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Is there a standard of care for eccentric viewing training?

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Abstract—A study was conducted to determine the current Department of Veterans Affairs (VA) standard of practice for eccentric viewing (EV) training. EV training is the process of teaching patients to realign the visual image away from a diseased foveal/macular region onto healthier retina. Optometrists and Visual Skills Instructors at all VA blind rehabilitation centers (BRCs) and VICTORS (vision impairment centers to optimize remaining sight) programs were asked to rate preference for EV prescription criteria, evaluation, and training techniques. Responses were received from 70% of BRCs and 67% of VICTORS. The respondents reported that all programs include EV training. The average minutes of training per patient varied from 20 minutes to nearly 24 hours, with instructors within a single center varying by as much as two orders of magnitude. Routinely, 82% of optometrists prescribe EV training, yet no consensus was found among these practitioners as to the criteria for selecting the best EV area. The results of this survey reveal an inconsistent standard of practice across VA centers and demonstrate the need for prospective studies of the efficacy, effectiveness, and cost-effectiveness of EV training.

Key words: eccentric viewing, eccentric viewing training, low-vision evaluation, low-vision rehabilitation, low-vision training, vision rehabilitation, vision training.

INTRODUCTION

Patients with low vision (LV) caused by macular diseases frequently have distortion, blur, or scotomas in their central visual field that hinder performance of many daily activities (reading [1–4], face recognition [5], visual search [6], and space perception [7]) and visual functions (contrast sensitivity [8], contrast discrimination [9], stereoscopic depth perception [10], and fixation stability/precision [11–13]). To compensate, patients with a central scotoma rely on a small area(s) of viable retina spared from damage or an area of retina outside of the damaged foveal/macular region [3]. The process of aligning the image into a new retinal viewing area is referred to as eccentric viewing (EV) [14]. The ability to resolve fine detail decreases as the image of interest is relocated from the fovea toward the peripheral retina. Therefore, the lower resulting visual acuity must be compensated through use of optical magnification [15].

Abbreviations: BRC = blind rehabilitation center, CCTV = closed-circuit television, EV = eccentric viewing, LV = low vision, PRL = preferred retinal locus, SLO = scanning laser ophthalmoscope, TRL = trained retinal locus, VA = Department of Veterans Affairs, VAMC = VA medical center, VICTORS = vision impairment center to optimize remaining sight.

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The work of greatest significance in the study of EV is the documentation of the preferred retinal locus (PRL), characteristics of size and shape of scotomas surrounding the PRL, and PRL ability measured with the scanning laser ophthalmoscope (SLO) [1–3,14–18]. In many cases, patients spontaneously develop eccentric fixation, consistently using a PRL to perform visual tasks previously performed by the nonfunctioning fovea [1–3,14–18]. Fletcher and Schuchard found that 84.4 percent (1,130 of 1,339) eyes of patients with LV seen consecutively at a Midwest LV clinic demonstrated a PRL [17]. Eyes that did not develop a PRL frequently displayed more recent vision loss or demonstrated a large dense scotoma in one eye and fixation in the other eye within the central 5° [17]. The PRL is not always located as close as possible to the fovea [17]. In the LV population reported by Fletcher and Schuchard, PRLs tended to border one or more scotomas and, in 17.4 percent of eyes, dense retinal scotomas completely surrounded the PRL [17]. Several investigators have reported that most patients with central field loss caused by age-related macular degeneration (AMD) develop a PRL below or to the left of the scotoma border in their visual field space [18–19]. Lei and Schuchard have reported that some patients use two or more well-defined PRLs with the use of each depending upon the brightness of the object [20]. The mechanism used by the visual system to choose a particular PRL is not known [17].

The shape, size, and placement of scotomas as well as retinal integrity may influence PRL ability [1–3,14–18,21–22]. Timberlake et al. first measured PRL ability [1]. Fixation stability was calculated from horizontal and vertical standard deviations of target position and bivariate contour ellipse area [1]. Fletcher and Schuchard have developed a scoring system to judge patients' fixation, pursuit, and saccades in the SLO [17]. These investigators report considerable variation in fixation stability, pursuit, and saccadic abilities. Based upon these findings, Fletcher and Schuchard conclude that PRL abilities are likely to impact performance of many daily activities such as reading, walking through a crowd, or recognizing faces [17].

