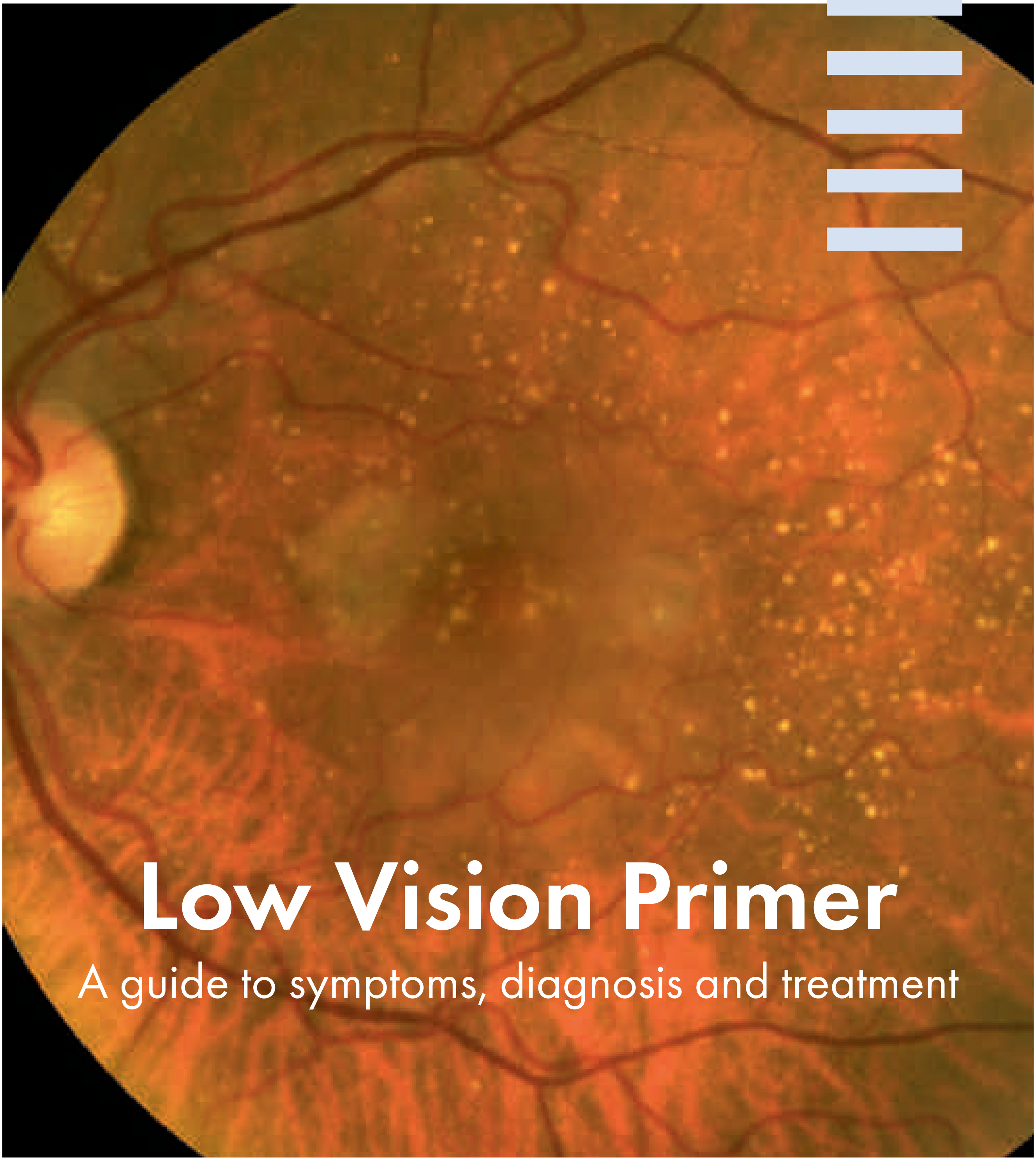
Supplement to
AUSTRALIAN OPTOMETRY

pharma

SEPTEMBER 2013

Special issue



Low Vision Primer

A guide to symptoms, diagnosis and treatment

- Essential Guide
- AMD treatments
- Psychosocial issues
- Orientation and mobility
- Devices and aids
- Technology
- Bionic eye
- Billing
- Resources

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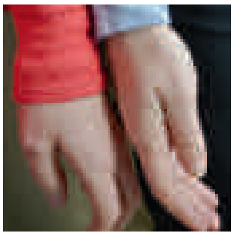
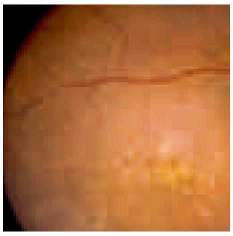

Published by

OPTOMETRISTS ASSOCIATION AUSTRALIA

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COVER: Subretinal fluid and drusen in early wet AMD
Photo: East Melbourne Optometry & Low Vision Centre

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Low Vision Primer

Editorial

OPTOMETRISTS
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LOW VISION WORKING GROUP

With the ageing of the population, practising optometrists can expect to encounter more cases of age-related macular degeneration, glaucoma and diabetic retinopathy that along with inherited and congenital diseases such as retinitis pigmentosa, may result in low vision. The growing prevalence of these eye conditions requires us to be knowledgeable in the treatments and the long-term care options available to patients.

While by no means comprehensive, this *Low Vision Primer* discusses the conditions surrounding low vision, as well as the broad range of low vision devices and rehabilitation strategies that can provide support, from the latest simple magnifiers and lighting, to smartphones as a low vision device and innovative electronic magnifiers. It puts into perspective significant advances in treatment options, such as anti-VEGF agents for wet macular degeneration and the bionic eye.

It also discusses how to detect and support patients with depression, and presents information on comprehensive low vision service providers and peer support organisations.

The aim of the *Low Vision Primer* is to expand your knowledge on this topic, and offer a handy chairside reference and some of the tools necessary for you to support and improve the quality of life of your patients with vision impairment.

Dr Sharon Bentley
Convenor, Low Vision Working Group
Optometrists Association Australia

A word from Pfizer Australia, sponsor of the *Low Vision Primer*

Pfizer Australia is one of the nation's leading providers of prescription medicines. At Pfizer, we are committed to advancing treatment in eye care by developing breakthrough medicines focused on key areas where there is unmet need, such as glaucoma and retinal diseases.

Within ophthalmology, we have a number of established products specifically for the treatment of glaucoma and its devastating long-term effects.

Through commitment to innovation and partnership, we continue to support Australian clinicians in developing new technologies and enhancing pharmacological therapies, providing patients with appropriate aid devices and compliance programs that assist in improving patient care and ultimately quality of life.

Low Vision Primer

A guide to symptoms, diagnosis and treatment

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This *Low Vision Primer* is a simple step-by-step explanation of how optometry helps people with low vision. Prepared by Australian practitioners, it provides reference material for the classification of low vision eye conditions, describes how optical powers can be determined to meet magnification objectives for particular tasks, and lists many of the prescription options available from our suppliers. In addition, we provide information on the medical treatment of AMD and from rehabilitation professionals on the contributions to care by their disciplines.

We encourage optometrists to refer low vision patients to rehabilitation agencies that provide advice to support activities of daily living such as household tasks and personal mobility. We must refer for specialist medical care when this has not been obtained, even if it appears to be not immediately necessary. A good referral relationship with ophthalmology is essential. Always inform the patient's general medical practitioner of your main advice.

This *Primer* does not replace manufacturers' catalogues, nor does it seek to be an encyclopaedic low vision care reference. For a more comprehensive examination of this topic, two particular books are invaluable. Eleanor Faye's classic, *Clinical Low Vision*[1] is out of print but available in optometric libraries. For many years it was the benchmark clinical reference. A more modern treatise and essential reading is the *Low Vision Manual*,[2] edited by optometrists Jonathan Jackson and James Wolffsohn, available from the OAA Bookshop. It provides detailed information on optometric techniques based in a UK setting.

Low vision care is logical and straightforward. It is immensely valuable for patients, challenging but rewarding for practitioners, and a source of sound and long-term practice growth. Remember that you may need low vision care one day.

What is in this *Low Vision Primer*?

1. What is low vision?

The World Health Organization[3] (WHO) defines a person with low vision as having:

- impairment of visual functioning even after treatment and/or conventional spectacle (or contact lens) correction
- visual acuity (VA) <6/18 to >6/60 or
- visual field <10 degrees from fixation

but who is able or potentially able to use vision for the planning and execution of a task.

We add:

- A person who is unable to complete ordinary day-to-day tasks because of vision impairment.

Who has low vision in Australia?

Children and teenagers—congenital or developmental anomalies in the first few years of life are the main causes of LV. These include:

- high ametropia (refractive error or RE)
- nystagmus
- albinism (so always transilluminate irides)
- congenital cataract
- optic atrophy
- monochromasy.

All of these conditions might present with a relatively normal field of vision.

Less frequent causes of low vision include:

- retinitis pigmentosa (RP) in older children
- maculopathies such as Stargardt's
- high myopia
- glaucoma
- retinopathy of prematurity (ROP)
- cortical blindness (related to premature birth).

Review general health and family ocular history. Most LV children (> 90 per cent) have stable vision and benefit in the long term from LV prescribing and support. Our ally in assisting children following medical diagnosis and treatment is the special teacher for the vision impaired. All states provide this service. Teachers provide special insights into children's classroom behaviour and vision demands, assisting us to meet prescription needs for vision devices.

Adults of working age—main causes

- RP (ask about night blindness as a child) and other progressive retinal dystrophies from childhood
- myopia
- diabetic retinopathy
- keratoconus and other corneal pathology such as trachoma and dystrophies
- cataracts
- uveitis
- injuries and other systemic conditions with eye-related complications.

Older adults and the very old—main causes

- age-related macular degeneration (one in four of those over age 85 years, and of these, one in 10 will have moderate or severe LV)
- cataracts prior to IOL implant (most surgery between 75 and 85 years)
- glaucoma
- diabetic retinopathy and other retinal vasculopathies.

Is low vision important?

The Centre for Eye Research Australia (CERA) is based in Melbourne at the Royal Victorian Eye and Ear Hospital and publishes regular reports on vision impairment in Australia. The impact on our population of people with LV and the cost to the community are large. CERA makes recommendations to government and the professions concerning management of vision impairment. See the 'Reports & Monographs' section of the CERA website (www.cera.org.au) for free access to these important documents.

Focus on Low Vision 2007[4] is an excellent summary of all the issues relevant to LV in our population. *Clear Sight Overview: The Economic Impact and Cost of Vision Loss in Australia 2004*[5] explains the financial costs of LV to individual patients and to the community, leaving us in no doubt about the benefits of care for this condition. This report was researched in the early 2000s, so the advent of anti-VEGF treatment and an improved outlook for AMD patients will have changed some of the reported expenditures, but the essential findings are that visual impairment is a huge cost to our community. These reports are essential reading.

