark-lined writing paper, felt-tip pens with black ink, and talking clocks, scales, and timers are a partial list of items that are often useful. Vision rehabilitation often includes learning new ways to address patients' goals with technology, optical devices, nonoptical devices, or new strategies (Table 10-4).

Sight Substitution

Patients with very limited or no vision, particularly those who lose vision quickly, will require blind rehabilitation with sight substitutes that may include electronic text-to-speech or braille. Refreshable braille displays can be connected to computers and tablet devices. They have small, moving pins that rise or lower to create braille patterns that can be read tactilely. Short-term residential blind rehabilitation services, available in some areas, can be of great benefit to patients faced with the daunting task of adjusting to sudden and profound loss of vision. Prosthetic visual devices are being developed, and many groups around the world are developing subretinal, suprachoroidal, and epiretinal devices, in addition to cortical visual prostheses that stimulate the brain directly. Currently, devices allow patients to see direction of motion or contrast.

Training

After the low vision evaluation and creation of a vision rehabilitation plan for interventions, patients should be trained to accomplish tasks with modifications and to use appropriate devices. Medicare and some other health insurers in the US fund occupational therapists to train patients, just as rehabilitation is provided for patients with other disabilities, such as neurological and orthopedic conditions. Occupational therapists, or other state- or privately funded vision rehabilitation therapists or technology specialists, can assess home safety, modify lighting, provide labels for appliances and dials, assist with strategies to manage glare, and instruct patients in accessibility features with computers,

Table 10-4 Examples of How Interventions Can Address Patient Goals

Patient Goals	Technology	Optical	Nonoptical/Strategies
Reading	Audio books played on a smart phone	Hand magnifier for spot reading	Large-print books
Daily Life Tasks	Smartphone Seeing AI app to read prices aloud	Pocket magnifier to read labels	Large-format playing cards
Safety	Audio medication labels	High-plus readers leaving hands free to check insulin dosage	Fall prevention
Participation	Smartphone GPS to independently navigate	Telescope to see numbers	Alternative transportation services
Well-being	Attending support groups virtually		In-person peer support groups

tablets, and cell phones. Physical, cognitive, psychosocial, and environmental factors that may impact performance must be considered. Although eccentric fixation will develop spontaneously in patients with central field loss, training may improve the efficiency of using eccentric fixation. Current research is evaluating perceptual training, oculomotor training, and training a new direction of fixation (trained retinal locus). A large-sample, randomized, placebo-controlled, double-masked trial comparing prisms for assisting eccentric viewing in maculopathy showed no significant benefit.

Gaffney AJ, Margrain TH, Bunce CV, Binns AM. How effective is eccentric viewing training? A systematic literature review. *Ophthalmic Physiol Optics*. 2014;34(4):427–437.

Pijnacker J, Verstraten P, van Damme W, Vandermeulen J, Steenbergen B. Rehabilitation of reading in older individuals with macular degeneration: a review of effective training programs. *Neuropsychol Dev Cogn B Aging Neuropsychol Cogn*. 2011;18(6):708–732.

Smith HJ, Dickinson CM, Cacho I, Reeves BC, Harper RA. A randomized controlled trial to determine the effectiveness of prism spectacles for patients with age-related macular degeneration. *Arch Ophthalmol*. 2005;123(8):1042–1050.

Vision Rehabilitation for Field Loss

Scanning training, sector prisms to displace images to the seeing field, and vision restoration with computer training are rehabilitation strategies proposed for patients with hemianopia. A comparative trial of scanning and prisms showed improvement in vision-related quality of life with scanning training and very common adverse events (typically headaches) with prisms. Scanning training may also be provided for patients with field loss from disease such as retinitis pigmentosa. Orientation and mobility specialists provide training in using white canes and strategies to ambulate safely.

Rowe FJ, Conroy EJ, Bedson E, et al. A pilot randomized controlled trial comparing effectiveness of prism glasses, visual search training and standard care in hemianopia. *Acta Neurol Scand*. 2017;136(4)310–321.

Trauzettel-Klosinski S. Rehabilitation for visual disorders. *J Neuroophthalmol*. 2010;30(1): 73–84.

Discussion With Patients

Often physicians must communicate information to patients with low vision that patients will perceive as "bad news," such as that they are not able to drive or that their vision will not improve. Communication techniques have been conceptualized in different communication models (Fig 10-12); however, keys to delivering bad news include allowing sufficient time for the discussion, acknowledging patient emotions, and conveying that the physician appreciates that the emotions are connected to the negative news. The *Guide to Assessing and Counseling Older Drivers* is an informative resource and includes a chapter about counseling patients who can no longer drive.

American Geriatrics Society. Pomidor A, ed. *Clinician's Guide to Assessing and Counseling Older Drivers*. 3rd ed. (Report No. DOT HS 812 228). National Highway Traffic Safety Administration; 2016.

The SPIKES Health Care Communication Model

S—*Setting:* The clinician is seated, appears comfortable, and does not interrupt when the patient speaks.

P—*Perception:* "What have you been told about your driving up to now?"

I—*Invitation:* "How much detail would you like to know about the licensing requirements?"

K—*Knowledge:* "Today I do need to discuss your driving with you." (Warning shot)

E—*Empathy:* "Hearing that you do not meet the licensing requirements is clearly a major shock to you. I wish the news were better."

(The patient cries, and the clinician pauses and looks away.) "I see that this news upsets you. Let's just take a break now until you're ready to start again."

S—*Strategy and summary:* "So the summary of all this is that your vision does not meet the requirements to maintain a valid driver's license, and, unfortunately, you will now not be able to drive. Is that your understanding?"

