OPTOMETRIC CLINICAL PRACTICE GUIDELINE

CARE OF THE PATIENT WITH LOW VISION

Reference Guide for Clinicians

Prepared by the American Optometric Association Consensus Panel on Care of the Patient with Low Vision:

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NOTE: Clinicians should not rely on this Clinical Guideline alone for patient care and management. Refer to the listed references and other sources for a more detailed analysis and discussion of research and patient care information. The information in the Guideline is current as of the date of publication. It will be reviewed periodically and revised as needed.

INTRODUCTION

Optometrists, through their clinical education, training, experience, and broad geographic distribution, have the means to provide effective primary eye and vision care services, including vision rehabilitation services, to children and adults in the United States.

This Optometric Clinical Practice Guideline for Care of the Patient with Low Vision describes appropriate examination and treatment procedures for evaluation of the visual abilities and eye health of people with visual impairments. It contains recommendations for timely diagnosis, management, and, when needed, referral for consultation with or treatment by another health care provider or rehabilitation professional. This Guideline will assist optometrists in achieving the following goals:

- Identify patients with visual impairment who might benefit from low vision care and rehabilitation
- Evaluate visual functioning of a compromised visual system effectively
- Emphasize the need for comprehensive assessment of patients with impaired vision and referral to and interaction with other appropriate professionals
- Maintain and improve the quality of care rendered to visually impaired patients
- Inform and educate other health care practitioners and the lay public regarding the availability of vision rehabilitation services
- Increase access to low vision care and rehabilitation for patients with visual impairment, thereby improving their quality of life.

I. STATEMENT OF THE PROBLEM

Visual impairment is defined as a functional limitation of the eye(s) or visual system[1] manifesting as reduced visual acuity or contrast sensitivity, visual field loss, photophobia, diplopia, visual distortion, visual perceptual difficulties, or any combination of the above. These functional limitations can result from congenital (e.g., prenatal or postnatal trauma, genetic or developmental abnormalities), hereditary (e.g., retinitis pigmentosa or Stargardt's macular degeneration), or acquired conditions (e.g., ocular infection or disease, trauma, age-related changes, or systemic disease). A visual impairment can cause disability by significantly interfering with one's ability to function independently, to perform activities of daily living, and to travel safely through the environment. Specific problems include, but are not limited to, loss of ability to read standard-sized print, inability or limitation with respect to driving, difficulty performing work-related tasks, and inability to recognize faces of familiar people. These disabilities can, in turn, limit both personal and socioeconomic independence.

An impairment of the visual system present at birth, or developing shortly thereafter, can adversely affect development.[2] Visually impaired children are often developmentally delayed in the areas of gross and fine motor skills and perception.[3] For students, the inability to read standard-sized print, to see the chalkboard, overhead projection, or computer screen, or to discriminate color can have a significant impact on their educational development. Parents, caretakers, and educators need information regarding the student's visual abilities, as well as how to maximize use of remaining vision, and strategies to modify the environment or task to minimize the negative effect of the visual impairment on performance.

Visually impaired adults are concerned with securing and maintaining employment, productivity, and independence, as well as maintaining a home and fulfilling family and social obligations.[4] Older adults who have new visual impairment face a significant challenge at a time when they may also be experiencing other major life changes, such as general health limitations or loss of spouse.[5,6] Loss of independence and the ability to enjoy leisure activities are predominant concerns of the visually impaired population. The significant negative impact of visual impairment on the well-being and quality of life of individuals of all ages can, in many cases, be lessened by appropriate optometric low vision intervention.[7]

It is estimated that there are 13.5 million visually impaired persons over the age of 45 in the United States,[8] and, as Americans age, the numbers of those with visual impairment are projected to increase dramatically over the next 20 years.[9] The number of Americans over the age of 65 will more than double over the next 50 years, from 33.2 million in 1994 to 80 million in 2050.[10] Because the most frequent causes of low vision are age related, the aging trend can be expected to increase the number of visually impaired adults substantially.

A. Description and Classification of Visual Impairment

The term "visual impairment" refers to a functional limitation of the eye(s) or visual system[1] that can result in a visual disability or a visual handicap. A visual disability is a limitation of the abilities of the individual, and a visual handicap refers to a limitation of personal and socioeconomic independence. Visual impairment may be considered as vision inadequate for an individual's needs.

The definitions and classification of the levels of visual impairment and legal blindness vary (Table I). The World Health Organization (WHO) defines blindness as profound impairment (i.e., blindness of one eye or blindness of the individual). In the United States, legal blindness is defined as severe impairment (i.e., blindness of the individual).[1] The ICD-9-CM classification of visual impairment is presented in Appendix Figure 3.

Insert Table 1 Here

The Social Security Administration defines legal blindness as:[11]

> Remaining vision in the better eye after best correction is 20/200 or less OR contraction of the peripheral visual fields in the better eye (A) to 10 degrees or less from the point of fixation; or (B) so the widest diameter subtends an angle no greater than 20 degrees.

It is further specified that the measurement of visual field must be made with "usual perimetric devices" (Goldmann perimetry or equivalent using a III4e target for phakic eyes or a IV4e target for aphakic eyes); tangent screen or threshold automated visual fields are not acceptable. This definition of legal blindness was legislated in 1935 and is felt by many to be inadequate and outdated.[12-14]

The existing classifications do not consider loss of function due to hemianopia, loss of contrast sensitivity, photophobia, visual distortion, diplopia, or visual perceptual difficulties. A classification system that considers the functional loss of the patient, rather than simply visual acuity or field loss, has been recommended.[15,16] Many visually impaired individuals do not meet the current criteria for legal blindness and thus are not entitled to benefits and services that would seem appropriate.[12]

One approach is to use functional terms to classify the type of visual impairment with respect to the presence of a visual field defect.[17] This approach is a useful way to think of the types of problems the patient may encounter:

l. No visual field defect, but a loss of resolution or contrast throughout the entire visual field; general haze or glare
2. Central visual field defect
3. Peripheral visual field defect.

There can be a loss of visual acuity or contrast sensitivity and increased disabling glare without a visual field defect.[17] Central or peripheral visual field defects can be absolute (i.e., vision is entirely absent within the field defect) or relative (i.e., area of depressed sensitivity); they may have characteristics of both. Generally, central visual field defects tend to affect discrimination and near vision more than mobility, while peripheral visual field defects affect mobility more than near vision. With some conditions (e.g., cone-rod degeneration or treated diabetic retinopathy), both central and peripheral visual field defects may be present.

B. Epidemiology of Visual Impairment

I. Prevalence and Incidence

The Lighthouse National Survey on Vision Loss shows that one in six adults (17%) age 45 and older has some form of visual impairment.[8] Of the more than 13 million Americans with visual impairment, it is estimated that more than half are severely visually impaired, including 120,000 who are considered totally blind or who have light perception only.[8] The incidence of visual impairment increases with age; more than two-thirds of persons with low vision are over the age of 65,[9] although the number of visually impaired school-age children and young adults is significant.

2. Risk Factors

The factors that place a patient at risk for visual impairment are numerous and are related not only to ocular diseases and abnormalities but also to trauma and systemic health conditions. The most common causes of visual impairment in the adult population are:[9]

- Age-related macular degeneration (45% of the low vision population)
- Cataract
- Glaucoma
- Diabetic retinopathy.

The incidence of these conditions increases with age. Concurrent with the increase in the average age of Americans, growth in the number of persons with severe visual impairments is expected. Medical advances that increase the survival of infants and adults with severe health problems will also contribute to the rising numbers of persons with severe visual defects. The increasing incidence and survival of persons with traumatic brain injuries further add to the numbers of visually impaired persons in need of appropriate rehabilitation. The causes of visual impairment are numerous, including not only congenital and acquired ocular conditions, but systemic diseases with ocular complications and neurological insult and trauma. Some of the more commonly encountered causes are listed in Table 2.

Insert Table 2 Here

C. Goals of Comprehensive Low Vision Care

Many causes of severe visual impairment cannot be medically or surgically cured, although there are conditions for which medical or surgical treatment will lessen the severity or progression of the vision loss. For patients with most conditions, however, appropriate optical, non-optical, or electronic prescriptions, and training, instruction, or therapies* designed to enhance sight and improve efficiency offer some level or form of remediation. Psychological counseling to improve the person's ability to cope with vision loss may also improve the functional resolution of vision loss.

* For the purposes of this Guideline, low vision instruction, low vision training, low vision therapy, vision rehabilitation therapy, and vision rehabilitation training are synonymous.

The goals of comprehensive low vision care are:

- To evaluate the functional status of the eyes and visual system
- To assess ocular health and related systemic health conditions and the impact of disease or abnormal conditions on visual functioning
- To provide appropriate optometric low vision intervention to improve the patient's visual functioning, taking into account the patient's special vision demands, needs, and adjustment to vision loss
- To counsel and educate patients regarding their visual impairment and ocular and related systemic health status, including recommendations for treatment, management, and future care
- To provide appropriate referral for services that are outside the expertise of the low vision clinician.

II. CARE PROCESS

This Guideline describes the optometric examination and care provided to a patient with a visual impairment. The components of patient care described are not intended to be all inclusive because professional judgment and individual patient symptoms and circumstances may significantly impact the nature, extent, and course of the services provided. Some components of care may be delegated; however, the optometrist should maintain overall management and decision-making responsibility.