The WHO uses the term 'biopsychosocial' to describe how the physical, psychological and social factors shape how LV impacts day-to-day function. Figure 1 shows CERA's diagram representing these interactions. Recent changes to definitions have replaced the term 'disability' with 'activity' or 'ability' and the term 'handicap' with 'participation' to take a more positive view of visual performance.

CERA describes the day-to-day functional difficulties in these terms:

- **Limited distance vision** creates difficulties with independent mobility, recognising people, objects or actions, integrating vision with other senses and understanding non-verbal communication.
- **Poor near vision** creates difficulties with personal care and hygiene, food management, taking care of clothes and reading.
- **Restricted visual fields** create problems with independent mobility and finding objects, particularly in poor light.
- **Personal mobility** under difficult light conditions or in crowded or unfamiliar environments becomes awkward. The risk of falling may limit outings or other social activity and, among other difficulties, lead to symptoms of **depression**.

Many of these issues are dealt with in later sections of this *Primer*.

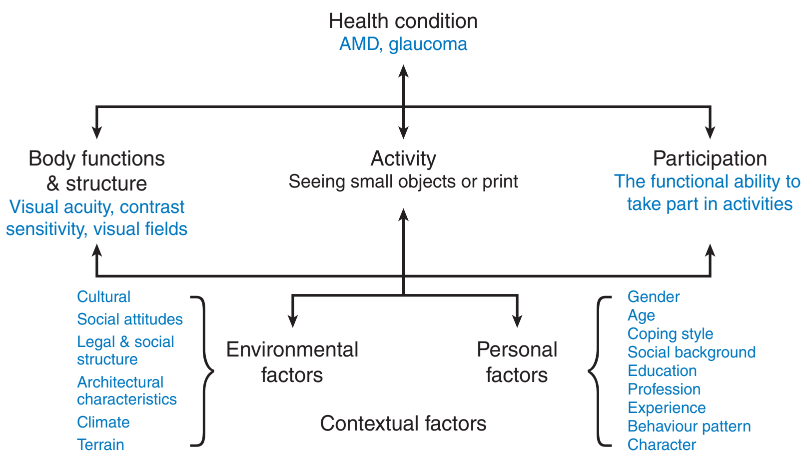


Figure 1. The WHO combines the physical, psychological and social factors that shape how LV impacts day-to-day function under the term 'biopsychosocial'. Rehabilitation care must address each of these factors.

Type of visual field defect	Functional visual symptoms and problems	Treatment and environmental considerations†
NO FIELD DEFECT		
Refractive opacities (including cataract), ametropia albinism, nystagmus, amblyopia, achromatopsia.	Blurred, hazy vision: distance worse than near, glare, usually good pedestrian mobility.	Surgery when indicated, refraction, shades and filters, large print for labels, telephone buttons, glare-free task lighting at higher luminance. Binoculars and telescopes for distance detail, electronic image enhancements.
CENTRAL FIELD DEFECT (SCOTOMA) *		
Macular degeneration, haemorrhage or oedema, diabetic retinopathy, optic neuropathy. * Total blindness is rare, independent travel is still possible.	Difficult or unable to see central visual detail at distance and near, for signs, faces, TV. Central field losses compromise driving ability and mobility. Formed hallucinations may occur. Reading fluency for print may be much worse than indicated by distance single letter VA. Scotomata may be recognised subjectively using the Amsler charts.	Medical/surgical including Lucentis and other anti-VEGF therapy, laser photocoagulation as appropriate. Optical including magnifiers, telescopes, filters and shades, refraction and near spectacles, electronic enhancements. Rehabilitation support for daily activities Area lighting, glare management, high contrast architectural surrounds, conspicuous stair treads.
PERIPHERAL FIELD CONSTRICTION		
1. Entire periphery glaucoma, retinitis pigmentosa, diabetic retinopathy following pan-retinal laser photocoagulation.	Difficult travel and orientation in unfamiliar environments (no threat detection). Night blindness with RP, even in children.	Medical management for glaucoma, diabetes and consequential cataracts. Image enlargement onto peripheral retina may be unhelpful because of field losses.
2. Sector defects# neurologic disease (stroke, brain tumours, tumours, chiasmal defects etc) post detachment losses.	Bumping into objects, glare difficulties, slow light-dark adaptation. Putting things down and losing them. Hemianopsia causes slow reading, losing the place in the text even if distance single letter VA is normal. Watch for cognitive decline in older patients.	Yellow and orange 'blue-blocking' filters, glare management. Mobility training and other rehabilitation. Area lighting, glare management, high contrast architectural surrounds, conspicuous stair treads.
# disability characteristics of these conditions are often unpredictable.		† Rehabilitation training to develop adaptation strategies and new skills are available from low vision clinics and blindness agencies.

Table 1. Faye's classification by visual field loss

2. Classifying low vision by diagnosis, visual field characteristics and task demand

Faye[1] classifies LV by visual field. Table 1 shows conditions, symptoms, treatment and environmental options.

Patients with normal visual fields (RE, nystagmus, early optic atrophy, anterior eye disease) and patients with central visual field losses (maculopathies) have the potential to benefit from image enlargement such as optical and electronic magnification.

Patients with peripheral field losses (RP, glaucoma, stroke, retinal detachment) experience mobility difficulty and may lack the useful peripheral retina that enables a benefit from magnification. Note that other impairments may occur with LV, such as light and dark adaptation difficulties, colour discrimination deficits, ocular motility abnormalities such as convergence failure and diplopia.

3. What are the principles for measuring vision impairment?

In 2002, the National Research Council in the USA attempted to standardise the measurement of visual impairments for determining eligibility for social security benefits.[6] The committee recommended that visual acuity and visual fields should continue as the fundamental tests and that contrast sensitivity testing should be included as a measure of function not expressed by the other two tests.

Other functions such as binocularity, glare sensitivity, colour vision and visual search were judged to be secondary. The question of testing disability directly using task performance was deemed less certain. Four domains were explored: reading, mobility, social participation and tool use–all representing important requirements of everyday life and jobs.

Other means of assessing disability included job analysis databases where vision was related to job tasks or skills, and measures of health-related quality of life. These could be related to employment outcomes but nationally representative datasets of people with serious vision limitations were not available for committee consideration.

A summary of the US National Research Council recommendations were:

Visual acuity: high contrast logMAR charts using glare-free, 160 cd/m^2 luminance scored on a letter-by-letter basis, with binocular or the better monocular VA being representative of everyday vision.

Visual fields: automated static perimetry using a target equivalent to a white III Goldmann, against a 31.5 apostilb (10 cd/m^2) white background. The Central 30-degree radius of the visual field is tested with equal number of target locations in each quadrant no more than six degrees apart. The mean deviation/defect MD is also used to score impairment. This represents the mean overall loss of sensitivity for this field, accounting the size of the defect and normalising this against an age-matched sample of normal observers.

Contrast sensitivity: the test should be used when VA is <6/15 and >6/60 or other evidence of VI is present. It should be relatively insensitive to changes in focus, viewing distance and chart illumination. Only the Pelli-Robson Contrast Sensitivity test was determined to meet these criteria.

The four secondary domains mentioned above could be taken into account as 'adjustments'. In particular, a normative database for reliable reading tests including speed, reading VA and critical print size was needed. When job applicants failed a vocational medical assessment, a test of reading vision was recommended to be included to assess task performance.

Standardised tests for driving ability and performance-based tests of tool use were also needed.

In this *Primer* we will review the application of these tests, suggest modifications for our consulting room use and discuss how results lead us to prescription of LV devices and other services.

4. Classifying impairment: what can be expected for 'ability' and 'participation'?

Match age and diagnosis, then:

- Measure VA at distance and near, measure visual fields using automated perimetry and measure contrast ability using letter charts or contrast edge tests, AND
- Determine level of impairment by low vision category, AND
- Consider what expected abilities might be for this patient for activities of daily living (ADL) and mobility.
- WHO,[7] Bailey,[8] Colenbrander[9] and Haymes et al[10] are essential references.
- Remember that age and physical infirmity are natural limits to ability, in addition to motivation, intelligence and co-operation. Do not demand postural contortions for very short viewing distances or head positions for magnifier or telescope use, particularly in older patients with arthritis or reduced mobility.
- Always ask about patients' personal goals, particularly regarding vocational, educational, personal, family and income issues. Address these goals individually (see below).
- Recent onset or progressing ocular pathologies frustrate adaptations to VI. Address these again once medical treatments have been completed, following physical rehabilitation after trauma or sudden loss or when some 'acceptance' of the inevitable has occurred.
- Talk through the nature of LV and a patient's individual circumstances. The informed patient is better able to judge what the future holds.
- The 'art' of LV care is a skill that comes with time and practice. Establish a realistic expectation for success for vision rehabilitation and the use of devices in the light of all of the above issues.

5. History: what are the issues facing the patient?

- Ensure that identifying information is correct and how to address your patient and any accompanying carer. Are Medicare details correct, or are there any existing entitlement to welfare benefits?
- Does the patient live alone or with others?
- Note present or former occupation and education level as a guide to the patient's potential to understand your explanations.
- Ask about reason for attendance so that a principal goal for the consultation might be established.
- Record a history of previous eye care, name of GP and ophthalmologist for contact and reports. Is there a history of low vision rehabilitation?
- Is the patient's general health robust, or is the patient at risk of other health incidents such as falls or cardiovascular event?
- What is the patient's awareness of the reason for low vision?
- Can the patient manage social interactions? These include
  - Recognising people and faces, actions, gestures and other non-verbal communication
  - Integrating other senses with vision such as hearing and touch
  - Being independently mobile in unfamiliar environments, within a crowd indoors, on the street pavement or in public transport. Is a mobility aid required?
  - Does the patient visit restaurants, play cards such as Bridge, play music, have craft activities or hobbies with others?
  - Has vision impairment caused social isolation or alienation from friends and family?
- Is personal care and personal hygiene manageable?
  - Is the patient required to purchase and prepare food, wash, iron and identify clothing colours and specific garments?
  - Can the patient recognise money easily and manage personal finances such as mailed accounts and banking?
  - Is the patient a computer user, managing email, personal correspondence and Internet banking?
- Does the patient have an issue with glare or lighting?
  - Have photochromic spectacles been prescribed? Are other therapeutic tints worn, such as orange or yellow?
  - Are tinted over-glasses used out of doors?
  - Are there special lighting requirements for near tasks?
- Are distance vision tasks easy? How close does the patient watch television?
  - Is vision for theatre, sports events or religious services adequate?
  - Beside spectacles, are other optical aids used to improve distance vision?
- Are near vision tasks manageable?
  - What can the patient read in newspapers or magazines? Headlines, sub-headlines, text, classifieds or advertisements?
  - Does the patient have library access to large print books?
  - Does the patient have a Daisy reader or other talking books?
- Finally, does the patient seem to have a realistic expectation of future vision status?
  - Does the patient appear depressed or overly anxious about the vision future?
  - Is the patient aware of other services such as adaptive technology, social welfare support such as home help, or education and training for continuing employment?
  - Might the patient be amenable to participate in community or peer support programs offered by blindness agencies and low vision clinics?