Reading speed, critical print size, and reading acuity are decreased when macular scotomas are located near the PRL [3]. Presence of a scotoma near fixation [3] and scotoma size [4] are associated with slower reading speed. Reading accuracy, however, can be maintained even with large scotomas [4]. The position of the scotoma relative to the PRL is not a statistically significant determinate of reading rate [3]. Reports by Fletcher et al. indicate considerable variability in maximum reading rates measured with the Minnesota Reading Test that were not explained by decreases in visual acuity or scotoma location [3]. Cognitive ability, PRL fixation ability, or saccadic eye movements may explain the reduced reading rates in patients who have scotomas [3].

Although most patients with macular disease develop a PRL, it is uncertain if this PRL is the best area for optimal visual function [14]. Patients might see better if they use another area called "trained retinal locus" (TRL) for their "pseudofovea" [21–22]. The TRL could be chosen on the basis of retinal integrity, visual acuity, or the size, shape and placement of scotomas. Based upon their clinical experience that time elapses before patients with dense central scotomas establish a definite PRL, Nilsson et al. attempted to teach patients with one normal eye who were using a retinal locus for fixation within a dense central scotoma in the other eye to use a new retinal locus [21]. They documented the location and stability of a newly established eccentric retinal locus more suitable for reading through retinal fixation photos in five of six patients after training [21]. In a more recent study, Nilsson et al. reports improved reading speed for 18 patients with central scotomas trained to use a retinal locus above or below a retinal lesion [22]. Scrolled text presented in the SLO was used for training. Use of a PRL prior to training and a TRL established after training time of 5 to 6 hours was confirmed by SLO. Long-term use of the new TRL has not been investigated.

EV training was developed and implemented before the discovery of the PRL. In 1976, Holcomb and Goodrich reported results from a controlled study demonstrating that EV could be trained [23]. Following Holcomb and Goodrich's discovery, EV evaluation and training techniques were introduced in Department of Veterans Affairs (VA) blind rehabilitation training programs [23–28]. These techniques are documented in LV training manuals [27–29]. These manuals, articles, and case reports describe methods for identifying and training an optimal pseudofovea as well as measuring visual skills for reading [23–29].

Although EV training has been used in LV practice for many years with anecdotal claims of success [24–30], some LV specialists are skeptical of its value. The literature on the efficacy or effectiveness of EV training is impoverished. Only a handful of studies even address the question and very few, if any, could be considered clinical trials in their design or execution.

A masked clinical study conducted at the Hines Blind Center showed improvement in reading speed for some patients, but not for all patients who received EV training and instruction in visual skills for reading [30]. The researchers assessed saccadic eye movements and reading capabilities in veterans with macular disease to determine whether changes in saccadic frequency are correlated with changes in reading rates or number of errors for a reading task [30]. This study was conducted to resolve a difference of opinion between optometrists regarding the value of EV training. Results suggest that individuals who read more than 10 words a minute with less than two errors for a short paragraph and with a saccadic frequency score of less than 2.0 prerehabilitation were more likely to make significant gains in reading rate after an LV program than were those individuals who initially read slower, had more errors, or had poor saccadic eye movements [30].

Based upon our experience and reports in the literature, EV evaluation and training are time-consuming. Training requires a high level of clinical skill from the instructors and considerable cooperation from the patient. Even in comprehensive rehabilitation programs, some patients benefit more from one type of training than another and the instructor may need to use several different techniques to achieve success [23–24]. Patients who will benefit from EV training and the specific procedures to use for best results in different clinical scenarios need to be identified to enable rehabilitation clinicians to demonstrate best practices by improving functional independence and quality of life for persons with vision loss.

METHODS

In this pilot study, a questionnaire was developed to assess (1) current practice patterns for EV evaluation, prescription, and training in VA blind rehabilitation centers (BRCs) and vision impairment centers to optimize remaining sight (VICTORS) programs and to assess (2) the perception of service providers as to the benefits of this training. Because we performed the study to determine the current standard of practice rather than to educate optometrists and instructors, we used the terms "area of retina currently used for EV," "natural EV position," and new "EV position" rather than formally defining EV, EV training, TRL, or PRL in the survey instrument. Our concern was that these definitions might bias the responses and that optometrists or instructors who were not familiar with the terminology of PRLs and TRLs or recent research studies in the area would decline to complete the survey.