A. Diagnosis of Visual Impairment

The comprehensive low vision examination may include, but is not limited to, the following procedures, which may be adapted or modified to accommodate different levels of visual functioning (see Appendix Figure 2).

I. Patient History

Most information regarding the history can be obtained from the patient, if able. It is also helpful to seek input from family members, other health care providers or therapists, teachers, rehabilitation counselors, or other persons who might provide information helpful to the clinician, as is appropriate and permitted by the patient. This information should include the nature and duration of the presenting problem, including diagnosis, visual difficulties, and chief complaint; visual and ocular history, including family ocular history; general health history, pertinent review of systems, and family medical history; medication usage and medication allergies; social history; and vocational, educational, and avocational vision requirements (i.e., needs assessment).

Table 3 contains specific areas of concern to be elicited from the patient history.[18,19] Comprehensive discussion of these areas is needed to adequately establish the patient's current status.

Insert Table 3

2. Ocular Examination

Examination of the visually impaired patient generally includes all areas of a comprehensive adult or pediatric eye and vision examination,* as the clinician deems necessary or appropriate, with additional evaluation specific to the visual impairment. The examination is conducted to determine the physical causes of the impairment and to quantify the remaining visual abilities for the purpose of determining a rehabilitation plan.[20]

The optometric low vision examination, which is tailored for each patient, depends upon not only the disease process responsible for the visual impairment but the chronological and developmental age of the patient, the patient's specific visual abilities and identified needs, and the optometrist's clinical judgment. The examination may include, but is not limited to, the following procedures:

* Refer to the Optometric Clinical Practice Guideline on Comprehensive Adult Eye and Vision Examination or the Optometric Clinical Practice Guideline on Pediatric Eye and Vision Examination.

a. Visual Acuity

Measurement of visual acuity is one component of the evaluation that allows the optometrist to quantify the degree of high-contrast vision loss and, in many cases, clearly identifies the patient's visual impairment as it relates to the chief complaint. Measuring visual acuity also allows the clinician to:

- Monitor stability or progression of disease and changes in visual abilities as rehabilitation progresses
- Assess eccentric viewing postures and skills, patient motivation, scanning ability (for patients with restricted fields), and, in many cases, afford the patient an opportunity to experience success
- Teach basic concepts and skills (i.e., to eccentrically view) relevant to the rehabilitation process.

Furthermore, the results of visual acuity testing are the basis for determining initial magnification requirements and the potential for specific rehabilitation strategies. The methods of assessing distance and near visual acuity in visually impaired patients may be modified to address specific concerns (Table 4).[21,22]

Insert Table 4 Here

Best suited to evaluation of the low vision patient are charts that have high contrast, are moveable, and have a number of characters or options in the 100- to 800-foot size range for better quantification of visual acuity.[23] Nonstandard testing distances of 10 feet, 2 meters, or closer are generally used, and the patient is encouraged to modify posture (e.g., turn the head or eye) to achieve the best eccentric viewing position. Any such movement should be noted and recorded. Chart and ambient illumination may be varied to determine the optimum lighting situation, effects of glare, or the potential need for filters to reduce photophobia. When visual acuity cannot be measured with specialized charts, an attempt to quantify vision can be made by calculating an environmental acuity based on target size and the distance at which it is detected.[24] Results can be recorded as detection of hand motion, light projection, light perception, or no light perception (i.e., an unequivocal measurement). "Counts fingers" is not an acceptable measure of visual acuity; if a patient can accurately count fingers, then large characters can be read at close range.[25]

Nonstandard techniques or those designed for use with infants, such as preferential looking with grating acuities or visually evoked potential (VEP) can sometimes be used with young children or multiply handicapped individuals who cannot respond to other methods.[26,27] The use of edible targets such as candies, environmental targets such as small toys, or diagnostic patching to determine whether behavior is affected by covering one or both eyes[28] can also be helpful with multiply handicapped patients or those who are difficult to test.

Distance visual acuity should be recorded as the actual testing distance used over the size of the character read. If a 20-foot visual acuity measurement is required, a projected standard Snellen chart should be used because acuities measured by specialized low vision techniques may not correlate by simple ratio to a standard 20-foot acuity measured with a projected chart.[29]

For measuring visual acuity at near, acuity charts designed for visually impaired patients (i.e., those with single letters, isolated words, or short sentences) should be utilized.[30] Testing distances should be measured and recorded. Use of the M system is preferred, because it yields a Snellen fraction that is more easily compared to distance visual acuities.[31] The designation of letter size (e.g., 1 M, 2 M) indicates the distance at which the print is equivalent in angular size to a 20/20 optotype. For example, 1 M print subtends 5 minutes of arc at 1 meter. The visual acuity is recorded as testing distance in meters over M-size letter read, thus yielding a true Snellen fraction (e.g., if 4 M letters are read at 40 cm, the acuity is recorded as .40/4 M and is equivalent to 20/200). Use of the M system also facilitates calculation of addition power (i.e., the dioptric power required to focus at a specific metric distance).

Graded continuous text materials will provide a more accurate measure of reading ability than single optotype measures and are recommended for evaluation of performance with reading devices.[32] Final determination and prescription of a lens system should be based on performance (i.e., reading actual printed materials such as newspapers and labels, not printed acuity charts).

b. Refraction

All low vision patients should undergo refraction to ensure optimal correction for best visual acuity and to determine the amount of magnification needed for certain tasks. The presence of uncorrected presbyopia or significant uncorrected refractive error could affect success with low vision devices, while the use of certain optical and electronic devices (e.g., stand magnifiers, closed-circuit television systems, computers) may require patients to accommodate or to use a multifocal correction.[33] When the correction of refractive error significantly improves visual acuity, or when it is subjectively appreciated, as may be the case with moderate to high amounts of cylinder correction, the refractive correction should be incorporated into spectacle-mounted optical devices.[34] In addition, many patients respond favorably to standard single vision distance, bifocal, or trifocal correction for some needs.[35]

Traditional procedures for the objective and subjective assessment of refractive error are less effective in some cases, due to poor fixation, eccentric viewing postures, or media opacities.[36] Evaluation of refractive status may include both objective and subjective refraction, comparison of the new prescription to present spectacle correction, and assessment of low vision devices (Table 5).[37,38]

Insert Table 5 Here

An autorefractor can give an accurate starting point for subjective refraction, especially when high refractive errors or media opacities are present. Radical retinoscopy (refracting at a closer than usual distance) will sometimes facilitate detection or neutralization of motion and can be helpful when media opacities are present, pupils are small, or the reflex is dull.[39] Moreover, refracting off axis may elicit a brighter reflex,[40] especially in patients who have high myopia.

The use of trial frame and lenses allows the patient to assume the customary head or body posture and eccentrically view, and allows the optometrist to make major changes in lens power easily. "Just noticeable difference" (JND), which refers to the least increment of change in lens power that a patient notices, is estimated by the denominator of the 20-foot Snellen acuity equivalent.[38] For example, a visual acuity of 10/100 (or 20/200) is approximately equivalent to a JND of 2 diopters (D) (range, $\pm$1.00 D). The clinician begins subjective refraction at $\pm$1.00 D over the retinoscopy lenses or over the patient's existing prescription. Refraction over the patient's spectacles may be helpful with cases of aphakia and high myopia, in which vertex distance is critical. When doing the subjective refraction at nonstandard (e.g., closer) distances or refining the refraction behind a telescope, the clinician must take accommodative demand into account.[41] The use of a stenopaic slit or multiple pinholes will help to determine the effect of corneal irregularities, crystalline lens changes, or irregular astigmatism on retinal image quality.[42] These aperture devices can also be used therapeutically.[43]

When the patient is using a lens system of any type, it should be neutralized and performance with the system evaluated. Conventional lenses can be measured using a lensometer in the standard manner. For thick lenses or multiple lens systems, several relatively simple methods of quickly measuring or verifying the equivalent power of the system enable the clinician to make appropriate modifications in lens power.[44-47]

c. Ocular Motility and Binocular Vision Assessment

The oculomotor system should be evaluated for the presence of nystagmus, ocular motility dysfunction (e.g., poor saccades or pursuits), strabismus, substandard binocularity, or diplopia, which could influence visual performance or treatment options. Any of the following procedures may be used to assess binocular function and to determine the need or potential for binocular correction:[48]

- Gross assessment of ocular alignment (e.g., Hirschberg estimation)
- Sensorimotor testing (e.g., Worth four dot, stereo fly, red lens test)
- Amsler grid testing, monocularly versus binocularly (to determine eye dominance and the need for occlusion)
- Contrast sensitivity, monocularly versus binocularly (to determine eye dominance and the need for occlusion)
- Effects of lenses, prisms, or occlusion on visual functioning.

In many cases, a visually impaired patient will have a preferred or better seeing eye or strabismus, negating the need for a binocular prescription. However, the potential for binocular or biocular use of optical devices, or conversely, the potential for improved functioning by occlusion of the nonpreferred eye should be carefully explored.[49] The patient with nystagmus may adopt an unusual head posture to attain the null point, which could affect the placement of the optical centers of bifocals or telescopes. Prism may be helpful in reducing head turn.[50]

d. Visual Field Assessment

Research has shown that visual field integrity may be as important as visual acuity to reading ability.[51,52] It is certainly a critical factor with respect to independent travel concerns.[53] Measurement of visual field integrity (central, peripheral, or both) should be conducted to determine the presence and location of relative or absolute losses of sensitivity. The visual field findings should then be correlated with the patient's visual functioning. Assessment of visual fields may include:[54,55]

- Confrontation visual field testing
- Amsler or threshold Amsler grid assessment
- Tangent screen testing
- Goldmann bowl perimetry or equivalent kinetic testing
- Automated static perimetry.