Summarise your recommendations in clear and unambiguous language suited to the patient's age, and cultural and educational background.

Allow time to discuss concerns and reflect on the information you provide. Additional consultations and reviews may be necessary to absorb the information you provide.

Figure 2. Simple clinical equipment, such as a retinoscopy lens rack, ± lens flippers and high near addition lens demonstrators in Halberg clips are practical tools for fine-tuning refractions

6. Optometric examination and refracting for low vision

Useful tools for refraction include:

- Distance letter chart, near word and sentence charts, low contrast edges or letter charts.
- Examples of other tasks such as food packages, medicine labels, bills, envelopes and personal reading.
- Autorefractor, retinoscope and prescribing equipment, ±0.37 D hand x-cyl and ±0.5, ±1.0 and ±2.0 D flippers, retinoscopy ±lens rack, topographer or Placido disc.
- Additive power trial lens set, Oculus or equivalent fully adjustable trial frame.
- Halberg clips for over-refractions, trials of high adds.
- Distance telescopes–2x, 4x, both spectacle loupe and hand-held types, 4x, 6x and 8x Keplerian monoculars, some other types.
- Near high bifocal adds (to +8 D Younger) in trial lens form (38 mm round lenses, segs half-way up). Eschenbach Bino plus and Noves.
- Hand and stand magnifiers, some with internal illumination (+6, +10, +16, +20, +32, +40, +50 D, see catalogues for details).
- Spec mounted illuminated 10x and 15x loupes.
- Various shades and filters, most useful in flipper demonstrators.
- PL fluorescent or LED desk lamp, reading stand.
- Access to video, smartphone and CCTV demonstration.

(Figure 2)

Procedure

- Complete an anterior eye (slitlamp) examination for corneal or lens irregularities that compromise reliable subjective refraction judgements.
- Use a vitreo-fundus lens (+78 D) for a complete fundus inspection if the patient has not seen an ophthalmologist previously. Refer for medical management if indicated.

Then ...

- Get information such as prescription details and lens form from previous glasses. If not available from the patient, telephone the previous practitioner for information.
- What VA do these give, and what might be expected if a large refractive error is present?
- Does pinhole improve vision?
- Is vision worse monocularly in latent nystagmus?
- Check for regularity of refraction (scissors retinoscopy reflex, keratometry, Placido disc or topography).
- Are there capsular remnants in the pupil, or a misplaced IOL?
- Are multiple autorefractor readings possible and reliable?
- Determine putative lens powers, then bracket alternative spheres using ±0.5, ±1.0 and ±2.0 D flippers, depending on vision level and patient sensitivity to defocus and image blur.
- Using retinoscopy or other indicated cylinders, check axis and powers using ±0.37 D x-cyl. High power x-cyls are better for high astigmatism off-axis or power but do not help for low astigmatism off-axis or cyls nearly correct.
- Perform cover testing for deviations and convergence failure when central fusion is compromised.
- Always demonstrate final spectacle prescription and compare vision with previous glasses.
- Measure near VA with word reading charts and reading fluency with text. Fluency (reading speed) declines over about two logMAR lines from the preferred smallest print size.
- Always check confrontation visual fields with a LED wand. Near reading tasks may be disabled with hemianopsia, even though distance single letter VA is near normal.
- Ask if Amsler charts grids have missing patches or metamorphopsia. Test monocularly.
- Test contrast sensitivity with low contrast letter or word charts.

7. Measuring distance and near vision to determine magnification needs

Use the Berkeley rudimentary vision test[11] if severe vision loss is present, when visual acuity letter testing is inappropriate (Figure 3). Generating optokinetic nystagmus with a striped tape in an infant demonstrates that vision is present, consistent with the spatial frequency of the tape (Figure 4).

Distance logMAR charts

The significant historical developments in the measurement of visual acuity are a century apart. Herman Snellen introduced his fractional notation for single letter vision tests in the 1860s and Bailey and Lovie[12] formalised the geometric progressions of letter charts in the 1970s, the notation we now know as logMAR (logarithm of the Minimum Angle of Resolution).

Each letter size has a stroke width of one minute of arc (1 ´) and overall height of 5 ´ for a particular viewing distance. The numerator of the Snellen fraction is the particular test distance, usually 6 m or 20 feet. The denominator is the size of the smallest line of letters read, expressed as its 5 ´ distance.

The principle is best known as the ETDRS charts.[13] Original Bailey-Lovie charts used the 10 British standard acuity letters DEFHNPRUVZ

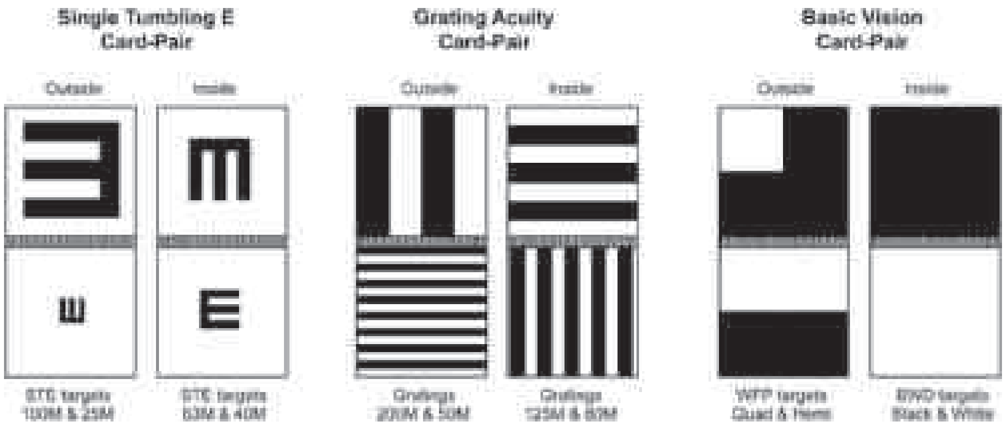


Figure 3. The Berkeley rudimentary vision test. When a patient's vision is beyond conventional letter chart testing, identifying shapes and gratings at a close distance is required to assess resolution.

Figure 4. Simple vision test for infants using reflex optico-kinetic nystagmus in response to a moving tape

while Sloan charts,[14] widely used in the USA, use CDHKNORSVZ. At any level, each line has five letters spaced apart by the letter width. Letters on each chart are thought to be about equally legible. Common confusions are calling V 'Y', N 'H', D 'O' in the British letters, and H 'N', K 'X' and S 'B' or 'E' (because of the three horizontal strokes) on Sloan charts.

The geometry

MAR is the stroke width of the smallest letter recognised. At a 6 m or 20 feet distance, VA is expressed as 6/x (20/x) where x is this smallest letter size. This denominator is the standard test distance at which this letter has a stroke width that subtends 1.0´. For example, a 12 m (40 ft) letter has a stoke that subtends 1.0´ at 12 m (40 ft). A VA of 6/12 (20/40) has a MAR or angular subtend of 2.0´. Thus the logMAR of 2.0 is 0.3 (Table 2).

A geometric progression of letter size or MAR (in multiples of 25 per cent larger or 20 per cent smaller) is a linear progression in the logarithm of MAR. Log_{10} 0.1 is a common Weber fraction in vision and is well chosen. Patients traverse their VA thresholds over about two logMAR lines of letters, from seeing all letters to seeing almost none. Charts without a 7.5, 15 or 30 m line of letters offer less reliable VA threshold measurements than ETDRS charts.

Note the similarity of number sequences: the progression of decimal VA from 1.0 to 0.1 is the same as MAR from 1.0 to 10 (but adjust the decimal point and direction). You will see that denominators for VA in feet have the same progression of numbers as print size on near logMAR charts.

The application

The beauty of the logMAR progression is its regularity. At any viewing distance and at any level of the chart, a three-line increase in VA is two times (2x) better vision, six lines are 4x better, nine lines are 8x, and a 10-line increase is 10x. Thus a 4x telescope should give six lines of VA improvement.

This progression allows the use of non-standard test distances and an easy conversion back to a 6 m VA numerator. Simply count up or down the number of steps change. For example, a VA of 2.4/60 has a numerator that is four steps smaller than 6 m. To proportion this VA back to 6 m, we must increase the VA denominator by four steps also, from 60 to 150 (2.4/60 ≅ 6/150). When a patient has VA less than 6/60, our use of a shorter vision test distance will measure a precise VA. Remember the dioptric adjustment for shorter distances (+0.25 D for 4 m).

Letter counting

In clinical trials where greater precision is required, researchers often count the number of individual acuity letters read correctly, giving each letter one point. Several notations are used. Bailey's visual acuity rating VAR[8] and Colenbrander's Functional Acuity Score FAS[9] were developed separately but both score visual acuity from 6/6 (100 points) to 6/600 (0 points). CERA is collaborating in the world's first multi-centred, randomised controlled trial of nanosecond laser of AMD, known as the LEAD[15] (Laser Intervention in Early Age-Related Macular Degeneration) www.cera.org.au/uploads//pdf/FS_Nanosecond.pdf. In this trial, 6/3 is tagged as 100 points, 6/6 is 85 and 6/300 is 0 points. This system is likely to be used more widely by ophthalmologists in future. Report letters using number counting usually give an equivalent Snellen VA.

Vision as a percentage

In 1926, Snell and Stirling[16] published a scale on which insurance compensation for vision loss was based. This was known as visual efficiency (VE) and scored 100 per cent efficiency for 6/6, 50 per cent for 6/30 and 20 per cent for 6/60. Patients often ask about their percentage of vision loss. This also has an exponential scale but is less regular than logMAR. This terminology is rarely used now.