Although many researchers believe that the best method to determine a PRL is an SLO—and this only applies to patients who are monocular—the SLO is a very expensive instrument that is primarily used in research. Most VA clinical centers do not have an SLO. Optometrists and instructors at these centers use other testing procedures to obtain information regarding patients' EV behavior. The methods for evaluation, training, and prescription of EV that are included on the questionnaire were identified through literature review and information obtained from discussions with VA optometrists and visual skills instructors [21–29].

At VA BRCs, rehabilitation is provided for legally blind veterans by an interdisciplinary team of optometrists, psychologists, social workers, physicians, nurses, and blind rehabilitation instructors [31]. Blind rehabilitation instructors, who usually have master degrees in rehabilitation teaching or orientation and mobility, are responsible for EV training. For legally blind veterans with LV, comprehensive rehabilitation is usually offered at a residential center where admission ranges from 1 month to 6 weeks. Veterans participate in a variety of skill courses including LV evaluation and training, orientation and mobility, daily living skills, manual skills, and adaptive computer training. Psychology and social work support the veteran with group and individual counseling to promote adjustment to disability.

At VA VICTORS, an interdisciplinary team consisting of optometrists, an LV (visual skills) instructor, a social worker, and/or a psychologist provides LV services [32]. Veterans are usually housed at the hospital as lodgers. Admission varies from a couple of days to a week. Both the BRCs and VICTORS provide LV devices for veterans and extensive training in their use.

To assess the standard of care for EV training, the administrative directors of all 10 VA blind rehabilitation programs and the 3 VICTORS programs were mailed a letter requesting that the optometrists and visual skills instructors at their sites complete a questionnaire on EV training. Included were the BRCs in Augusta, Georgia; Hines, Illinois; Birmingham, Alabama; San Juan, Puerto Rico; Tacoma, Washington; Waco, Texas; Tucson, Arizona; West Palm Beach, Florida; West Haven, Connecticut; and Palo Alto, California, and the VICTORS programs in Chicago, Illinois (West Side); Kansas City, Missouri; and Northport, New York. The visual skills instructors were asked to rate both the frequency of use and preference for EV evaluation and training techniques. The optometrists were asked to rate EV evaluation techniques and EV training prescription criteria.

RESULTS

Responses were received from 70 percent of BRCs and 67 percent of VICTORS programs. Respondents included 24 visual skills instructors: 5 from Hines BRC, 5 from Palo Alto BRC, 3 from San Juan BRC, 3 from Birmingham BRC, 2 from Tacoma BRC, 2 from Augusta BRC, 2 from West Palm Beach BRC, 1 from Kansas City VICTORS, and 1 from West Side (Chicago) VA Medical Center (VAMC) VICTORS. The questions asked of the visual skills instructors and their responses are presented in **Table 1**.

Of the visual skills instructors who completed the survey, 92 percent reported that they routinely try to estimate the area of retina used for EV prior to training and routinely evaluate patients' EV skills; the others reported that they perform those evaluations occasionally. Eighty-eight percent of the respondents routinely evaluate other areas of retina as candidates for use with EV; the others state that they do so occasionally. The instructors use a wide variety of techniques to evaluate EV. The most commonly used methods are estimating from visual fields; observing the patient's head or eye movement; measuring visual acuity in different directions of gaze; observing the patient looking at clock hours on the clock face or above, below, left, or right of a letter or object to be identified; and moving acuity cards until numbers or letters are identified. Less commonly used methods are SLO, examining of retinal fixation photographs, or observing the first Purkinje image. Observation techniques were preferred by 37 percent, visual acuity by 32 percent, visual fields by 26 percent, and SLO by 5 percent. Of the instructors who reported using visual fields to evaluate EV, 77 percent preferred tangent screen measures. Goldmann visual fields, SLO, and Amsler Grid were also reported as preferred methods.