For patients with reduced acuities or poor visual functioning, the central visual field should be evaluated for the presence of scotomas, metamorphopsia, or relative loss of sensitivity. The size and location of the scotoma can affect reading ability, despite appropriate magnification and visual acuity improvement.[56] The presence of significant distortion may necessitate as much as, or more than, twice the magnification calculated on the basis of acuity measures alone.[54] With peripheral visual field losses, the extent and depth of the field loss, including the presence of peripheral islands of vision, should be quantified to determine whether the patient is a candidate for visual field enhancement devices. For purposes of certifying legal blindness or disability, Goldmann perimetry with appropriate targets (i.e., III4e for phakic eyes, IV4e for aphakic eyes) should be utilized.[11]

e. Ocular Health Assessment

A thorough assessment of the health of the eyes and associated structures is an integral component of the comprehensive low vision examination.[57] A diagnosis, or confirmation of the diagnosis, should be made to determine the physical cause of the impairment and the effects of the ocular condition on visual functioning. This will help the clinician advise the patient as to the prognosis and establish a treatment plan for the visual impairment, and, if applicable, for genetic counseling. The components of ocular health assessment may include:

- External examination (adnexa, lids, conjunctiva, cornea, iris, lens, and pupillary responses)
- Biomicroscopy (lids, lashes, conjunctiva, tear film, cornea, anterior chamber, iris, and lens)
- Tonometry
- Central and peripheral fundus examination with dilation, unless contraindicated.*

The central fundus can be examined with the aid of a precorneal minus or plus lens (e.g., Hruby, +90, +78) and the peripheral retina with a binocular indirect ophthalmoscope.

Gross observation of the patient can alert the optometrist to photophobia, abnormal head postures, ptosis, pupillary abnormalities, or other factors that can impact visual functioning. Standard slit lamp examination of the ocular tissues and adnexa, tonometry, and fundus examination can provide valuable insight into specific functional difficulties, such as photophobia, fluctuating vision, metamorphopsia, and illumination requirements, and indicate the stability of the disease process.[17,58,59] In some cases, more than one disease or condition may be present.

3. Supplemental Testing

Additional testing may be indicated by the presence of a specific disease or condition, a patient complaint, educational or work-related needs, inadequate response to magnification, or other unexplained findings. Such testing may include, but is not limited to:

* Dilated-pupil examination should not be done on the day of low vision evaluation unless it is done at the end of the visit, because dilation can affect visual abilities significantly.

- Contrast sensitivity testing
- Glare testing
- Color vision testing
- Visually evoked potential (VEP)
- Electroretinogram (ERG)
- Electro-oculogram (EOG).

Contrast sensitivity has emerged as a valuable measure of visual function; reduced contrast sensitivity can affect reading ability,[60] glare sensitivity, amount of light needed,[61] and ability to navigate through the environment.[53] Glare testing can be done with commercially available instruments or by environmental stress testing to assess qualitatively the effects of disabling glare and to indicate the need for special filters.[43] Color vision anomalies, which can significantly affect educational, vocational, daily living, and mobility needs, can be diagnostic of specific diseases.[62] Some color vision tests (e.g., Holmgren wool) can help assess the functional implications of color vision loss. The electrodiagnostic tests (VEP, ERG, and EOG) are important in clarification of diagnoses, particularly when clinical information is inconsistent,[63] or when the patient is very young or multiply handicapped.

B. Management of Visual Impairment

The extent to which an optometrist can provide treatment for the disease or condition underlying visual impairment will vary, depending on both the state's scope of practice laws and regulations and the individual optometrist's experience or certification. The goal of the primary care optometrist should be to provide basic low vision care in the form of (but not limited to) high power near or multifocal additions and recommendations for other appropriate optical devices and environmental modifications. Management of patients with severe vision loss may require consultation with or referral to another optometrist skilled in low vision rehabilitation, the patient's primary care physician, an ophthalmologist, or some other health care practitioner. In managing the patient's visual impairment, the clinician may chose to provide the low vision care, or to comanage or refer the patient to an optometrist who has advanced training or clinical experience with low vision.

The stability of the ocular or systemic disease or condition should be considered before embarking on a rehabilitation treatment plan. It may be appropriate to postpone prescription of sophisticated optical devices until the condition is thought to be stable, or at least to advise the patient of the possibility of changes in vision that could result in the need for new prescription lenses or devices. Temporary or interim approaches to either training or optical devices should be explored. For example, loaner systems can be invaluable for a patient with immediate needs but unstable vision loss.

To address the functional deficits created by the underlying ocular abnormality, the optometrist should interpret and evaluate the examination results to establish and formulate a written rehabilitation treatment plan. Patient management may include, but is not limited to, these goals:

- Improving distance, intermediate, or near vision
- Improving reading ability (print)
- Reducing photophobia or light-to-dark adaptation time
- Improving the ability to travel independently
- Improving the ability to perform activities of daily living, thereby enhancing the quality of life
- Maintaining independence
- Understanding the diagnosed vision condition, prognosis, and implications for visual function.

Patient management may include referral for additional treatment, therapy, or rehabilitation* instruction. The importance of maximizing independence and safety through low vision rehabilitation cannot be overemphasized.

I. Basis for Treatment

The indications for specific types of treatment or management should be individualized for each patient. When planning a course of therapy, the optometrist should consider the following factors:

- Degree of visual impairment, disability, or handicap
- Underlying cause of visual impairment and prognosis
- Visual requirements, goals, and objectives
- Patient's age and developmental level
- Overall health status of the patient
- Other physical impairments which may affect the ability to participate in low vision rehabilitation
- Patient's adjustment to vision loss
- Patient's expectations and motivation
- Lens systems or technology available
- Support systems available.

The following review of available treatment options assumes that the patient's refractive error has been corrected or accounted for prior to evaluating magnification, or determined to be noncontributory to the

* For the purposes of this Guideline, low vision rehabilitation, vision rehabilitation, and comprehensive low vision care are synonymous.

optics of the systems described in this Guideline. Appendix Figure 1 provides a brief flowchart of the optometric management of the patient with low vision.

2. Available Treatment Options

a. Management Strategy for Reduced Visual Acuity

Appropriate magnification systems should be determined for the patient with reduced best corrected visual acuity. Based on identified needs, this determination will be made for near or distance visual acuity improvement, or both. The required level of magnification may be task specific, i.e., vary for different activities.

Magnification for Near. There are several methods of calculating a starting lens power or addition (add) power for near magnification. Each method is based on either a distance or near visual acuity measurement (Table 6).[64]

Insert Table 6 Here

Once the starting power has been determined, the lens can be put into a trial frame or other appropriate lens form, such as a microscope, for evaluation of the patient's ability to read single letters and continuous text. Often considerably more magnification is needed for reading continuous text materials. Initial lens power may be modified according to the results of Amsler grid or contrast sensitivity testing. Modification of the power or form of the lens (single lens or doublet) should continue until the clinician is satisfied that the most appropriate lens power has been found. Equivalent-powered lens systems (e.g., telemicroscopes, hand-held or stand magnifiers, and electronic devices) should then be explored. (Table 6).[65-67]

Determining appropriate magnification for near may take several visits or even months, because the patient is not only learning the use of a sophisticated lens system that requires a specific working distance and posture, but (often at the same time) learning the most efficient use of remaining vision. Frequently, as part of this process, training is also implemented to improve eccentric viewing skills. In essence, the patient is learning to fixate with peripheral vision.[68] Loaner or training lens systems can be useful until a final lens prescription is determined.

- **Spectacle-mounted Reading Lenses**. These lenses, also called "microscopes," afford hands-free magnification, provide a wider field of view than other equivalent-powered systems, and are more "normal" looking than other reading devices.[69] They are available in a wide range of powers, up to an equivalent power (F_e) of +80.00 D. Although binocularity is possible for some patients with near addition power of +10.00 D,[70] convergence demand, when working distances are less than 16 cm, is significant and may preclude binocularity, even with prismatic spectacles.[71,72] The greatest challenge faced by patients using microscopes is adaption to the close working distance required. Working distance (expressed in meters) is determined by taking the reciprocal of the equivalent addition power; the working distance of a +20.00 D lens is .05 meters, 5 cm, or 2 inches. With such close working distances, proper use of illumination is critical for optimum functioning. A reading stand may help maintain the proper focal distance and reduce postural fatigue. Once the patient is accustomed to the working distance, however, the reading speed with this type of lens will often be faster than with other lens systems of equivalent power.[73]

- **Telemicroscopes**. These telescopic systems are designed or modified with reading caps or close-focus capability to be used at near. They allow magnification at a greater distance than equivalent-powered microscopes.[74] The increased working distance is achieved at the expense of field of view, which can result in reduced reading speed.[75] Nevertheless, telemicroscopes may be considered for those patients who are unable, due to specific working distance demands, or unwilling to adjust to the closer working distance of microscopes but still require hands-free magnification. The working distance of a telemicroscope system is determined by the power of the reading cap, or, for focusable systems, the setting of the focusing mechanism, which also affects the equivalent power of the system.[76,77]

- **Hand magnifiers**. These devices afford magnification at variable working distances, and are especially useful for viewing targets at arm's length or for short-term spotting activities. A shorter lens-to-eye distance will allow a greater field of view. Users require practice to maintain the proper lens-to-object distance. The clinician's decision to use a patient's bifocal addition in conjunction with the magnifier is based on the magnifier-to-eye distance. When the magnifier lens is held further from the eye than the focal length of the magnifier, the patient should view through the distance part of the spectacles. When the magnifier is used at a distance less than its focal length, the bifocal can be used for maximum magnification.[78] In the first situation, using the bifocal would actually reduce the overall equivalent power to less than the magnifier itself; in the second, the equivalent power is greater with the bifocal than without it. When the lens-to-object distance is less than the focal distance of the lens, divergent light rays leave the system, and an addition should be used, accommodation should be supplied by the patient, or a combination of both is needed.