Visual acuity						log VA	Letter counts		LEAD	VE (%)
Snellen		Decimal	MAR		MAR	$log_{10}MAR$	VAR	LEAD	VA	
6/600	20/2000	0.01	100.0′	=	$10^{2.0}$ or $1.26^{2.0}$	2.0	0	-		
6/480	20/1600	0.0125	80.0′	=	$10^{1.9}$ or 1.26^{19}	1.9	5	-		
6/380	20/1250	0.016	63.0′	=	$10^{1.8}$ or 1.26^{18}	1.8	10	-		
6/300	20/1000	0.02	50.0′	=	$10^{1.7}$ or 1.26^{17}	1.7	15	0	4/200	
6/240	20/800	0.025	40.0′	=	$10^{1.6}$ or 1.26^{16}	1.6	20	5	4/160	
6/190	20/630	0.032	32.0′	=	$10^{1.5}$ or 1.26^{15}	1.5	25	10	4/125	0.4
6/150	20/500	0.04	25.0′	=	$10^{1.4}$ or 1.26^{14}	1.4	30	15	4/100	1.4
6/120	20/400	0.05	20.0′	=	$10^{1.3}$ or 1.26^{13}	1.3	35	20	4/80	3.3
6/95	20/320	0.063	16.0′	=	$10^{1.2}$ or 1.26^{12}	1.2	40	25	4/63	7.0
6/75	20/250	0.08	12.5′	=	$10^{1.1}$ or 1.26^{11}	1.1	45	30	4/50	12.8
6/60	20/200	0.1	10.0′	=	$10^{1.0}$ or 1.26^{10}	1.0	50	35	4/40	20.0
6/48	20/160	0.125	8.0′	=	$10^{0.9}$ or 1.26^{9}	0.9	55	40	4/32	28.6
6/38	20/125	0.16	6.3′	=	$10^{0.8}$ or 1.26^{8}	0.8	60	45	4/25	38.8
6/30	20/100	0.2	5.0′	=	$10^{0.7}$ or 1.26^{7}	0.7	65	50	4/20	48.9
6/24	20/80	0.25	4.0′	=	$10^{0.6}$ or 1.26^{6}	0.6	70	55	4/16	58.5
6/19	20/63	0.32	3.2′	=	$10^{0.5}$ or 1.26^{5}	0.5	75	60	4/12.5	67.5
6/15	20/50	0.4	2.5′	=	$10^{0.4}$ or 1.26^{4}	0.4	80	65	4/10	76.5
6/12	20/40	0.5	2.0′	=	$10^{0.3}$ or 1.26^{3}	0.3	85	70	4/8	83.6
6/9.5	20/32	0.63	1.6′	=	$10^{0.2}$ or 1.26^{2}	0.2	90	75	4/6.3	89.9
6/7.5	20/25	0.8	1.25′	=	$10^{0.1}$ or 1.26^{1}	0.1	95	80	4/5	95.6
6/6	20/20	1.0	1.0′	=	$10^{0.0}$ or 1.26^{0}	0.0	100	85	4/4	100.0
6/4.8	20/16	1.25	0.8′	=	$10^{-0.1}$ or 1.26^{-1}	-0.1	105	90	4/3.2	103.6
6/3.8	20/12.5	1.6	0.63′	=	$10^{-0.2}$ or 1.26^{-2}	-0.2	110	95	4/2.5	106.8
6/3	20/10	2.0	0.5′	=	$10^{-0.3}$ or 1.26^{-3}	-0.3	115	100	4/2	109.4
6/2.4	20/8	2.5	0.4′	=	$10^{-0.4}$ or 1.26^{-4}	-0.4	120			

Table 2. Numerical values for visual acuity

Visual acuity is given in metric and imperial Snellen fractions, in decimal notation and MAR. LogMAR is the exponent of the MAR value. Letter counting is given as both VAR (visual acuity rating) and LEAD score. LEAD VA is measured at 4 m. Efficiency refers to the Snell-Stirling VE percentage showing calibrated vision remaining after injury, accident or other loss.

Rules of thumb

1. If you need to test VA at distances other than 6 m, just remember to count any steps of change in test distance from 6 m, we do not need to deal with logarithms. Record the smallest letters read to determine the denominator at this closer distance, then increase the denominator by this number of steps to obtain an equivalent VA at 6 m. Record actual values , for example: '2.4/48 (= 6/120)'.
2. Refraction that improves VA, even if not to 6/60, may be well worth prescribing.
3. Prescribe with confidence if a three logMAR line improvement is obtained with refraction, at any level of the chart (even 6/150 to 6/75). We miss this benefit if we measure VA only to 6/60.
4. For patients with low vision, binocularity might offer little benefit if VA difference between eyes is greater than three lines.
5. For absolute (non-accommodative) ametropia and a normal pupil size, we can expect a loss of VA of about one logMAR line of letters for every 0.25 D of spherical defocus.
6. Accurate and repeatable measures of low VA between 6/60 and 6/600 means that inaccurate 'counting fingers' should never be needed.

LogMAR charts have five letters per line and the same proportional between-letter and between-line spacing. The recognition task is constant despite changes in viewing distance. On older (Snellen) charts, smaller letters are widely spaced with less crowding. Many conversions between other units have this regular sequence. Inch to centimetre is four logMAR steps, feet to metres is five steps, diameter to circle area is five steps (π) and kilometres to miles is two steps.

After measuring VA, determine what vision improvement is needed. This can be achieved at a short viewing distance by the necessary number of steps or by magnification of the required 'times' or 'x' to meet this goal. Alternatively, the task (signs, sheet music and so on) can be made larger. Optical magnification for distance or intermediate tasks is achieved with a telescope or by changing the task. (Figure 5)

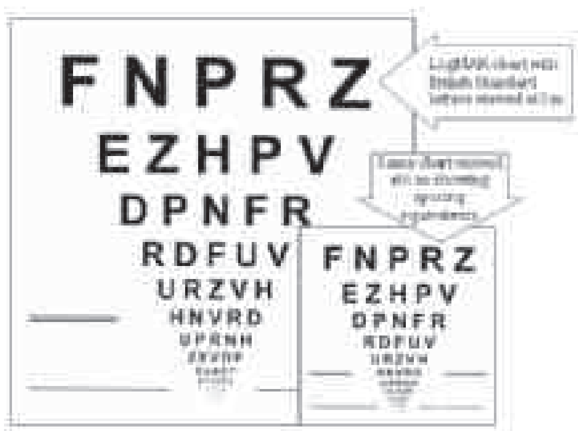


Figure 5. Bailey-Lovie distance logMAR chart. The same chart at a different viewing distance maintains its regular progression of size.

Reading distance (cm) Equiv distance	Dioptres Equiv power	Enlargement ratio (magnification) (at 40 cm)	(at 25 cm)
50 cm	2.0	0.8	0.5
40	2.5	**1.0**	0.63
32	3.2	1.25	0.8
25	4.0	1.6	**1.0**
20	5.0	2.0	1.25
16	6.25	2.5	1.6
12.5	8.0	3.2	2.0
10	10	4.0	2.5
8.0	12.5	5.0	3.2
6.3	16	6.3	4.0
5.0	20	8.0	5.0
4.0	25	10.0	6.3
3.2	32	12.5	8.0
2.5	40	16.0	10.0
2.0	50	20.0	12.5

Table 3. Columns 1 and 2 link reading distance with dioptric power of a near spectacle lens addition or accommodation demand F_a. Columns 3 and 4 show ER for the two commonly used reference distances, 40 cm and 25 cm, when a closer reading distance is required for a larger F_a. Dioptric power and ER increase in 1.26x steps.

N print (points)	M units (Sloan)	logMAR (40 cm)	logMAR (25 cm)	'Equivalent' VA (@40 cm)	'Equivalent' VA (@25 cm)
80	10.0	1.4	1.6	6/150	6/240
64	8.0	1.3	1.5	6/120	6/190
50	6.3	1.2	1.4	6/95	6/150
40	5.0	1.1	1.3	6/75	6/120
32	4.0	1.0	1.2	6/60	6/95
25	3.2	0.9	1.1	6/48	6/75
20	2.5	0.8	1.0	6/38	6/60
16	2.0	0.7	0.9	6/30	6/48
12.5	1.6	0.6	0.8	6/24	6/38
10	1.25	0.5	0.7	6/19	6/30
8.0	1.0	0.4	0.6	6/15	6/24
6.3	0.8	0.3	0.5	6/12	6/19
5.0	0.63	0.2	0.4	6/9.5	6/15
4.0	0.5	0.1	0.3	6/7.5	6/12
3.2	0.4	0.0	0.2	6/6	6/9.5

Table 4. The progression of print size and logMAR scores for the Bailey-Lovie near reading card viewed at 40 cm and 25 cm. Equivalent Snellen fractions are also shown for these viewing distances.

Near visual acuity using logMAR

Near visual acuity is specified by print size in points (or British N units) for practical reasons but to be exact, we always specify a reading test distance. A shorter distance (requiring a stronger dioptric near spectacle addition or accommodation F_a) increases the visual angle of print and is our first approach to improving near VA.

Bailey-Lovie[17] logMAR near charts are the preferred tests. Magnification is a ratio and compares enlargement with vision usually at 25 cm (10 inches) using $F_a/4$. Other test distances such as 40 cm (16 in) may be more practical using $F_a/2.5$. Manufacturers use $M = F_a/4 + 1$, presuming the magnifier touches the spectacles. Enlargement ratio is a better notation for increase in image size.

Sloan's[18] M units ('metre equivalent') designation was developed to convert near VA into a 'reduced' Snellen fraction (for example, '6/48 at 40 cm'). We divide points or N units by 8 to get M units. We divide the test distance in metres by the smallest letter size read in M units to get a 'reduced' Snellen fraction. For example, at 25 cm (0.25 m), M2 print is converted into 0.25/2 = 1/8 or 6/48.

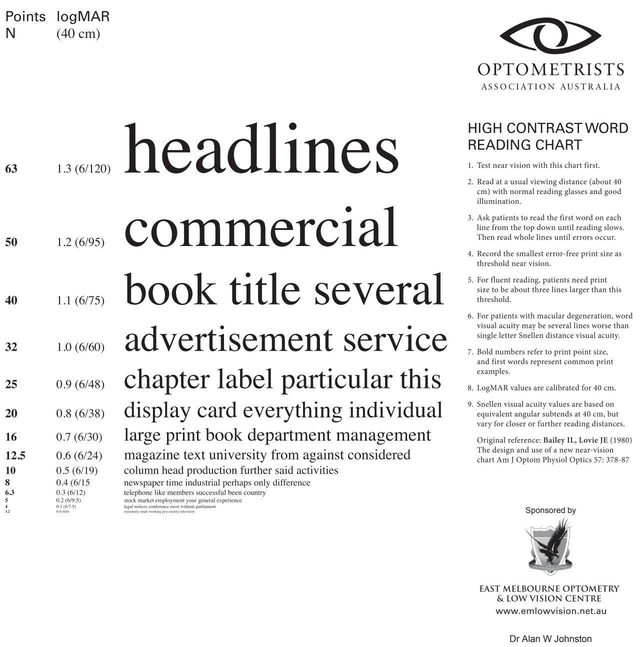


Figure 6A. OAA logMAR near visual acuity card

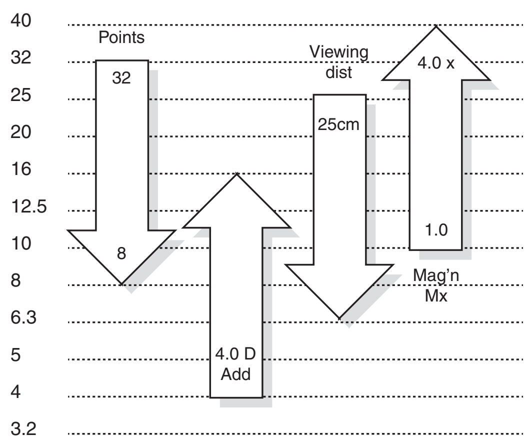


Figure 6B. How equal 'steps' of change in point size, near spectacle lens addition, viewing distance and magnification are related. In this example, our patient reads N32 at 25 cm with +4.0 D, but goal VA is N8. The arrows indicate the six steps to N8 print: add +16 D at 6.3 cm giving magnification of 4x.