Respondents (visual skills instructors) who reported that they routinely provide EV training were 96 percent; the others communicate providing EV training occasionally. EV training is routinely provided by 26 percent using the natural EV position and 29 percent using a new EV position. More than half the respondents (54%) believe training patients to move their eyes instead of their heads is always important, while 42 percent believe it is sometimes important. The most common training techniques used are reading exercises with optical LV aids or reading exercises on closed-circuit television (CCTV) that have patients practice scotoma placement and eye movement control, practice EV through telescope or tube, practice with playing cards, practice with word games, and find objects on an EV wall.

An EV wall is a modification of the stand with the bar technique developed by Goodrich and Quillman [24,33]. The fixation bar is a vertical pole mounted on a rolling stand. A cross arm about 6 feet in length that can be rotated vertically, horizontally, or obliquely is attached in the center at the top of the bar. While the patient stands 5 to 10 feet away with one eye covered, a letter that subtends a visual angle corresponding to the patient's best visual acuity is placed on a peg in the center of the bar at the patient's eye level. The patient moves his eye slowly in the correct direction until the target is seen as clearly as possible and the letter can be identified. Multiple letters can be put on pegs and the bar can be rotated in different directions for scanning practice. The EV wall is a portable 4-foot by 8-foot black wall constructed with pegboard. The wall replaces the fixation bar mounted on a stand. Letters can be put on pegs for patients to practice fixation and vertical, horizontal, or diagonal scanning.

Less commonly used training techniques are reading exercises on a computer, prism, fixation bar mounted on a stand, SLO, and other experimental devices. None of the visual skills instructors reported using strobe techniques, a tachistoscope, or a slide projector. It is not surprising that the strobe techniques are not used, because Holcomb and Goodrich reported these techniques caused discomfort [23]. Reading exercises were preferred by 43 percent, and the EV wall/stand was preferred by 29 percent. Also included in preferred techniques were playing cards, find-the-letter or word games, and looking through a telescope. Most instructors (92%) routinely provide EV training before training with LV devices. Over 78 percent of instructors routinely provide or reinforce EV training during instruction with LV devices.

We were surprised that none of the instructors reported using the Pepper Visual Skills for Reading Test (VSRT). The Pepper VSRT, developed by Baldasare et al., is an oral reading test developed to assess reading skills of adults who read efficiently prior to vision loss

Table 1.
Instructor eccentric viewing (EV) evaluation and training questionnaire responses.

No.	Question	Responses (%)		
1	In your low-vision (LV) evaluations, do you try to determine the area of retinal viewing currently used by the patient for EV?	92 (routinely)	8 (occasionally)	0 (never)
2	Do you evaluate the patient's skills in using EV?	92 (routinely)	8 (occasionally)	0 (never)
3	Do you evaluate potential use of other areas of retina for EV that might be more effective than the one the patient habitually uses?	88 (routinely)	12 (occasionally)	0 (never)
4	Which techniques do you use to evaluate EV?			
	Visual fields	92	—	—
	Observation of patient's head or eye movement	88	—	—
	Patient looks at instructor's face	83	—	—
	Visual acuity at different positions of gaze	79	—	—
	Patient identifies clock hours	75	—	—
	Patient identifies object or line above, below, left, or right of the letter/word/object he or she is trying to see	75	—	—
	Instructor moves acuity cards for the patient until letters/numbers identified	58	—	—
	Scanning laser ophthalmoscope (SLO)	13	—	—
	Examination of retinal fixation photographs	8	—	—
	Observation of corneal light reflex	8	—	—
	Pepper Visual Skills for Reading Test	0	—	—
	Which technique do you prefer?			
	Observation (head/eye movement/corneal reflex)	37	—	—
	Visual acuity	32	—	—
	Visual fields	26	—	—
	SLO	5	—	—
5	If you use visual fields to evaluate EV, which method do you find to be most useful?			
	Tangent screen	77	—	—
	Goldmann	14	—	—
	SLO	5	—	—
	Amsler Grid	4	—	—
6	If a patient has difficulty with EV, do you believe that EV training will be useful (assuming the patient has the ability to learn)?	67 (always)	33 (occasionally)	0 (never)
7	Do you provide EV training?	96 (routinely)	4 (occasionally)	0 (never)
	Using the natural EV position	26 (routinely)	65 (sometimes)	9 (never)
	Using a new EV position	29 (routinely)	71 (sometimes)	0 (never)
8	Is it important to train patients to move their eyes rather than their head?	54 (always)	42 (sometimes)	4 (never)
9	When EV is indicated, do you teach this skill before training with optical/electronic LV devices?	92 (routinely)	8 (occasionally)	0 (never)
10	When EV training is indicated, do you teach this skill as part of training with optical/electronic LV devices?	78	22	0
11	Which EV training methods do you use?			
	Reading exercises with optical devices/closed-circuit TV	88	—	—
	Practice EV through telescope or tube	67	—	—