- **Stand Magnifiers**. These magnifiers allow greater working distance with a smaller field of view than equivalent-powered spectacles.[69] Most stand magnifiers require some degree of accommodation or the use of a near addition to compensate for divergent light leaving the system.[33] Nevertheless, many patients appreciate a stand magnifier for reading needs because the lens-to-object distance is predetermined and fixed. In addition, illuminated stand magnifiers are helpful when lighting cannot be controlled. Manufacturers' information regarding the optical parameters of stand magnifiers is not always accurate.[79] The clinician should verify the equivalent power and the image location of commonly used stand magnifiers in order to prescribe appropriately.[67]

- **Electronic Devices**. Closed-circuit television systems (CCTVs), adaptive computer hardware and software, and head-mounted devices (HMDs) not only magnify the image, but enhance contrast and allow binocular viewing. In many cases, these devices permit the user to manipulate both the magnification and contrast, including reverse contrast, to the preferred level.[80] The working distance and usable field of view can also be varied. When extended reading or writing is a goal, a CCTV should be considered because it may enable the use of a more comfortable reading posture, longer reading duration, and faster reading speed than optical devices.[81]

The clinician can determine the final lens or device prescription for near viewing on the basis of a number of factors, including, but not limited to:

- Ease of use (e.g., working distance, reading speed, reading duration)
- Requirement for hands-free magnification
- Contrast considerations
- Lighting requirements
- Weight
- Cosmesis
- Cost.

In some cases, the optimum near low vision prescription(s) can be determined after the initial comprehensive low vision examination (i.e., for low vision patients who require minimal low vision management or for low vision patients who have had previous experience with sophisticated lens systems). More often, the final determination of the most appropriate system(s) will be made as part of the comprehensive rehabilitation program, which can include extended or additional training in the office or at home. To minimize unreasonable expectations, the optometrist should help the patient anticipate the time and effort needed to adapt to the prescription. This understanding will help to ensure that the final prescription is based on the patient's ability to use the devices successfully after adequate training and practice.

Magnification for Distance. The magnification required to improve distance visual acuity is predicted by the ratio of the denominator of the best corrected visual acuity to the denominator of the desired visual acuity level. For example, if the measured visual acuity is 10/60 and the desired visual acuity is 10/20, then 3X(60/20) magnification is required (Table 7). In prescribing telescopic devices, consideration should be given to:

- Visual demands of the task (e.g., acuity, lighting)
- Field of view
- Exit pupil location (eye relief)
- Image brightness
- Form of telescope (hand-held versus spectacle-mounted).

Insert Table 7 Here

- **Telescopes**. These devices can be prescribed as hand-held or spectacle-mounted systems, monocular or binocular. Spectacle-mounted telescopes are known as "full diameter" when they are center mounted or as "bioptic" (superior) or "reading" (inferior) when they have off-center mountings.[82] Hand-held telescopes are most appropriate for short-term viewing or spotting activities (e.g., reading bus numbers or street signs, or viewing a chalkboard in the classroom). For extended viewing (e.g., watching a television program or sporting event), or hands-free use (e.g., driving, where legally permitted), a spectacle-mounted system is needed. When binocularity is possible, the relative benefits of a binocular system should be weighed against potential drawbacks (e.g., weight factors). In determining the position of a spectacle-mounted telescope, the optometrist should consider the patient's need to access the unmagnified view as well as head posture and mobility concerns. For example, when the patient will be using the telescope primarily for distance or mobility needs, a bioptic position is preferred, but when the telescope is to be used primarily for watching television or computer access, a full diameter position may be more comfortable and effective.

Galilean or terrestrial telescopes, which are available up to 6X, are two-lens systems which generally have a brighter image, but a smaller field of view, than equivalent-powered Keplerian or astronomical telescopes.[69] The exit pupil of a Galilean telescope is a virtual image located inside the telescope, so it is impossible to place the exit pupil in the same plane as the eye's entrance pupil; thus, the field of view is limited.[83]

Keplerian telescopes, which are available up to 20X, are multiple-lens systems which have wider fields of view but less light transmission than equivalent-powered Galilean systems.[69] The exit pupil of a Keplerian telescope is a real image located behind the ocular lens of the telescope which places it in the same plane as the eye's entrance pupil, thus affording a larger field of view.[83] The distance between the ocular lens and the exit pupil is referred to as eye relief.[84]

- **Electronic Devices**. Several head-mounted video devices or electronic magnification systems are now available, with features including variable autofocus magnification, variable contrast enhancement, and reverse polarity capability. These devices are useful for both distance and near application, but they are not currently recommended for mobility needs (i.e., ambulation or driving).

The selection of the final distance magnification system can be determined based on a number of factors, including, but not limited to:

- Ease of use (e.g., field of view, spotting, scanning, focusing)
- Requirement for hands-free magnification
- Requirement for mobility
- Contrast or image brightness
- Weight
- Cosmesis
- Cost.

In some cases, the optimum distance low vision system prescription(s) can be determined after the initial comprehensive low vision examination (i.e., for those patients who require minimal low vision management or for low vision patients who have had previous experience with sophisticated lens systems). More often, final determination of the most appropriate system(s) will be made as part of the comprehensive rehabilitation program, which may include extended or additional training in the office or at home. To minimize unreasonable expectations, the optometrist should recognize and help the patient anticipate the time and effort needed to adapt to the prescription. This understanding will help to ensure that the final prescription is based on the patient's ability to use the devices successfully after adequate training and practice.

b. Management Strategy for Central Visual Field Defects

A central visual field defect can significantly affect visual functioning, such as reading ability. Size, location, and density of the scotoma (relative, absolute, or both) will determine its effect on visual functioning and can influence the response to near magnification. In many cases, even with appropriate magnification, certain parameters of print reading ability (e.g., print size, reading speed, comprehension, and duration) may be compromised due to the central field disturbance and nature of the task,[51] even though ability to navigate through the environment is relatively unaffected.[85] In the eye with a macular scotoma, the stimulus to foveate the target may persist;[86] however, with time or training, the patient may learn to view eccentrically.[87]

Eccentric viewing requires the development of a new preferred retinal locus (PRL) next to the scotoma which will be used as the "new" fovea.[56] A scotoma with areas of relative loss of sensitivity and/or distortion at the periphery of an absolute loss may make it more difficult for the patient to learn eccentric viewing. Reading with an off-foveal point is difficult and less efficient, because saccades and pursuits are difficult to execute peripherally.[88] A scotoma to the right of fixation may make reading continuous text much more difficult, despite relatively good visual acuity and response to magnification. Although some patients do learn eccentric viewing independently, training may be beneficial to improve reading ability; this training is most often accomplished with a reading task and appropriate magnification devices.[89] Eccentric viewing training may include any of the following strategies:[68]

- Teaching awareness of the scotoma
- Teaching off-foveal viewing with guided practice techniques
- Reading single letters or words
- Reading with low magnification and large-print materials
- Moving the reading material rather than the eyes or head
- Using prism relocation.

Once aware of the scotoma, the patient can be taught to position the scotoma with eye movements. This control can be achieved in a guided practice manner with a variety of above-threshold targets (e.g., faces, the television, or large print materials) prior to introducing magnification. Print materials appropriate for both unaided practice and use with magnification have been developed[90] and are most appropriate when reading is the goal.[90]

Prism relocation can be a helpful demonstration tool in some cases, by shifting the image closer to the new retinal locus, stimulating eye movement. In this manner, the benefits of eccentric viewing can be demonstrated to the patient. Success with reading systems may hinge on the development of this critical skill. In addition, patient motivation is a significant factor in the outcome of training for eccentric viewing.[68] However, the size and location of the scotoma can influence the difficulty of controlling eccentric viewing and the reading speed, even after training.[56]

c. Management Strategy for Peripheral Visual Field Defects

Persons with peripheral visual field defects have more difficulty navigating through the environment than persons with reduced acuity and no peripheral visual field losses.[85] Optical devices or training can often improve awareness of the environment and independent travel ability for those patients with debilitating peripheral visual field losses. Once careful assessment of the visual field loss has been accomplished, both the patient's understanding of the loss and the ability to compensate for it should be explored by careful questioning and observation of functioning. Mobility evaluation by a certified orientation and mobility (O&M) specialist may also be indicated. There are several options which may be considered, evaluated, and prescribed if deemed appropriate (Table 8).[55,91]

Insert Table 8

- **Prisms**. Prisms may be used to shift the image toward the apex of the prism. The prism can be placed segmentally on the lens with the base toward the field defect:[92] the prism segment is placed off center so that when looking straight ahead, the patient cannot see it. By glancing into the prism the patient can detect obstacles or targets in the nonseeing area with less eye movement than would be required without the prism. Fresnel press-on prisms can be used or the prism can be ground or cemented segmentally into any part of the lens. Prisms that are ground in or cemented on the lens provide an optically clearer image than Fresnel prisms.[93] Prisms can be helpful when there is any type of restricted field (e.g., hemianopia or generalized constriction).