Equivalent Snellen notation can be spurious because widely-spaced single letter VA and extended text read in M units are very different tasks. Equivalent Snellen notation is included here for completeness sake and does give a first order approximation of potential near VA when distance VA is known. It is widely quoted in the USA. Never use a Snellen fraction alone to specify near VA.

Table 3 links reading distance with dioptric power, increasing these in 1.26x steps. It shows that large changes in dioptres are required for small changes in very close reading distances, indicating practical lens power increments. We obtain a one line near VA increase from add +2.5 to +3.25, one line from +8.0 to +10.0 and one line from +20 to +25 D, all single steps on the progression in Table 3.

Table 3 compares enlargement ratios for the two reference distances of 40 cm (near spectacle add +2.5 D) and 25 cm (10 inches) with add +4.0 D, the traditional F/4 magnification.

This table also shows the geometric progression of print size on the logMAR reading chart (Figure 6A), again increasing in 25 per cent steps from small to large. This sets up our predictive ability.

Application

1. Measure near VA at 25 cm (+4.0 D) or 40 cm (+2.5 D).
2. Determine how many steps of increase of print size are needed to reach our goal VA (Columns 1 and 2 in Table 4).
3. Increase near add and decrease reading distance by this number of steps (Table 3).
4. Counting from 1.0 for either 40 cm or 25 cm, use this same number of steps to determine the enlargement provided at our new reading distance in Table 4.

Note the similarity between progressions of point size, reading distance, dioptric power and visual acuity in Tables 3 and 4. All we need is the one set of numbers, printed on the reading card (as point size). Any increase required in VA (by number of lines) will require the same number increase in near add dioptric power and decrease in reading distance in centimetres.

Figure 6B shows a logMAR near chart sequence with this numerical progression. The arrows 1 to 4 demonstrate the changes we make to achieve better vision in this particular example.

A final tip. VA is a threshold, a 'just visible' level of vision, but fluent reading requires some spare capacity, vision above threshold. Always try to add two extra lines, three if possible, to our predicted goal improvement for more comfortable reading.

8. Visual field losses and field enhancers

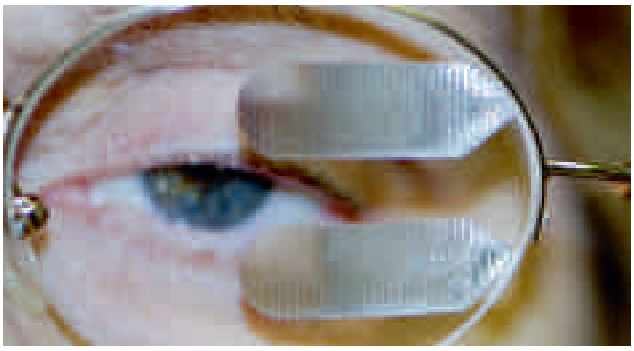
An adequate visual field is essential for orientation in the environment, personal mobility, fluent reading and efficient scanning.

Measure visual fields carefully and record for reference. Consider using an automated visual field analyser as a screening routine on all patients. Short duration screening fields are still helpful when a patient has little tolerance for threshold fields. When all else fails, a flashing LED confrontation wand is the minimum alternative, easy to make and more reliable than finger counting in the periphery.

- Where possible, explain to patients the nature of field losses (central scotomata, peripheral constrictions, segmental losses quad- and hemianopsias). Show patients and if appropriate, their carers the automated visual field plots. Patiently explain what they might now expect of their vision.
- Demonstrate scanning techniques to look above AMD central scotomata, or to the left or right of hemianopsias. Refer for vision rehabilitation for further training in eccentric viewing.
- Remember that many patients with visual field losses might also be VA impaired and have other vision difficulty unrelated to their field losses.
- RP and glaucoma patients might benefit from field expanders. First, use a -3 D hand-held, 70 mm Ø CR39 lens at arm's length. This acts as the objective of a reverse Galilean telescope. If this helps, consider a 2x simple Galilean telescope used in reverse, in either hand-held or spectacle-mounted form. 1.7x minifying telescopes are available commercially but may provide too little improvement in field size to be a benefit. RP and glaucoma patients often have concomitant VA loss so may not appreciate a smaller retinal image

A

B



C

Figure 7. A: A simple confrontation wand uses primary school electronics: flashing green LED in a dripper irrigation tube, a nine-volt battery in a box and a momentary 'on' switch. B: Peli prisms are Fresnel 50$^{\Delta}$ BO on the hemianopic side only, above and below the midline. C: Swedish supplier Multilens can cement a prism including the patient's prescription on the hemianopic side, giving clear vision access to the hemianopic side. This prism is 10$^{\Delta}$ BO.

that comes with field expansion.

- Security viewers for doors are about 5x reverse telescopes and diminish image size significantly but also demand accommodation for a sharp image. Good in principle, unhelpful in practice.
- For hemianopsias, trial narrow segment 20$^{\Delta}$ Fresnel prisms (BO), above and below the line of sight from the lens optical centre to the (hemianopic) temporal side of one spectacle lens. This gains about 10 degrees of lost peripheral field. Peli prisms[19] are 50$^{\Delta}$ segments available commercially. They provide awareness of object movement on the hemianopic side but blur vision severely. (Figure 7B)
- Train patients to use these prisms for pedestrian mobility. Field expanding prisms are not acceptable for cycling or driving. They are not a panacea.
- VisioCoach[20] is a PC-based program to improve the use of exploratory eye movements towards the blind visual field. This is a Windows Excel-based program developed by the Centre for Ophthalmology at the University of Tübingen.[21] It can be demonstrated in-clinic or purchased by a patient for home use.
- Refer to a mobility instructor for evaluation of mobility skills and training when necessary. Broach the use of non-optometric strategies, such as a long cane or folding cane if field losses are significant. Cane use alerts other pedestrians to our patients' vision disability, orientates the patient to obstacles on the blind side and prevents falls or bumps, thus minimising injury.
- Understand that patients resist cane use because of 'blindness' connotations. Occasionally, a trained guide dog is an appropriate alternative primary mobility aid but cane use is still valuable. A mobility instructor is the expert to deal with these concepts.

9. A brief introduction to lighting and disability glare

We are well aware of the difficulty patients report with glare, their need for sunglasses out of doors and their reluctance to drive at night. For patients who have incipient cataract changes, these symptoms might be their principal presenting symptom. However, if high contrast VA is relatively good, say about 6/9 and still within an acceptable range for driving, cataract surgeons may not be impressed with our referrals.

Glare testing using formal instrumentation has not found its way into ophthalmic practices, in part because of unrecognised demand and the lack of widely acceptable standards for glare performance. Two instruments have been commercially available:

- The Mentor BAT (Brightness Acuity Tester)[22] is a hand-held illuminated eyecup with a central aperture through which the patient reads a VA chart. VA is recorded with the illumination both on and off, to determine the level of reduction in VA from the glare source.
- The Berkeley Glare Test[23] is a large box containing a logMAR chart and an illuminated surround that acts as a glare source. VA scores both with and without glare are compared.

Both these instruments present a source of veiling luminance that scatters light into the eye from non-target features of the surround. Their effect is to reduce target contrast. CS at the retina may still be relatively normal.

Glare testing per se is unlikely to be adopted widely in ophthalmic practice until it becomes mandatory for motor vehicle licensure or other vocational demand. In the interim, we assess it by subjectively judging cataract density or less commonly, corneal opacity and estimating contrast sensitivity reductions using high and low contrast letter charts[24,25,26].

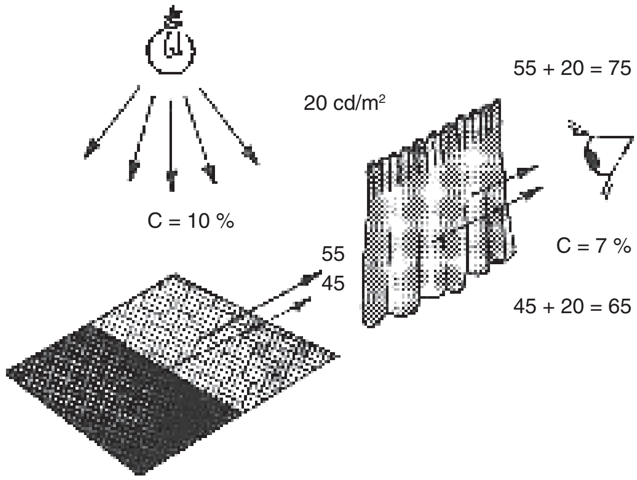


Figure 8. Schematic lighting information

Disability glare is caused by 'veiling' luminance. Figure 8 shows a 10 per cent contrast target viewed through a 'veil' or illuminated curtain (cataract, corneal scar?) that adds luminance to each side of the target so the relative difference between the sides is reduced. In this schematic, a 10 per cent contrast is reduced to seven per cent.

The curtain is a good example. We see through a lace curtain easily during the day, because the exterior is much brighter than the curtain (little additional luminance is added to the exterior). At night, we cannot see out of the window because the curtain is brighter than outdoors.