Table 1. (Continued)
Instructor eccentric viewing (EV) evaluation and training questionnaire responses.

No.	Question	Responses (%)		
11	Which EV training methods do you use? (cont'd)			
	Practice with playing cards	46	—	—
	Practice with games such as “find the letter or word”	42	—	—
	EV cards placed on wall or stand	33	—	—
	Reading exercises on the computer	21	—	—
	Prism	8	—	—
	Exercises on SLO	4	—	—
	Other experimental devices	4	—	—
	Tachistoscope	0	—	—
	Which method do you prefer?			
	Reading exercises	43	—	—
	EV wall/stand	29	—	—
	Playing cards	9	—	—
	Find-the-letter or word games	9	—	—
	Practice EV looking through telescope or tube	9	—	—

from macular disease [34]. Although the Pepper VSRT does not evaluate the specific area of retina used for EV, the test establishes baseline performance, providing the visual skills instructor with an estimate of a reader's eye movement control, word recognition skills, and scotoma placement [35]. Assessment of the type of errors that a reader may make is important information to be used in planning EV and reading training [36,33].

The average number of minutes of EV training per patient varied widely between instructors, even those from the same center. The lowest reported average training time per patient is 20 minutes and the greatest is nearly 24 hours. The **Figure** illustrates histograms of the average EV training time per patient for each center (across instructors).

The least amount of training occurs in the VICTORS programs (30 minutes average before LV devices are used and 60 minutes average with the LV devices for the West Side Chicago VAMC and 20 minutes average for both before LV devices and with LV devices for the Kansas City VAMC). The Hines BRC provides the most EV training time (266 minutes average per patient before LV devices are used and 483 minutes average with LV device).

Although every responding BRC and VICTORS program provides EV training, few agree on the preferred methods and training protocols. Not only does poor agreement exist among centers on the amount of EV training offered each patient, but also instructors within a single center can vary by as much as two orders of magnitude. This finding might be because some instructors specialize in more difficult patients who take more time, but that would not explain the discrepancies in the average training

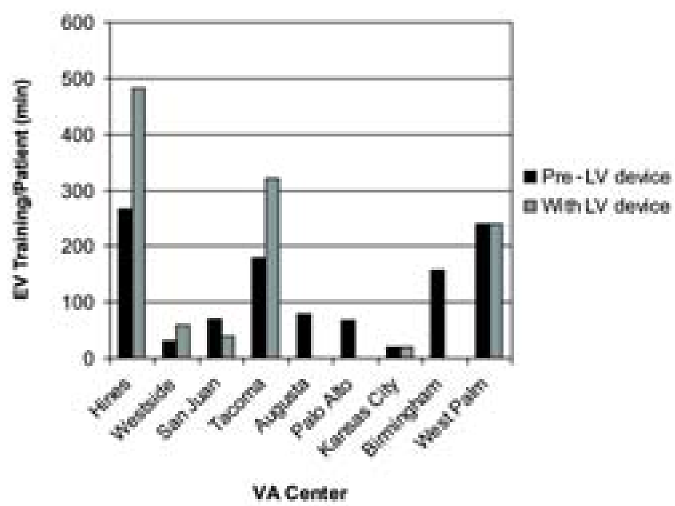

Figure.
Average time spent in eccentric viewing (EV) training (pre-low-vision [pre-LV] device use and with LV devices) for each center. Black bars illustrate average number of minutes of EV training per patient before LV devices are used. Gray bars are average number of minutes per patient of EV training with LV devices.

time per patient among centers. Not surprisingly, the same variability is seen in the pattern of responses to similar questions posed to optometrists at the same centers.