- **Mirrors**. Attached to the nasal aspect of the spectacle lens, a mirror can be angled toward the nonseeing area much like a side mirror on a car.[94] By glancing into the mirror, the patient can detect objects within the field defect. Image reversal, a significant perceptual factor to be considered when working with mirrors, requires the patient to understand left-right reversal. Mirrors are available in clip-on form or can be permanently affixed to the spectacle frame and are prescribed primarily for hemianopic field defects.[55]

- **Reverse telescopes and minus lenses**. These devices minify the entire visual field in one or all meridians so that more information "fits" into the restricted area, but at the expense of visual acuity.[55] The reverse telescope can be hand held or spectacle mounted, either in the full diameter or bioptic position. Good visual acuity is required due to the minification effect of the telescope. Generally, reverse telescopes are prescribed only in low (i.e., 0.66X) powers.[95] The amorphic lens is a cylindrical (minus) telescope that minifies in the horizontal meridian only and is provided as a full diameter or bioptic-mounted spectacle system.[96] Minus lenses held away from the eye will also minify the entire field and can be used briefly for orientation purposes or to view larger print.[97]

Training in the use of visual field enhancement devices is necessary before any true potential for success can be determined. The lens systems used and their optical characteristics are generally unfamiliar to patients and a basic understanding of the optics involved will facilitate efficient use of the lenses. The patient should be taught basic visual skills such as scanning (especially for prisms and mirrors) and spotting (especially for reverse telescopes and minus lenses) and how to use these techniques with the lenses.[55] Additional training by a certified O&M instructor, as part of a structured orientation and mobility program, may be beneficial.

d. Management Strategy for Reduced Contrast Sensitivity and Glare Sensitivity

Reduced contrast sensitivity in low vision patients can affect functional performance in tasks such as reading,[98] mobility,[53] and the ability to perform activities of daily living.[99] Likewise, glare sensitivity can interfere with both comfort and visual efficiency.[43] When contrast sensitivity is depressed, or glare sensitivity is a problem, the optometrist should consider the following strategies:[43,100]

- Optimum lighting (ambient, task, or use of illuminated devices)
- Increased magnification
- Use of specific lens designs (e.g., biconvex aspheric lens, achromatic doublets)
- Use of tints, filters, lens coatings, apertures, etc.
- Non-optical devices (e.g., hats, visors, sideshields, typoscopes)
- Electronic devices.

Most visually impaired persons are very sensitive to changes in illumination and require specific lighting conditions for optimum comfort and visual functioning.[61,101] Recommendations to add to or modify lighting in the home or work environment to improve overall visual functioning should be considered. Special lighting needs for reading or other near tasks should be explored because magnification alone may not adequately improve reading ability when reduced near visual acuity is accompanied by reduced contrast sensitivity. Often proper lighting is critical for optimum functioning with optical devices.

The most appropriate type of lighting can be easily determined in the office by the comparison of incandescent, fluorescent, halogen, or combinations of these light sources. It should also be noted that the distance of the light from the object being viewed is very important. Both increased and decreased illumination should be evaluated, as increasing the quantity of light may increase glare, thus reducing comfort and visibility. This can be especially true with fluorescent light sources.[100]

Illuminated optical devices can be considered when lighting is critical. However, some may not provide uniform illumination of the object and will need to be supplemented with auxiliary lighting. In cases of severely reduced contrast sensitivity, increasing magnification over that predicted by visual acuity alone may be necessary.[43] Specific reading lens designs that produce clearer images and allow increased light transmission (e.g., achromatic doublets, biaspheric lenses with antireflective coatings) may also be beneficial.

Assessment of sensitivity to glare may be performed both indoors and out with attention to different lighting environments, which may be problematic (e.g., fluorescent lighting in the workplace or in the grocery store). Tinted lenses or acetate overlays can improve visibility of low contrast print materials. Various prescriptive filters and lens tints are available to increase contrast in the environment or reduce glare sensitivity.[100,102]

When used alone or in conjunction with sunfilters, non-optical devices, such as hats, visors, and sideshields, can reduce disabling glare. A typoscope is useful for reducing reflected glare from the printed page, especially when extra illumination is required to enhance the perception of contrast of the print.

Electronic devices such as CCTVs or HMDs allow for manipulation of contrast, brightness, and magnification. These devices may be appropriate options for patients who have reduced contrast sensitivity, even when visual acuity is relatively good, particularly when illuminated magnifiers cause glare.

e. Non-optical Devices

A variety of non-optical devices that use relative size magnification, contrast enhancement, or tactual or auditory clues should be explored to assist visually impaired persons in using their residual vision more efficiently, or in doing certain tasks nonvisually. Specific recommendations for non-optical aids may include:[102]

- Large print materials
- Writing aids (e.g., felt-tipped pens, writing templates, signature guides, bold-lined paper)
- Reading stands
- Typoscopes
- Devices and aids for activities of daily living
- Tactile markers for marking stove dials, etc.
- Auditory aids such as talking watches or clocks
- Audio or taped materials.

f. Training/Instruction Considerations

All patients should receive in-office training to familiarize them with the uses and limitations of the optical systems being prescribed or considered. More complex optical aids may require additional training to ensure optimum functioning with the device prior to its prescription.[103] When a loaner device is to be used, the patient should be able to demonstrate adequate, though not necessarily proficient, use of the device before taking it home. In most cases, practice will improve the use of optical devices; reading speeds and duration may also improve dramatically with training and practice.[104] Patients' preferences for devices may change as they become familiar with the use of other devices.[105] The following issues should be addressed, as appropriate, during the initial training session or in subsequent separate sessions:[106-108]

- Name or category of optical device
- Relative advantages and limitations of optical system(s)
- Most efficient use of optical devices (which may require lighting or non-optical devices for optimum efficiency)
- Use of the device for specific activities for which it is prescribed
- Care, cleaning, and maintenance of optical systems (including changing batteries and bulbs)
- Safety (e.g., the patient should not walk while wearing certain spectacle or head-mounted devices)
- Use of a loaner system when indicated.

Many patients also need additional training to learn how to use residual vision more efficiently. In addition to in-office training, remediation activities or therapy can be given for the patient to do at home over a period to time.[89,90,109] Training procedures should be adapted to the individual patient on the basis of acuity level, type of low vision device prescribed or loaned, size and location of any scotoma, and specific goals. The time required for training depends upon the nature of the visual impairment, cognitive level of the patient, and, most important, motivation and expectation.[110] Training in the use of residual vision might include:[68,111]

- Eccentric viewing
- Scanning
- Fixating (saccadic eye movements)

- Pursuits
- Blur interpretation
- Memory
- Word recognition.

g. Additional Services

The American Optometric Association supports an interdisciplinary approach to low vision rehabilitation.[57] In addition to optometric vision rehabilitation, there may be other resources for evaluation, education, training, assistance, and support, or tools that may benefit the visually impaired patient. Referral for services might include, as appropriate:

- State blind rehabilitation services
- State or local vocational rehabilitation services
- State or local educational services
- U.S. Department of Veterans Affairs, Optometry Service and Blind Rehabilitation Service (for military veterans)
- Orientation and mobility services
- Occupational therapy
- Counseling services (psychiatric, psychological, or social work)
- Technology evaluation for computer software and hardware needs and other assistive technology, which may be nonvisual (available through state vocational rehabilitation or other agencies)
- Talking Books programs and other sources of taped materials available through state library programs, large print book and periodical publishers, and nonprofit organizations
- Descriptive video services
- Nonvisual approaches (auditory output aids, tactual aids)

- Nutritional counseling (especially for diabetics)
- Genetic counseling
- Additional medical/ocular services as indicated.

3. Patient Education

The clinician should review and discuss examination findings with the patient at the conclusion of the clinical evaluation. Providing the patient and the family a clear understanding of the ocular diagnosis, the natural course of the disease, the prognosis, and the functional implications is an important aspect of successful low vision management. The advantages and disadvantages of various treatment options and the prognosis for success should be thoroughly discussed. Both the time required and the importance of patient compliance for successful rehabilitation should be discussed frankly and should not be underestimated. These factors should also be reviewed and discussed at followup visits, because low vision rehabilitation is a dynamic, ongoing process. Patient counseling and education may include:

- Review of the patient's visual and ocular health status in relation to visual symptoms and complaints
- Explanation of available treatment options, including risks and benefits
- Recommendation of a rehabilitation plan, with the reasons for its selection and the prognosis for attaining identified goals
- Written information and/or instructions for the patient
- Discussion of the need for followup care and ongoing patient compliance with the treatment prescribed
- Recommendation for followup and re-examination.

4. Prognosis and Followup

The prognosis for success with low vision rehabilitation depends on a variety of factors, including, but not limited to, the ocular condition causing the visual impairment, the nature and extent of vision loss, the goals of rehabilitation, the patient's attitude, motivation, and expectations, and the clinician's attitude and motivation. The number and frequency of followup visits will depend on the stability of the eye condition and the patient's response to therapy and specific visual devices.

The patient's needs and vision may change over time. Once the specific goals of rehabilitation have been met or addressed, followup to assess ongoing concerns should be continued on a regular schedule, as determined by the clinician and patient. This followup should include ongoing assessment of eye health and vision status.