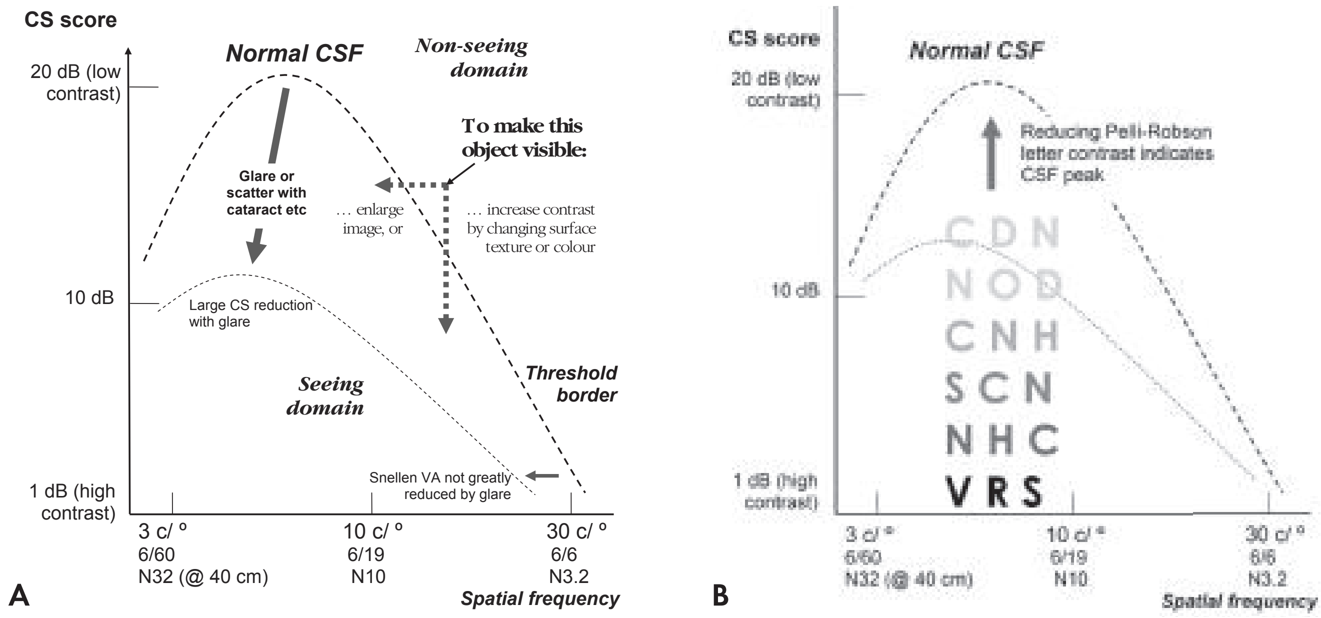
Discomfort glare is the other example of glare, where the brightness of the scene is too great to view with comfort. This is a result of our retinal illuminance being in excess of our adaptation level and our eye pupils trying to constrict to a level smaller than their comfortable limit. Sunglasses and fit-over filters, hats with a brim and other eyeshades are easy ways to manage discomfort glare.

10. Contrast sensitivity

VA tests use high contrast black letters on a white background but most everyday tasks involve subtle grey or colour contrasts that are more difficult to see with a VI. Testing contrast gives us insights into everyday vision.

Two different measures of contrast are used. Weber contrast ΔL/L is appropriate for small bright targets against a large uniform background, whereas Michaelson contrast (L-L´/L+L´), previously used for contrast gratings, is more appropriate for extended targets such as letters. Colenbrander's contrast reading cards are calibrated using Michaelson contrast while the Pelli-Robson test[23] uses Weber notation.

Contrast is a product of the reflectance of a surface or object and is constant for that object. However, our sensitivity to that contrast task is dependent on the task luminance (how well illuminated it is) as well as other factors such as glare, retinal adaptation level and interocular scatter. Target or task size is also important. Optimising any of these factors will improve contrast sensitivity. (Figures 9A and 9B)



Figures 9A and 9B. Gratings targets that vary in spatial frequency and contrast give the characteristic inverted 'U'-shaped curve. The graph shows how changing target size, target contrast and target illuminance interact to improve vision.

Procedure

- Test contrast using high and low (10 per cent) contrast letter charts of Pelli-Robson,[24] Verbaken[25] or Hamilton-Veale[26] charts of graded letter contrast.
- Melbourne Edge Test[27] (MET) grades contrast by decibels (dB), where 10 dB = 10 change in contrast (one logarithmic unit). 20 dB is considered normal contrast sensitivity.

Use the smartphone app 'eyeSnellen' to measure contrast if alternative methods are not available. On video screens, contrast may vary because of screen luminance settings.

- dB as a unit is useful because it grades contrast in steps similar to logMAR gradations, that is, 3 dB = 2x change in contrast.
- Low contrast word reading charts are quick and easy indicators of contrast impairment. Read down the 10 per cent letter chart first until threshold, then move over to the high contrast chart and continue reading until VA threshold is reached. Two to three logMAR lines should separate these two thresholds if vision is normal. A four or more line difference suggests that the peak of the CSF is depressed. Check this using the edge test.
- Measure contrast vision using standard lighting for consistency.
- Reading for AMD patients may improve greatly with 10x increases in page illuminance because retinal 'gain' increases and peak CSF value elevates.

Bigger, bolder and brighter. This widely used homily for how we assist patients is justified easily with reference to the CSF.

BIGGER (image enlargement or magnification) moves an object horizontally, from the non-seeing domain outside the CSF to the seeing domain.

BOLDER (increase in contrast, usually by changing the object colour) moves an object down vertically (since spatial frequency does not change).

BRIGHTER (increased illuminance on the task) may lift the peak of a reduced CSF to include a faint or low contrast task.

11. Understanding distance, intermediate and near vision tasks

Vision improvement requires enhancing the properties of images. Often the only option is to enlarge image size–contrast and task illuminance may be given parameters.

- Consider **distance tasks** as being 2 m or further away. Use approach magnification if possible (within a room, for example, television) where reducing the distance to half gives a 2x increase in image size and 4x in image area, or a 4x reduction in the area obscured by a scotoma.
- Try the best refractive correction, then use a 2x spectacle-mounted telescope for wide field and least image movement. Then, try 4x if necessary (the smaller field may limit usefulness).
- Conventional binoculars are helpful for far distance (>30 m) but require a steady hand. 6x and 8x monoculars have a close focus range to 40 cm. Finger rings and neck straps aid security.

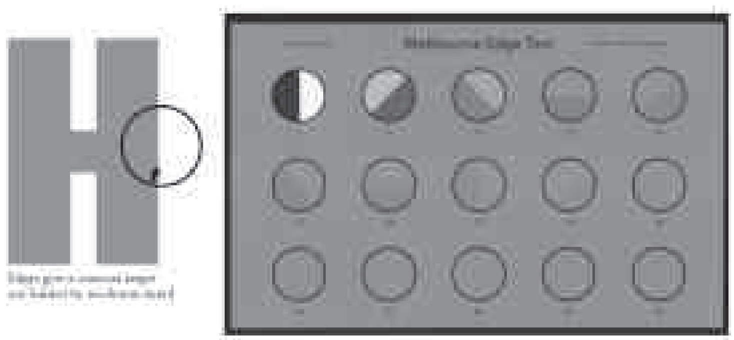


Figure 10. The Melbourne Edge Test (MET) uses large targets of decreasing contrast between hemifields. The test can be repeated using a different orientation and is scored on the ordinate axis of the CSF. The MET and low contrast letter tests are inexpensive, quick to apply and indicative of contrast loss. Poor performance may indicate ocular media opacity or optic neuropathy even if high contrast VA is near normal.

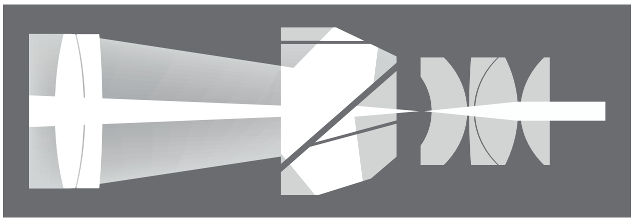
- Focusable telescopes adjust for specific viewing distances; adjust centre post focus of binoculars for the 'fixed focus' eye, then the focusable eyepiece for the other eye.
- Binoculars rarely focus closer than about 3 m so are not useful in a domestic space. Use a front lens cap (+3 D for 33 cm) for a closer distance. The Pentax Papilio 6x binocular focuses to 50 cm.
- Consider **intermediate tasks** as being 50 cm to 2 m. If approach magnification is not possible, use focusable spectacle-mounted telescopes as a first step.
- Begin with fixed focus 2x Galilean telescopes with near objective lens caps (+2 D for 50 cm, and so on). Use bifocal caps for flexibility (+2 D upper segment with an add of +2 D, for both 50 cm and 25 cm viewing distances).
- Try other magnifications if greater image enlargement is necessary.
- Workshop or kitchen tasks may require large fields of view. Do not compromise safety when using power tools, heat or knives.
- Field reductions with telescopes may cause tripping or falls. Set telescopes in spectacles to achieve 'bioptic' use and leave the visual field unimpaired for walking—or recommend taking off glasses.
- Consider **near tasks** as being closer than 50 cm. Approach magnification is usually easy to apply, so that higher near spectacle lens additions and closer viewing distances offer specific 'steps' of image enlargement
- Exceptions to approach magnification include keyboard and computer screen use and many industry and vocational tasks.
- Use embroidery magnifiers for handcrafts such as knitting, or spectacle-mounted telescopes when the task prevents a closer distance, such as seeing the foot of a sewing machine.
- Use Visolettes (image doublers or 'Bright Field' magnifiers). These are on-the-page magnifiers that can be used with existing reading glasses or near adds, and even with hand magnifiers.
- Vision is greatly improved with local lighting (illuminated magnifiers or stand lamps).
- Spectacle-mounted loupes and aplanatic magnifiers require close distances but allow hands-free use for task manipulation. These provide inexpensive image enlargement up to 10x to 15x, but also demand patient adaptation and tolerance.
- Closed circuit video magnifiers are alternatives when necessary optical magnification is too limiting of field of view. A fixed workspace may be necessary.
- Portable cameras with conventional television sets, such as the Bierley mouse cam also help. Other devices from Humanware, Pacific Vision and Quantum Technology help—the gadgets improve almost daily.
- Remember that low vision aids are task-specific. What is appropriate for fine print may not be useful for sewing or woodworking. A device for distance viewing may not be appropriate for near. More than one aid will be necessary. Unless you carry a variety of electronic image enhancers, refer to an agency for a full selection of these options.

12. Aberrations and lens design

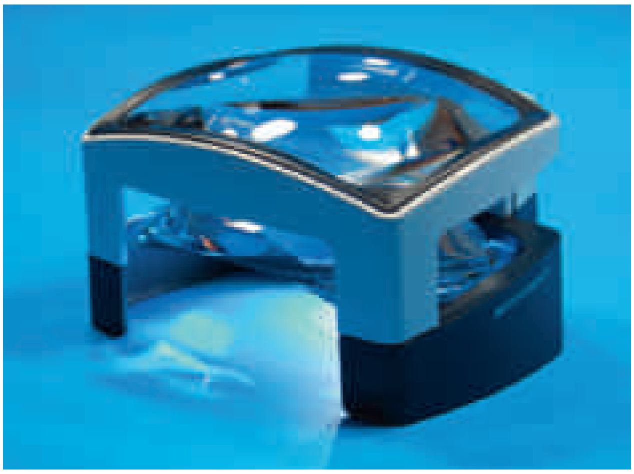
New methods of wave front analysis use Zernicke polynomials for mathematical analysis of aberrations; however, computer ray tracing is still the method of choice of optical designers to optimise image quality in a complex system.

Simple optical ray tracing presumes that all rays are paraxial, f-number is large but diffraction does not limit performance and aberrations are negligible. This is known as first order or Gaussian optics, where sines and tangents of angles and radians are almost equivalent. The error is less than 0.1 per cent up to three degrees and less than 1.0 per cent at 10 degrees. This assumption is impracticable for the more complex optical systems of most low vision aids requiring extended images in a wide field of view. Lens design must also consider weight, performance suited to the application, serviceability and of course, cost.