Ten optometrists responded from 9 facilities, including Hines BRC, West Palm Beach BRC, Palo Alto BRC, Tacoma BRC, Birmingham BRC (2), Waco BRC, Tucson BRC, Kansas City VICTORS, and West Side VICTORS. The questions asked of the optometrists and their responses are presented in **Table 2**. All the VA optometrists responding to the questionnaire routinely evaluate the habitual EV posture of their patents and the patient's skill in using EV. Seventy-three percent also evaluate alternative areas of the retina that might be trained. Techniques most frequently used to evaluate EV include observation of the patient's head or eye movement, measurement of visual acuity at different positions of gaze, and visual field reports. At the time of this survey, two facilities, Augusta and Kansas City, have SLOs that are used in clinical practice. The evaluation technique preferred by 50 percent of optometrists was observation of head or eye movement or corneal reflex. When visual field is used to evaluate central scotomas, tangent screen is used most frequently (60%).

When patients demonstrate difficulty with EV, 64 percent of the optometrists responding to the questionnaire believe that EV training will be useful when the patient has the ability to learn this skill. More than half (55%) agree that it is always important to train patients to move their eyes rather than their head. No area of retina is prescribed more frequently than any other for EV training by 37 percent, although retina temporal to the fovea was preferred by 27 percent. Of the optometrists, 55 percent base their EV prescription on best visual acuity with the EV position, while 18 percent cited scotoma placement relative to reading continuous text as the criteria favored for determining EV position. Only 9 percent of the respondents used the natural EV position as the area of retina to be trained.

When surveyed, optometrists at the VA BRCs and VICTORS did not agree on which factors are most important in prescribing EV training. Of all optometrists, 20 percent use scotoma placement relative to reading continuous text, 50 percent use best acuity with EV position, 10 percent use the largest field of view with EV position, and 10 percent use the natural EV position. An active disease state, which may impact future use of an existing EV area, is also considered and may explain the choice of retinal areas with poorer visual acuity.

DISCUSSION

The results of this survey, particularly with regard to EV training time per patient, reveal an inconsistent standard of practice across VA centers. This inconsistency is not surprising because EV training was developed and implemented before the PRL was discovered with the SLO and before routine evaluation of the retina to determine the effects of the eye condition on visual functioning was standard practice in LV evaluations.

Table 2.
Optometrist eccentric viewing (EV) evaluation and prescription questionnaire responses.

No.	Question	Responses (%)		
1	In your LV evaluations, do you try to determine the area of retina viewing currently used by the patient for EV?	100 (routinely)	0 (occasionally)	0 (never)
2	Do you evaluate the patient's skills in using EV?	100 (routinely)	0 (occasionally)	0 (never)
3	Do you evaluate potential use of other areas of retina for EV that might be more effective than the one the patient habitually uses?	73 (routinely)	27 (occasionally)	0 (never)
4	Which techniques do you use to evaluate EV?			
	Observation of patient's head or eye movement	100	—	—
	Visual acuity at different positions of gaze	82	—	—
	Patient identifies object or line above, below, left, or right of the letter/word/object he or she is trying to see	73	—	—
	Visual fields	73	—	—

Table 2. (Continued)
Optometrist eccentric viewing (EV) evaluation and prescription questionnaire responses.