CONCLUSION

Visual impairment has a significant impact on the patient's quality of life. It affects the ability to read, watch television, drive, work, learn, perform simple activities of daily living, and, in many cases, to maintain independence in a safe manner. The number of patients who are visually impaired is increasing as is the need for appropriate evaluation, management, and rehabilitation services for these patients. Optometrists are uniquely qualified to manage visually impaired patients in that they can assess ocular status, evaluate visual functioning, prescribe low vision devices (e.g., optical, non-optical, electronic), and provide therapeutic intervention or coordinate other forms of care to improve the functioning of the patient's impaired visual system. Comprehensive optometric low vision care can significantly improve the quality of life for visually impaired patients.

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IV. APPENDIX

Figure 1

Optometric Management of the Patient with Low Vision: A Brief Flowchart

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Figure 2

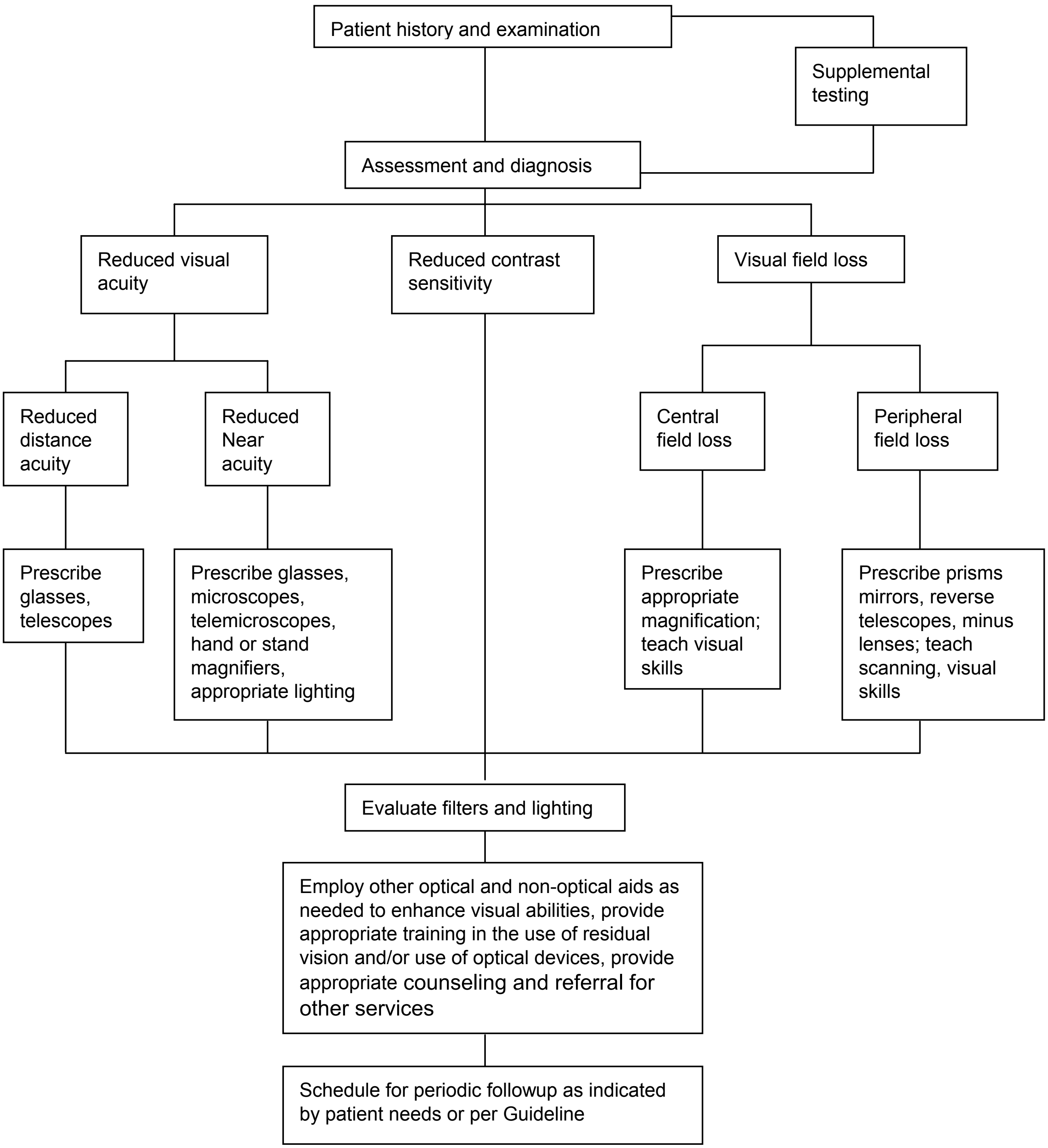

Figure 2

Potential Components of the Comprehensive Examination of the Patient with Low Vision

A. Patient History
1. Nature of the presenting problem, including diagnosis, visual difficulties, and chief complaint
2. Visual and ocular history, including family ocular history
3. General health history, pertinent review of systems, family medical history
4. Medication usage and medication allergies
5. Social history
6. Vocational, educational, and avocational vision requirements (i.e., needs assessment)

B. Visual Acuity
1. Distance visual acuity testing
2. Near visual acuity testing

C. Refraction
1. Objective refraction
2. Subjective refraction
3. Assessment of present spectacles and low vision devices

D. Ocular Motility and Binocular Vision Assessment
1. Gross assessment of ocular alignment
2. Sensorimotor testing
3. Amsler grid testing, monocular and binocular
4. Contrast sensitivity testing, monocular and binocular
5. Effects of lenses, prisms, or occlusion on visual functioning

E. Visual Field Assessment
1. Confrontation visual field testing
2. Amsler grid assessment, monocular and binocular
3. Tangent screen testing
4. Goldmann bowl perimetry or equivalent kinetic testing
5. Automated static perimetry

F. Ocular Health Assessment
1. External examination
2. Biomicroscopy
3. Tonometry
4. Central and peripheral fundus examination

G. Supplemental Testing
1. Contrast sensitivity
2. Glare testing
3. Color vision
4. Visually evoked potential
5. Electroretinogram
6. Electro-oculogram

Figure 3

ICD-9-CM Classification of Visual Impairment

Classification	Code
Profound impairment, both eyes	**369.0**
Impairment level not further specified Blindness: NOS according to WHO definition both eyes	**369.00**
Better eye: total impairment; lesser eye: total impairment	**369.01**
Better eye: near-total impairment; lesser eye: not further specified	**369.02**
Better eye: near-total impairment; lesser eye: total impairment	**369.03**
Better eye: near-total impairment; lesser eye: near-total impairment	**369.04**
Better eye: profound impairment; lesser eye: not further specified	**369.05**
Better eye: profound impairment; lesser eye: total impairment	**369.06**
Better eye: profound impairment; lesser eye: near-total impairment	**369.07**
Better eye: profound impairment; lesser eye: profound impairment	**369.08**
Moderate or severe impairment, better eye; profound impairment, lesser eye	**369.1**
Impairment level not further specified Blindness one eye; low vision other eye	**369.10**
Better eye: severe impairment; lesser eye: blind, not further specified	**369.11**
Better eye: severe impairment; lesser eye: total impairment	**369.12**
Better eye: severe impairment; lesser eye: near-total impairment	**369.13**
Better eye: severe impairment; lesser eye: profound impairment	**369.14**
Better eye: moderate impairment; lesser eye: blind, not further specified	**369.15**
Better eye: moderate impairment; lesser eye: total impairment	**369.16**
Better eye: moderate impairment; lesser eye: near-total impairment	**369.17**
Better eye: moderate impairment; lesser eye: profound impairment	**369.18**
Moderate or severe impairment, both eyes	**369.2**

Impairment level not further specified **369.20**
Low vision, both eyes NOS

Better eye: severe impairment; lesser eye: blind, not further specified **369.21**

Better eye: severe impairment; lesser eye: severe impairment **369.22**

Better eye: moderate impairment; lesser eye: not further specified **369.23**

Better eye: moderate impairment; lesser eye: severe impairment **369.24**

Better eye: moderate impairment; lesser eye: moderate impairment **369.25**

Unqualified visual loss, both eyes **369.3**
Excludes: blindness NOS
legal [USA definition](369.4)
WHO definition (369.00)

Legal blindness, as defined in USA **369.4**
Blindness NOS according to USA definition
Excludes: legal blindness with specification of impairment level (369.01-369.08, 369.11-369.14, 369.21-369.22)

Profound impairment, one eye **369.6**

Impairment level not further specified **369.60**
Blindness, one eye

One eye: total impairment; other eye: not specified **369.61**

One eye: total impairment; other eye: near-normal vision **369.62**

One eye: total impairment; other eye: normal vision **369.63**

One eye: near-total impairment; other eye: not specified **369.64**

One eye: near-total impairment; other eye: near-normal vision **369.65**

One eye: near-total impairment; other eye: normal vision **369.66**

One eye: profound impairment; other eye: not specified **369.67**

One eye: profound impairment; other eye: near-normal vision **369.68**

One eye: profound impairment; other eye: normal vision **369.69**

Moderate or severe impairment, one eye **369.7**

Impairment level, not further specified **369.70**
Low vision, one eye

One eye: severe impairment; other eye: not specified **369.71**

One eye: severe impairment; other eye: near-normal vision	**369.72**
One eye: severe impairment; other eye: normal vision	**369.73**
One eye: moderate impairment; other eye: not specified	**369.74**
One eye: moderate impairment; other eye: near-normal vision	**369.75**
One eye: moderate impairment; other eye: normal vision	**369.76**
Unqualified visual loss, one eye	**369.8**
Unspecified visual loss	**369.9**

NOS = not otherwise (further) specified

Source: International Classification of Diseases, 9th rev. Clinical Modification

Abbreviations of Commonly Used Terms

CCTV	Closed-circuit television
CF	Counts fingers
D	Diopter
EOG	Electro-oculogram
ERG	Electroretinogram
ETDRS	Early Treatment Diabetic Retinopathy Study
Fe	Equivalent power
HM	Hand motion
HMD	Head-mounted device
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
JND	Just noticeable difference
LP	Light perception
LPP	Light projection
NLP	No light perception
O&M	Orientation and mobility
PRL	Preferred retinal locus
VA	Visual acuity
VEP	Visually evoked potential
VF	Visual field
WHO	World Health Organization

Glossary

Activities of daily living Activities such as personal grooming, shopping, cooking, and cleaning, that are part of the daily routine.