Spherical and chromatic aberrations occur for rays on-axis. We describe these as both longitudinal and transverse aberrations, but in practice we see lateral blur and coloured fringes when looking at images, as demonstrated in Figure 11C.



A



B

C

Figure 11. A: This telescope schematic shows an achromatic doublet objective lens and a modified König eyelens system to reduce aberrations and maintain a flat image field. B: The Eschenbach Visolux has a 100 mm aperture and an aplanatic system. C: It gives a wide flat field with excellent control of spherical aberration and distortion, showing just a little lateral colour at the edges of the field.

Astigmatism, field curvature, coma and distortion arise for off-axis object points.

Astigmatism is characterised by focal line images from a point source imaged obliquely and is exaggerated for large object/image (conjugate) ratio.

Coma occurs when peripheral zones of a lens give greater magnification than central zones and can be controlled using aperture stops and multiple surfaces.

Curvature of field occurs when image surfaces are curved rather than flat planes. This is managed using positive and negative lenses in combination. Astigmatism, coma and field curvature are seen by an observer image as peripheral blur in the image.

Distortion occurs when off-axis image points depart from paraxial assumptions and a grid object appears barrel- or pincushion-shaped. It is least at 1:1 magnification or conjugate ratio, when object and image distances are similar.

For 'simple' magnifiers, spherical and chromatic aberration become more important with large aperture systems and are managed by bending lenses, using aspheric designs, aplanats and in telescope objectives and eyepieces, crown/flint glass achromatic doublets. Lens designers optimise lens shapes and combinations for given apertures and conjugate ratio to minimise aberrations.

Optical design to control aberrations can be expensive, often for diminishing gains in image quality. Simpler designs usually work well when images are enlarged and sharp detail is not critical. Aberration control is necessary for telescopes and compound systems of high magnification

13. Specification of magnification and image enlargement

We use the term 'magnification' in a general sense when we talk about image enlargement and it is established in the optometric lexicon. Magnification is a ratio. Depending on the application, it has several definitions.

- Angular magnification is appropriate for telescopes.

For simple magnifiers at near ...

- Apparent magnification compares image size through the magnifier with the object outside it, so varies with object distance.
- Relative magnification compares the image through the magnifier with a given reference standard, usually an object size at 25 cm ($F_m/4$) or 40 cm ($F_m/2.5$). German DIN standard 58383 specifies magnification as $F_m/4$.
- Manufacturers' rating is a special case of iso-accommodative magnification where the magnifier is placed against the spectacles so $M = F_m/4 + 1$ or $F_m/2.5 + 1$. The image is in the same plane as the object viewed through spectacles. This compares image size obtained with conventional reading glasses only, with the enlarged image seen through the magnifier touching the spectacles. How a magnifier is used is not in the control of the manufacturer.

Bailey[28] introduced the term 'Enlargement ratio' (ER) that compares image height with object height. This leads to:

- Equivalent viewing distance (EVD) compares the distance at which the image subtends same angle as the object. If the image is at infinity, then EVD = f_m, the equivalent focal length of the magnifier.
- Equivalent viewing power (EVP in dioptres) is the reciprocal of EVD in metres, but refers to effective power (as though the magnifier were a 'thin' lens) rather than the sum of its surface powers, sometimes used by manufacturers to calculate F_m. EVP represents the spectacle lens power or accommodation F_a necessary to focus the object if it were placed at the EVD.

Simple magnifiers are usually positive power, single lenses up to F_m +24 D, although higher powers (up to +80 D) are aspheric, aplanatic or have other aberration-corrected, compound lens forms. Ideally, simple magnifiers work best when they are no further from the eye than their focal length f_m, although often lens design asphericity to achieve a flat field of view requires a larger eye-to-magnifier separation than f_m.

We calculate enlargement ratio ER to determine the true improvement in vision likely to be obtained from the circumstances of magnifier use.

Magnifier field of view is greatest when the magnifier is very close to the spectacles, but may be limited by spherical aberration and the mounting or stand of the magnifier.

When separated from the eye by its focal length, the magnifier has a linear field of view equal to its effective aperture. At greater eye-to-magnifier separations, both image enlargement and field of view are reduced.

Hand and stand magnifiers offer flexibility of use, and both can be combined with in-built illumination.

Visolettes, 'paperweight' or 'bright field' magnifiers' are a special case of the simple magnifier.[29] These dome magnifiers have their principal planes about 12 mm above the page. Both the image and object distances are short, but the image distance is about twice the object distance, so that ER is about 1.8x to 2x. The image plane is virtual, but just below the page so that it is within the depth of field of the usual reading glasses worn by the patient. This means that Visolettes used with stronger reading glasses or other magnifiers act as 'image doublers'.

14. Essential magnification formulae and basic optics

A simple magnifying lens is a positive power lens of dioptric power F_m and effective aperture width A mm placed between a page of print and a reader's eye. The page is always closer to the magnifying lens than its focal length f_m if the image is not to be inverted.

The image is always further away from the magnifying lens than the page. For clear vision, the image should be f_a metres from the reader's eye, a distance appropriate for the accommodation of the eye F_a or the power of any reading spectacles worn. Distances measured to the left are negative.

This reader holds a magnifying lens F_m a distance z m from the eye, and the page a distance $-l$ m. from the magnifier. The image is enlarged but virtual, a further distance $-l'$ from the magnifier. The eye-to-image distance is the sum of z and $-l'$ and this should be a distance similar to f_a, the focal length of the spectacle lens near addition F_a (or for a non-presbyopic reader, accommodation F_a) if the image is to be sharply focused on the retina. The ratio of image and page distances l'/l, or page and image vergences L/L', is the transverse magnification or enlargement ratio ER. Image and object vergences are related to Fm by the simple lens formula $L' - L = F_m$. If a patient uses reading spectacles alone, the page must be placed in the image plane of the spectacles for a sharply focused image. If the patient uses only distance glasses, the magnifying lens acts as a collimator and the image is at its focus.

Field of view, expressed as the linear width of the page W (mm) visible through F_m, is related to the aperture width A (mm) of the magnifier by the relationship $W = A/F_e.z$, where F_e is the equivalent viewing power (EVP) of F_m and F_a in combination, separated by the magnifier-to-eye distance z. Dimensions A and W must be expressed in the same units.

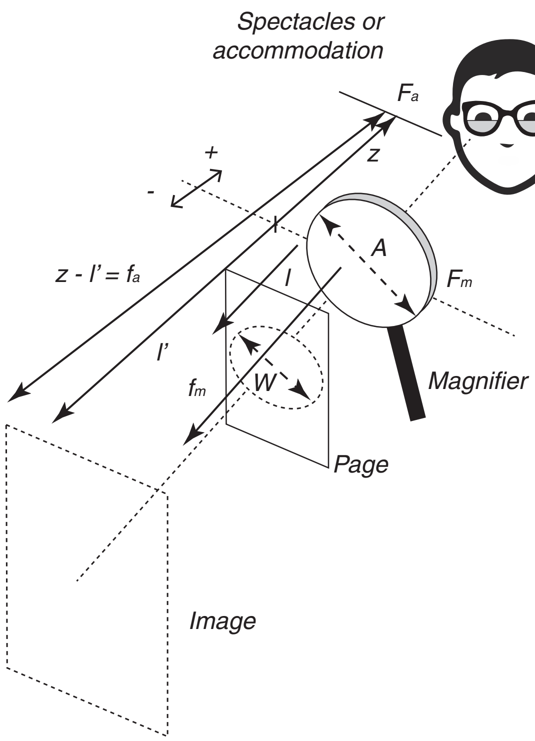


Figure 12. Essential optics of a simple magnifier
Equivalent Power $F_e = F_a + F_m - z.F_a.F_m$
Vergences $L' - L = F_m$
Enlargement ratio ER = $l'/l = L/L'$
F_a = accommodation or near add = l/f_a
F_m = dioptric power of magnifier
Image distance from eye = $f_a = z - l'$ for a clear image.
Field of view $W = A/F_e.z$
For f_a = 25 cm, Mx = $F_e/4$
For f_a = 40 cm, Mx = $F_e/2.5$
When $z = f_m$, $F_e = F_m$ and W = A
When $-l = f_m/2$, ER = 2x for any F_m

Distances are calculated from the principal planes of the lens, but in practice, we measure these distances from lens surfaces as shown above. Except for high powers, the errors are small. (Figure 12)

Calculating enlargement ratio is not difficult. Follow the procedure in the two examples in Table 5.

15. Axioms for magnifier use

- Field of view is widest when the magnifier touches the spectacle lens. The more curved lens surface should face the page, but the edges of the field may be blurred from aberration. EVP = $F_a + F_m$. This is the reason that bifocal near adds 28 mm wide still give full page reading fields.
- For every focal length f_m that the magnifier is separated from the eye, EVP falls by one F_a, until when the magnifier rests on the page, EVP = F_a.
- Intermediate separations (for example: $z = 2f_m$) chosen by manufacturers for best image quality provide a balance between image enlargement and comfortable use.
- A special case is when the page is placed at half a focal length from the magnifier ($f_m/2$), when ER = 2x, regardless of F_m. Stronger magnifiers incorrectly used this way are a disappointment to their owners. Training in the use of magnifiers is essential for satisfied patients.
- Remember that eye-to-magnifier distances may never be exact, spectacle near adds may vary, and with hand-held magnifiers, eye-to-page distances are often shorter than design distances. The take-home message is that we should see magnification Mx specified on a handle only as a guide. The benefit to the patient of trials with alternative devices viewing relevant print tasks is the best way to prescribe a magnifier successfully.

16. Spectacles, high near additions and special purpose reading spectacles

High near lens additions in spectacles are a special case of the simple magnifier. They offer a wide field of view given their small size but the page must be held at or just inside the focal length of the near spectacle lens.

	Procedure	Example 1	Example 2
1.	Measure the spectacle near addition F_a, then calculate fa ($=1/F_a$)	+2.5 D (0.4 m)	+4.0 D (0.25 m)
2	Determine F_m from magnifier specification or by empirical method	+10.0 D	+16.0 D
3.	Measure magnifier aperture A	75 mm	70 mm
4.	Ask the patient to hold the magnifier comfortably, then measure lens-to-eye separation z	say, 15 cm	say, 12 cm
5.	Subtract z from f_a to calculate image distance $-l´$ for a sharp focus	0.4-0.15 = 0.25 m	0.25-0.12 = 0.13 m
6.	Calculate L´ ($1/l´$)	-4.0 D	-7.7 D
7.	Calculate L from the simple lens formula ($= L´ - F_m$)	-14 D	-23.7 D
8.	Calculate ER (= L/L´)	3.5x	3.1x
9.	Calculate relative magnification $F_m/4$	2.5x	4x
10.	... so true ER is ...	under-estimated	over-estimated
11.	Calculate EVP ($= F_m + F_a - z.F_m.F_a$ specifying z in m)	+8.75 D	+12.32 D
12.	Linear field of view $W = A/F_e.z$	57 mm	47 mm

Table 5. Two examples of how we calculate true ER and linear field view for simple magnifiers used under different conditions

A

B

Figure 13. A: An aspheric lenticular used monocularly in a look-over frame with a frosted balance lens. B: Prism clip-on adds for vocational or hobby work still require a relatively close working distance.