A

The Four Es Model of health care communication

Engagement: "Would you like to take your coat off? We talked about your vision and the diagnosis of age-related macular degeneration in your last visit. Is there anything else you were wondering about?"

Empathy: "It is tough to have to think about alternate ways to get around if you cannot drive the way you used to."

Education: "What would you like to know about licensing requirements and vision standards?"

Enlistment: "I believe we have common ground here, since neither of us wants you to be involved in an accident. We both want to keep you driving safely as long as possible and make the decision not to drive at the right time."

B

Figure 10-12 Communication models. **A,** The SPIKES Healthcare Model of Communication was authored by Robert Buchman. **B,** The Four-E Model of Health Care Communication was developed by the Institute for Healthcare Communication. *(Part B from Buchman R. Breaking bad news: the S-P-I-K-E-S strategy.* Community Oncology. *2005;2:138–142.)*

Other Services

Many other agencies and services are involved in multidisciplinary vision rehabilitation, including optometric practices, state services, services for veterans, driving-rehabilitation services, talking-book libraries, transportation services, counseling, and support groups. Orientation and mobility training is offered by some agencies to provide instruction in using visual cues, telescopes, white canes, and GPS devices for safe and independent ambulation. Vision loss also affects the patient's spouse and family. Referral to psychological counseling and support groups may be part of the rehabilitation team's approach to helping patients and their families cope and adapt. The goal of multidisciplinary vision rehabilitation is collaboration among services to best address patients' goals and achieve optimal clinical outcomes.

Binns AM, Bunce C, Dickinson C, et al. How effective is low vision service provision? A systematic review. *Surv Ophthalmol.* 2012;57(1):34–65.

Owsley C, McGwin G Jr, Lee PP, Wasserman N, Searcey K. Characteristics of low-vision rehabilitation services in the United States. *Arch Ophthalmol.* 2009;127(5):681–689.

Pediatric Vision Rehabilitation

Although vision loss is less frequent in the pediatric population, this cohort is an important group that requires the ophthalmologist's attention. Every child with loss of vision needs to be recognized, and the ophthalmologist's response should include recommending vision rehabilitation. Most adults with low vision have lost vision because of an ocular disease incurred later in life. Thus, they have already acquired many of the vision-aided skills (eg, reading, understanding social cues, cooking, self-care tasks) that are important for functioning in society. Children with low vision, however, need to learn these skills despite poor or no vision.

The most prevalent causes of visual impairment in children in the US are cortical visual impairment, retinopathy of prematurity, optic nerve hypoplasia, albinism, optic atrophy, and congenital infections. Many of these children have coexisting physical and/or cognitive disabilities that create further challenges to successful integration into society.

Resources

Materials for Patients

The American Academy of Ophthalmology's vision rehabilitation patient handout is available for download (at www.aao.org/low-vision-and-vision-rehab). It provides essential tips for making the most of remaining vision and offers a list of resources, including a website that allows patients to search for services in their communities.

Materials for Ophthalmologists

- *BCSC Section 6: Pediatric Ophthalmology and Strabismus*
- American Academy of Ophthalmology. Vision Rehabilitation Committee. Preferred Practice Pattern Guidelines. *Vision Rehabilitation.* American Academy of Ophthalmology; 2017. Accessed December 7, 2021. https://www.aao.org/preferred-practice-pattern/vision-rehabilitation-ppp-2017
- American Academy of Ophthalmology. Vision rehabilitation web page updated with information about vision rehabilitation initiatives and education. Accessed December 7, 2021. www.aao.org/low-vision-and-vision-rehab
- Mishra A, Jackson ML, Mogk, LG. Comprehensive vision rehabilitation. *Focal Points: Clinical Practice Perspectives.* American Academy of Ophthalmology; 2017, module 4.

Chapter Exercises

Questions

9.1. What level of visual function is considered "legal blindness"?
   a. cannot read any letters on the 20/100 line of an ETDRS acuity chart
   b. best-corrected visual acuity 20/70
   c. visual field extending 30° around fixation
   d. hemianopic visual field

9.2. What is the optimal prescription for a patient who requires +8.00 reading add?
   a. +8.00 OU with 10 prism diopters (Δ) base-in OU
   b. OD +8.00 with 8Δ base in; OS +8.00 with 8Δ base in
   c. +8.00 OU with 8Δ OU
   d. +8.00 OU with 10Δ OD

9.3. The American Academy of Ophthalmology's Preferred Practice Pattern Guidelines regarding vision rehabilitation recommend referral to low vision consultation at what level of visual function?
   a. only when patients become legally blind
   b. when a patient's acuity is less than 20/40 or the patient has reduced contrast sensitivity, field loss, or a scotoma
   c. only if the patient asks for referral to vision rehabilitation
   d. when a patient cannot read fine print

Answers

9.1. **a.** Legal blindness is defined in the United States as visual acuity less than or equal to best-corrected visual acuity of 20/200 (ie, if evaluated with a chart such as an ETDRS chart, a person cannot read any of the letters on the 20/100 line) or a visual field of equal to or less than 20 degrees around central fixation. (See https://www.ssa.gov/disability/professionals/bluebook/2.00-SpecialSensesandSpeech-Adult.htm)

9.2. **a.** A guideline for adding prism to high-add spectacles over 4.00 D is to incorporate base-in prism for each eye at a correction that is 2.00 D greater than the required add power.

9.3. **b.** The American Academy of Ophthalmology's Preferred Practice Pattern Guidelines regarding vision rehabilitation recommend that patients with acuity less than 20/40, contrast sensitivity loss, peripheral field loss, or central field loss be referred for low vision evaluation.