Amsler grid A chart with horizontal and vertical lines used for testing the central visual field.

Astronomical telescope A refracting telescope in which both the objective and the ocular lens are plus lenses so that the image is inverted, requiring erecting prism. Synonym: Keplerian telescope.

Cataract An opacity of the crystalline lens or its capsule.

Closed-circuit television An electronic magnification system consisting of a television camera and a monitor. The user places the reading material under the camera and an enlarged image is displayed on the monitor.

Contrast The manifestation or perception of difference between two compared stimuli.

Diabetic retinopathy A disease of the retina associated with diabetes mellitus, characterized by microaneurysms, hemorrhages, exudates, and proliferative retinal changes.

Diplopia A condition in which a single object is perceived as two rather than as one. Double vision.

Distortion Any change in which the image does not conform to the shape of the object.

Eccentric viewing The use of a nonfoveal point on the retina for viewing where the patient has the sensation of looking past the target.

Equivalent power The vergence power of an optical system expressed with reference to the principal point.

Exit pupil The image of the aperture stop formed by the portion of an optical system on the image side of the stop.

Eye relief The distance from the ocular lens to the exit pupil.

Field of view The extent of the object plane visible through, or imaged by, an optical instrument or device.

Filter A device or material that selectively or equally absorbs or transmits wavelengths of light.

Focus To adjust the elements of an optical system to achieve sharp imagery.

Galilean telescope A refracting telescope in which the objective is a plus lens and the ocular is a minus lens, forming an erect, virtual image. Synonym: terrestrial telescope.

Glaucoma An ocular disease characterized by elevation in the intraocular pressure, which causes damage to the optic nerve fibers entering the optic nerve, leading to loss of vision.

Head-mounted devices Video magnification units worn on the head.

Hemianopia Blindness in one half of the visual field of one or both eyes.

Keplerian telescope A refracting telescope in which both the objective and the ocular are plus lenses so that the image is inverted, requiring erecting prism. Synonym: astronomical telescope.

Kestenbaum's rule The reciprocal of the best corrected distance acuity gives the dioptric power of the addition needed to read standard print.

Legal blindness Such degree or type of blindness as is defined in, or recognized by, statute to constitute blindness. In the United States, it is defined by Social Security Administration as remaining vision in the better eye after best correction of 20/200 or less, OR contraction of the visual fields in the better eye (A) to 10 degrees or less from the point of fixation; or (B) so the widest diameter subtends an angle no greater than 20 degrees.

Low vision Bilateral reduced acuity, not correctable with conventional lenses, or abnormal visual field due to a disorder in the visual system, resulting in decreased performance level.

Low vision training See Training.

M system Metric system for specifying near visual acuity, where a 1 M letter subtends 5 minutes of arc at 1 meter. The system is linear so that a 2 M letter is exactly twice the size of a 1 M letter. Acuity is measured as testing distance (in meters) over optotype read, yielding a Snellen fraction.

Macular degeneration Degeneration of the central part of the retina which results in reduced visual acuity.

Metamorphopsia An anomaly of visual perception in which objects appear distorted or larger or smaller than their actual size.

Microscope A converging lens placed between the object and the eye to provide a larger retinal image of the object.

Non-optical devices Devices which do not use lenses to improve visual function.

Null point A head position that minimizes eye movement with nystagmus.

Nystagmus Rhythmic oscillations or tremors of the eyes which are independent of normal eye movements.

Off-axis retinoscopy Retinoscopy performed while the clinician is looking off the visual axis.

Optotype Test type for determining visual acuity.

Photophobia Abnormal sensitivity to light.

Preferential looking technique Method for assessing vision by presenting two stimuli simultaneously while an observer determines which pattern is being fixated.

Preferred retinal locus A region of the peripheral retina adjacent to an absolute central or paracentral scotoma that is used consistently for eccentric viewing.

Presbyopia A reduction in accommodative ability that occurs normally with age and necessitates a plus lens addition for satisfactory seeing at near.

Prism An optical element or system that deviates the path of light.

Ptosis Drooping of the upper eyelid below its normal position.

Radical retinoscopy Retinoscopy at a closer than normal working distance to elicit a red reflex when media is not clear or pupils are small.

Reciprocal of vision Calculation of near lens power by using the reciprocal of the distance or near acuity, which gives the dioptric power of the addition.

Refraction Determination of the refractive errors of the eye.

Refractive status (refractive error) The degree to which images received by the eyes are not focused on the retina (e.g., myopia, hyperopia, astigmatism).

Relative size magnification Enlarging the object to a size adequate to be seen, as with large print.

Retinitis pigmentosa A primary degeneration of the neuroepithelium of the retina resulting in night blindness and progressive contraction of the visual field.

Reverse telescope Telescope that is reversed so that when the eye looks through it, the field of view is increased by the same factor as the telescope magnification, but the image is minified, as when the eye views through a 2X telescope in reverse, the field of view is doubled but the image is half the size of the object.

Scanning Technique for surveying the environment in a systematic fashion, while using a telescope, or to compensate for visual field loss.

Scotoma An area of partial or complete absence of vision, surrounded by an area of vision. Can be central or paracentral and is referred to as positive or negative when a person is aware or unaware of the blind area.

Spotting Technique for finding objects through a telescope whereby the user first locates the target unaided, then introduces the telescope, pointing it directly at the target.

Telemicroscope Telescope that is modified for near viewing distances by focusing or adding a reading cap.

Telescope An optical system for magnifying the apparent size of a distant object, which consists of an objective lens that forms a real image of the object and an ocular lens or eyepiece that magnifies the image formed by the objective.

Training (i.e., low vision training, instruction, rehabilitation, or therapy) Instruction in the use of residual vision or optical or non-optical systems to improve visual functioning.

Visual acuity A measure of the acuteness or clearness of vision, expressed as the angle subtended at the anterior focal point of the eye by the detail of the letter recognized. Visual acuity depends upon the sharpness of focus of the retinal image and the integrity of the retina and visual pathway.

Visual disability Any loss of functional ability to perform visual tasks necessary to maintain one's lifestyle.

Visual field The area or extent of space visible to an eye in a given position.

Visual handicap Any economic, social, or psychological disadvantage that is the result of a visual impairment.

Visual impairment Any measurable functional limitation of the eye or visual system.

Working distance The distance between the object of regard and the standard spectacle plane.

Working space The unobstructed distance between the object of regard and the front of the optical device.

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Table 1
Levels of Visual Impairment

<table>
<tr><td colspan="2">Classification</td><td>Levels of Visual Impairment</td><td rowspan="2">Additional Descriptors That May Be Encountered</td></tr>
<tr><td>“Legal”</td><td>WHO</td><td>Visual Acuity (VA) and/or Visual Field (VF) Limitation (Whichever is Worse)</td></tr>
<tr><td rowspan="3"></td><td rowspan="2">(NEAR-)
NORMAL
VISION</td><td>RANGE OF NORMAL VISION
20/10 20/13 20/16 20/20 20/25
2.0 1.6 1.25 1.0 0.8</td><td></td></tr>
<tr><td>NEAR-NORMAL VISION
20/28 20/30 20/40 20/50 20/60
0.7 0.6 0.5 0.4 0.4</td><td></td></tr>
<tr><td rowspan="2">LOW
VISION</td><td>MODERATE VISUAL IMPAIRMENT
20/70 20/80 20/100 20/125 20/160
0.29 0.25 0.20 0.16 0.12</td><td>Moderate low vision</td></tr>
<tr><td rowspan="4">LEGAL
BLINDNESS
(U.S.A.)

both eyes</td><td>SEVERE VISUAL IMPAIRMENT
20/200 20/250 20/320 20/400
0.10 0.08 0.06 0.05</td><td>Severe low vision, “Legal” blindness</td></tr>
<tr><td rowspan="3">BLINDNESS
(WHO)

one or
both eyes</td><td>PROFOUND VISUAL IMPAIRMENT
20/500 20/630 20/800 20/1000
0.04 0.03 0.025 0.02

CF at: less than 3m (10 ft.)
VF: 10 degrees or less</td><td>Profound low vision, Moderate blindness</td></tr>
<tr><td>NEAR-TOTAL VISUAL IMPAIRMENT
VA: less than 0.02 (20/1000)

CF at: 1m (3 ft) or less
HM: 5m (15 ft.) or less
Light projection, light perception
VF: 5 degrees or less</td><td>Severe blindness, Near-total blindness</td></tr>
<tr><td>TOTAL VISUAL IMPAIRMENT
No light perception (NLP)</td><td>Total blindness</td></tr>
</table>