No.	Question	Responses (%)		
4	Which techniques do you use to evaluate EV? (cont'd)			
	Patient identifies clock hours	45	—	—
	Patient looks at examiner's face	45	—	—
	Examiner moves acuity cards for the patient until letters/numbers identified	45	—	—
	Examination of retinal fixation photographs	27	—	—
	Scanning laser ophthalmoscope (SLO)	9	—	—
	Observation of corneal light reflex	9	—	—
	Pepper Visual Skills for Reading Test	9	—	—
	Which technique do you prefer?			
	Observation (head/eye movement/corneal reflex)	50	—	—
	Visual acuity	30	—	—
	Retinal photos	10	—	—
	SLO	10	—	—
5	If you use visual fields to evaluate EV, which method do you find to be most useful?			
	Tangent screen	60	—	—
	Humphrey 10-2	20	—	—
	Goldmann	10	—	—
	SLO	10	—	—
6	If a patient has difficulty with EV, do you believe that EV training will be useful (assuming the patient has the ability to learn)?	64 (always)	36 (occasionally)	0 (never)
7	Do you prescribe EV training?	82 (routinely)	18 (occasionally)	0 (never)
	Using their natural EV position	27 (routinely)	73 (sometimes)	0 (never)
	Using a new EV position	27 (routinely)	64 (sometimes)	9 (never)
8	Is it important to train patients to move their eye rather than their head?	55 (always)	45 (sometimes)	0 (never)
9	Which area of the retina do you most frequently prescribe for EV training?			
	No area prescribed more frequently than others	37	—	—
	Retina temporal to the fovea	27	—	—
	Retina superior to the fovea	9	—	—
	Retina inferior to the fovea	9	—	—
	Retina nasal to the fovea	9	—	—
	Retinal area indicated by SLO	9	—	—
	In deciding which area of retina to prescribe for EV training, which factor do you consider most important?			
	Best visual acuity with EV position	55	—	—
	Scotoma placement relative to reading continuous text	18	—	—
	Largest field of view with EV position	9	—	—
	Using the natural EV position	9	—	—
	SLO results	9	—	—

Although the SLO is the gold standard for research on PRLs, limitations to its use exist, including the high costs of purchase and maintenance. SLO measurements are made under monocular viewing conditions. Whether the PRL for monocular viewing is the same as the PRL for binocular viewing is not known. Visually impaired patients often view binocularly when using some LV aids (e.g., CCTV). Often PRL studies performed on an SLO conclude that PRLs may be different and occur at non-corresponding points in the two eyes [15]. The SLO and similar devices can be used to determine retinal areas used for EV or to measure visual skills with the PRL using stimuli that can be displayed in the instrument. However, the SLO cannot be used to evaluate eye position outside the instrument. Thus far, LV clinicians and researchers have depended on the assumption that TRL or PRL used in instruments or observed by the instructor during training is the area of retina actually used during daily activities. This may or may not be a correct assumption, especially because determining the area of the retina the patient is using while looking through LV devices such as telescopes is extremely difficult.

Head- and eye-tracking systems that do not interfere with the patient's vision while she or he performs everyday activities may enable researchers to judge patient's viewing behavior by observing the patient's pupil and the first Purkinje image. Investigators have successfully used these systems to evaluate gaze behavior in mobility [37]. Head- and eye-tracking systems may provide measures of the efficacy of EV training and enable us to measure how well and consistently learned EV skills are used while the patient is performing everyday activities. However, to measure the effectiveness of EV training investigators must also measure the patient's perception of his or her functional ability with visual function questionnaires such as the VA Low Vision Visual Functioning questionnaire 48 that was developed to measure outcomes of the LV rehabilitation intervention [38]. These methods and tools are needed for the randomized clinical trials that will determine who will benefit from EV training and the specific procedures to use for best results in different clinical scenarios.

CONCLUSIONS

We can conclude from these preliminary studies that all VA BRC and VICTORS personnel believe that EV training is important and they provide it routinely. However, an enormous disagreement exists on how much training should be provided, the criteria for choosing the EV area for training, the best method for evaluating EV, and the best method of EV training. These results are not surprising considering that researchers, e.g., Schuchard et al., perceive that there are "currently no clinically practical means for accurately and precisely measuring scotomas and preferred retinal loci for visual tasks in LV patients. In addition, there is neither a reliable nor efficient method for training EV at optimal retinal areas, nor for evaluating the effectiveness of the training" [16]. These preliminary results demonstrate that it is necessary to develop and validate objective and quantitative measures that can be used in clinical settings to evaluate EV behavior, to characterize the visual capabilities of EV loci, and to evaluate both the efficacy and effectiveness of EV training. Without such objective measures, it will not be possible to build a consensus among providers on how patients should be evaluated for EV training, what criteria should be used to judge patient eligibility for training, and which methods are most cost-effective in producing the desired outcome.

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