CF = counts fingers (without designation of distance may be classified to profound impairment)
HM = hand motion (without designation of distance may be classified as near-total impairment)
VA = visual acuity (refers to best achievable acuity with correction)
VF = visual field (measurements refer to the largest field diameter for a 1/100 white test object)

Modified from the International Classification of Diseases, 9th rev. Clinical Modification

Table 2

Common Causes of Visual Impairment

Achromatopsia
Albinism
Age-related maculopathy:
  atrophic, exudative
Amblyopia
Angioid streaks
Aniridia
Anterior cleavage syndromes
Cataract
Central retinal artery occlusion
Central retinal vein occlusion
Cerebrovascular accident
Choroideremia
Coloboma
Cone-rod dystrophy/degeneration
Congenital cataract
Corneal dystrophies
Cortical visual impairment
Cystoid macular degeneration
Cytomegalovirus retinitis
Diabetic retinopathy:
  nonproliferative, proliferative,
Glaucoma: open angle, juvenile,
  primary angle closure
Gyrate atrophy
Harada's disease
Histoplasmosis
Keratoconus
Leber's congenital amaurosis
Leber's optic atrophy
Macular hole
Malignant myopia
Microphthalmus
Nystagmus (congenital)
Optic atrophy:
  primary, ischemic
Optic nerve hypoplasia
Persistent hyperplastic primary
  vitreous
Retinal detachment
Retinitis pigmentosa
Retinoblastoma
Retinopathy of prematurity
Retinoschisis (juvenile)
Solar retinopathy
Stargardt's macular degeneration
Toxoplasmosis
Traumatic brain injury

Table 3
Components of the Patient History

I. Ocular History
- Diagnosis and onset of symptoms
- Past, current, or planned surgeries or treatments
- Stability of vision
- Family history of eye disease
- Previous history of eye disease or vision problems
- Current or previous use of spectacles, contact lenses, or low vision aids
- Patient's understanding of vision condition and implications for functioning

II. Visual Functioning
- Ability to read print and specific reading needs (e.g., bank statements, bills, magazines)
- Other near visual abilities and needs (e.g., writing, sewing, activities of daily living)
- Intermediate visual ability and needs (e.g., use of computer, reading music)
- Distance visual ability and needs
- Independent travel ability and needs (e.g., driving and use of public transportation)
- Photophobia, glare sensitivity, and lighting requirements

III. Medical History
- General health review
- Current medications
- Hearing impairment or other handicapping conditions
- Self-care needs (e.g., ileostomy, diabetes)
- Orthopedic handicaps
- Psychological considerations (e.g., denial, depression, codependency, or suicidal tendencies)

IV. Social History
- Living arrangements (e.g., lives alone)
- Support systems
- Family interactions
- Employment issues
- Educational concerns
- Recreational concerns

V. Specific Goals or Needs
- Needs as stated by the patient
- Needs as determined by the history
- Needs as identified by the employer, teacher, family, or caregiver
- Realistic patient goals (an ongoing process developing during the course of the examination and exploration of rehabilitation options)

Table 4
Recommendations for Measurement of Visual Acuity

I. Distance Visual Acuity Measurement
- Use appropriate vision charts (Feinbloom, Bailey-Lovie, ETDRS, etc.).
- Use appropriate testing distances (10 feet, 2 meters, 5 feet, etc.).
- Evaluate eccentric viewing techniques.
- Assess effects of illumination.
- Record measurement of very poor vision as HM, LPP, LP, NLP.
- Record distance visual acuity as actual test distance over size of character read.
- Use nonstandard techniques (preferential looking, visually evoked potentials, edibles, environmental targets, diagnostic patching, etc.) when appropriate.

II. Near Visual Acuity Measurement
- Use appropriate vision charts (Lighthouse near acuity chart, near ETDRS chart, etc.).
- Use single character visual acuity.
- Evaluate word recognition abilities.
- Measure continuous text visual acuity.
- Select appropriate testing distances.
- Use M system along with testing distance for recording visual acuity.
- Assess effects of illumination.

HM = hand motion; LPP = light projection; LP = light perception; NLP = no light perception.

Table 5
Refraction Techniques for Use with the Low Vision Patient

I. Objective Refraction Procedures
- Autorefraction
- Standard techniques with trial lenses
- Radical retinoscopy
- Off-axis retinoscopy
- Near retinoscopy
- Keratometry or corneal topography to measure anterior corneal curvatures and corneal integrity

II. Assessment of Subjective Refraction
- Trial frame, when indicated
- Just noticeable difference (JND) technique
- Hand-held Jackson cross cylinder
- Nonstandard distances
- Stenopaic slit
- Multiple pinhole lens

III. Assessment of Habitual Spectacles and Use of Low Vision Devices
- Equivalent power (F_e) or magnification of current lenses and optical systems
- Performance with current lenses and optical systems

Table 6
Determining Magnification for Near Needs

I. Determine the Required Starting Addition Using One of the Following Approaches:[64]

A. Add based on starting near visual acuity with appropriate accommodation or addition required. Measure near visual acuity using the M system and record as a fraction (testing distance over M letters read). When the goal is 1 M, a simple ratio gives the focal distance of the addition required to read 1 M.

Example: If 4 M is read at 40 cm and recorded as .40/4 M = x/1 M, then x = .10 (or 10 cm), which requires a +10.00 D addition.

B. Reciprocal of vision. Use the ratio of the denominator of distance Snellen visual acuity (20-foot equivalent) to the desired near visual acuity (reduced Snellen equivalent at 16 inches) multiplied by +2.50.

Example: If distance visual acuity is 20/200 and desired visual acuity is 20/50, then the starting addition is 200/50 x +2.50 = +10.00 D lens.

C. Kestenbaum's rule. Use the reciprocal of the distance visual acuity to calculate the dioptric power of the addition.

Example: If distance visual acuity is 20/200, then the reciprocal is 200/20 = +10.00 D addition.

II. Refine Addition Power with Continuous Text Materials:

Once the starting addition power has been determined using single-letter acuities, and taking into consideration Amsler grid and contrast sensitivity results, use continuous text materials to refine the dioptric power needed to read text most fluently. Attempt to base the final addition power on the actual materials the patient wishes to see (e.g., newspaper, music), not on a text chart.

III. Evaluate Equivalent-powered Systems:[65-67]

Equivalent power refers to the single lens power that could replace the entire optical system and takes into account the power of the low vision device, the addition or accommodation being used, and the separation between the two:

$$F_e=F_1+F_2-(d)F_1F_2$$

where F_1 is the power of the device, F_2 is the addition or accommodation in play, and d is the distance between F_1 and F_2.

A. Spectacles. Equivalent power depends on the dioptric power of the spectacle correction addition (F_1) along with any accommodation (F_2) supplied by the patient. The patient's refractive error is not included in F_1 or F_e.

$$F_e = F_1+F_2$$

B. Hand-held magnifiers. Equivalent power depends on the power of the hand magnifier (F_1), the near addition or accommodation (F_2), and lens-to-eye distance (d).

Table 6 (Continued)

$$F_e = F_1+F_2-(d)F_1F_2$$

C. Stand magnifiers: Equivalent power of stand magnifier, which depends on the accommodation or addition power (F_2) and the transverse magnification of the stand magnifier itself.

$$F_e = (\text{transverse magnification}) \times (F_2)$$

D. Telemicroscopes. Equivalent power depends on the telescope (TS) power and reading cap power.

$$F_e = [F(\text{reading cap})] \times [Mag_{TS}]$$

E. CCTV and electronic devices. Equivalent power depends on the magnification ratio of the image size to the object size, and accommodation or addition power used.

$$F_e = (F_2) \times \frac{\text{image size}}{\text{object size}}$$

Table 7
Determining Magnification for Distance Needs

I. Determine Magnification Required (task dependent)

The magnification required for distance vision improvement is predicted by the ratio of the denominator of the present visual acuity to the denominator of the desired visual acuity.

Example: If actual visual acuity is 10/60 and desired visual acuity is 10/20, then 60/20 = 3X magnification required.

II. Assess Appropriateness of Telescopic Systems

A. Galilean vs. Keplerian. Consider magnification requirements, field of view, image brightness, and exit pupil positioning.
B. Hand-held vs. spectacle-mounted or clip-on lenses.
C. Bioptic or full-diameter telescopes.
D. Other considerations (weight, cosmesis, cost, etc.).

III. Consider Electronic/electro-optical Options

Head-mounted video display systems provide variable autofocus magnification, variable brightness, and contrast enhancement and reverse polarity capability.

Table 8
Management of Peripheral Field Defects

I. Select the Appropriate Optical Systems

A. Prisms. Place with the base toward the field defect, so that when the patient looks into the prism, the image is shifted towards the apex.

B. Mirrors. Place angle toward the field defect, so that when the patient looks into the mirror, objects are visible in the nonseeing area (the image is reversed).

C. Reverse telescope system. Use to minify the image so that more information fits inside the usable visual field.

D. Minus lens. Hold away from the eye to minify the image overall so that more information fits inside the usable visual field.

E. Amorphic lens system. Use the cylindrical reverse telescope to minify the horizontal meridian only so that more information fits inside the usable visual field.

II. Train the Patient

A. Use of optical systems

B. Improvement of visual skills (e.g., scanning)

C. Improvement of mobility.