- Hands-free use is an advantage if the close viewing distance can be maintained. High add reading glasses have the advantages of portability, look like conventional glasses and are of modest cost to the patient.
- Determine what reading VA the patient shows with present reading glasses, in terms of fluent reading of words or sentences.
- Calculate the steps of enlargement needed for goal near VA (newspaper, magazines, telephone book and so on) in terms of the number of VA logMAR lines.
- Provide an increase in the near add by this number of steps, show this in a trial frame and demonstrate, at the required closer viewing distance for this addition, that the goal print size and fluent reading is achieved.
- Practice reading the patient's own text (foreign newspaper, religious texts, medicine labels and so on) to determine if a high near add in glasses is practicable.
- Consider making these glasses with a +2 or +3 D add in the 'distance' of a bifocal with the balance of the final add as a D28 or D25 mm segment.
- Call these 'special purpose reading glasses' rather than reading bifocals. The upper portion provides headline and sub-headline access at a normal viewing distance of 45-33 cm and the segment provides access to the column of text.
- Prescribe near adds for binocular use up to +8 or +10 D where convergence is not over-challenged.
- Consider binocular high adds to +16 D in aspheric lenticular form with convergence relieving prism built in. Noves are diffractive lenses intended for monocular use. These ready-made lenses ignore low astigmatism.
- Prescribe monocularly for near adds above +10 D if there is a clear preference for one eye or if convergence fails at near.
- Prescribe monocularly for the eye with better VA eye when the difference between eyes is more than three logMAR lines.
- If necessary, occlude the worse eye with a frosted plano, or use three layers of translucent adhesive film, such as 'Contact', over the reading part of that eye as a trial or temporary occluder while the patient adapts to spectacle use.
- The adhesive film can be a full lens occluder or simply match the shape of the reading segment. Cut it out with scissors, peel off the backing paper and adhere the film to the back surface of the lens. Demonstrate to the patient how to peel it off the lens without causing damage to the surface.
- Many types of bifocal high adds are available to +3.5 or +4.0 D.
- Use Younger high adds in D28 to +8.0 in 0.5 D steps, or D35 to +6.0 D. Maximum upper lens power is limited by the front base curve of +6 D. Check with your lens laboratory to see if tooling permits requested prescription powers.
- Sola LVA bifocals and aspheric lenticulars are no longer available. COIL hyperoculars (+16, +20, +24 and +32 D) in a half-eye frame are useful but require specialist edging (ask your supplier for advice).
- Unilens stick-on adds (up to +40 D) over a patient's existing complex spectacles (extreme astigmatism or high hyperopia) might be practicable.
- Set all special purpose reading segments as high as possible in the frame to get maximum reading space and a perpendicular line of sight through the segment.
- For keen readers and experienced LV patients needing very high near adds, consider using aspheric lenticular lenses in look-over frames so that orientation vision is not disrupted. (Figure 13)
- For better image quality again and the flexibility to change total add power if vision deteriorates, prescribe wide-angle Eschenbach or Multilens telescopes. These are aspheric or aplanatic systems that correct spherical aberration and offer flat fields of view. The objective lens of ML telescopes can be altered in-office to a stronger power to increase telescope magnification.
- Handicrafts such as embroidery, sewing or model making may demand a longer viewing distance. Consider the Embroidery magnifiers worn around the neck.
- Spectacle mounted, clip-on loupes come in binocular forms in 1.7x, 2x, 2.5x and 3x (all with prism to aid convergence) and as monoculars of 4x and 7x.
- For non-spectacle wearers, use Labo-med spectacle bar and bridge or the head-band magnifier with glare shade, the Labo-comfort. Lenses are interchangeable.

For these LV aids and those described later in this document, training in their effective use is essential.

17. Hand-held and pocket magnifiers

Busy patients need to access a magnifier for reading price tags, public transport timetables or shopping lists. Small pocket magnifiers are neat and convenient but may not provide the wider field of more conventional magnifiers. What is appropriate for reading extended text such as newspapers may not be appropriate for incidental tasks such as 'spot' reading.

Many manufacturers make hand-held magnifiers. Inexpensive lenses are usually biconvex coloured glass of +4 to +6 D where the low cost is reflected in performance. Better quality lenses have wider apertures and optimised aspheric surfaces, designed for specific viewing conditions. They offer wide, relatively undistorted fields of view for the serious user. Many magnifiers include a battery operated, high-intensity LED light source for increased task illuminance and elimination of lens surface reflections. Electronic pocket magnifiers and smartphones may be preferred. Remind patients that quality really is worth the cost.

Pocket magnifiers should be slim, lightweight and convenient.

- Look through product catalogues for many examples of other multipurpose, technical, ornamental or convenience magnifiers.

Hand magnifiers work best when the eye-to-lens distance is short. We have mentioned that the full dioptric value is obtained when held at or less than f_m from the eye and the linear field is equal or greater than the aperture dimension. Magnifier-to-page distances should be (just) less than f_m, so that the eye-to-page separation is appropriate for the near spectacle lens add F_a.

If the magnifier is held too close to the page, image enlargement reduces. My tip is to show patients how to hold their magnifiers comfortably, resting the wrist or side of the hand on the page. Often, they achieve this by holding the magnifier handle like a spoon, between the thumb and forefinger to maintain a stable magnifier-to-page distance. (Figure 14)

Remind patients to read for short times at first, getting used to the smaller fields of view offered by magnifiers. Check whether 60 words per minute can be obtained for fluency with your chosen magnifier. Fast reading is less important for price tags, accounts or personal correspondence. Try other lenses or devices if fluent reading is important and reading is too slow.

Eschenbach's Easypocket illuminated slide out diffractive lens, or the smaller, 1711 +20 D aspheric model are useful. I fit these with a lanyard for convenience.

Figure 14. Older patients may have difficulty steadying magnifiers. Advise them to hold magnifiers like a spoon so the edge of the hand rests on the page. Small credit-card sized illuminated magnifiers and price tag magnifiers are quick and easy to use. Smartphone imaging and zoom is an alternative for the technologically competent patient for shopping tasks.

18. Telescopes

Telescopes are compound lens systems providing angular magnification of a distant object when approach magnification is not useable. Distance refractive error is corrected in part by eyelens focus. Specification such as 7 x 42 represents a 7x angular magnification and a 42 mm objective lens diameter.

Telescope prescription is sought by patients with stable low vision who appreciate the benefit of flexibility. Many telescopes work well over spectacles so that rated magnification is correct. However, correcting ametropia by eyelens focusing changes performance. Myopes need shorter telescopes and hyperopes need longer telescopes to correct ametropia, but magnification alters. Myopes get more magnification focusing a Keplerian telescope and less with a Galilean, while the opposite applies for the hyperope.

Telescope length can be increased for near viewing, so that some of the objective lens power is used for the closer distance focus. In each type of telescope the magnification increases but longer tube length decreases the field width. Field of view is a maximum when the telescope is close to the eye, particularly for Keplerians when eye relief may be short (9-10 mm). Field lens design in the eyepiece system can provide for spectacle wearers, but field width may suffer.

For Keplerian systems, 50/Mx gives an indication of field angle, surprisingly constant across most brand designs. Galilean telescopes have about half the field width for comparable magnification, but field is less affected when the telescope is moved away from the eye.

Accommodation through telescopes is inefficient because the requirement is proportional to Mx^2. Upside down bifocal solutions are useful for fixed focus Galileans in special circumstances. (Figures 15 and 16)

Telescopes make stars brighter, but do not add brightness to extended terrestrial objects. For Keplerian telescopes, exit pupil diameter smaller than the eye pupil dims the object, so larger objective lenses are better for use at night. Zeiss recommends calculating 'twilight performance' rather than 'light gathering'.

Light gathering is the diameter of the exit pupil, so for a 8 x 40 telescope this is 40/8 = 5 mm. Larger objectives in stronger telescopes give the same exit pupil (for example,10 x 50) diameter, even though more light enters the more powerful telescope objective. Twilight performance represents this better as $\sqrt{8 \times 40} = 17.9$ whereas $\sqrt{10 \times 50} = 22.4$. When the eye pupil is smaller than the exit pupil, large objectives (usually in large and heavier telescopes) give little benefit.

Bailey[30] describes field of view as 'IFAR' (image field aspect ratio). Keplerian telescopes have IFAR about 0.9 to 1.0, whereas Galilean telescopes have an IFAR about 0.5. The field width is IFAR x EVD, where EVD is the closer viewing distance seen through the telescope. For an object at 40 m viewed through a 10 x 30 monocular, EVD = 40/10 = 4 m. If IFAR is 0.9, then field width is 4 m x 0.9 = 3.6 m.

Focusable Keplerian telescopes provide added flexibility when fitted through a spectacle lens as a bioptic providing wide fields of view and close focusing ranges. They are particularly helpful for intermediate tasks such as computer screens and for distance tasks such as theatre, art gallery or sporting events.

Figure 15. Common Galilean telescopes are opera glasses, usually about 2.5-3x. Fixed focus Galileans mounted in spectacles suit emmetropes for distance viewing, but need near caps for close vision. These images show a fixed focus Galilean telescope fitted over a spectacle lens to fully correct high astigmatism. For bioptic use, this telescope is fitted through the carrier lens and angled upwards with 'wedge washers' providing an axial view through the telescope when the head is lowered. Note the near cap in a custom bifocal form, where the lower segment gives a near working distance through the telescope.

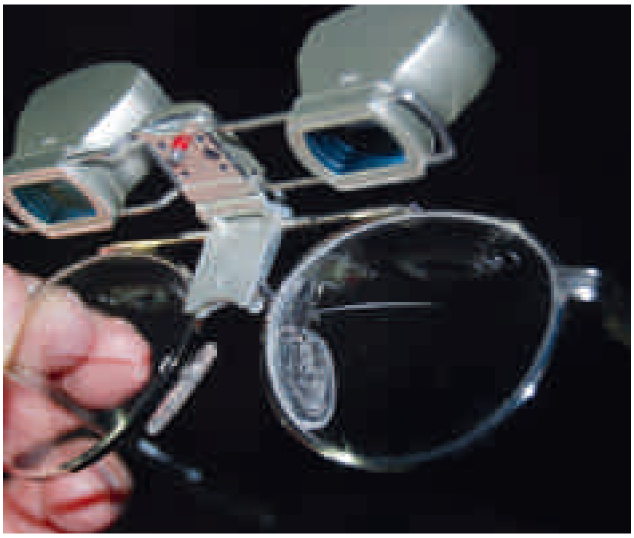


Figure 16. An alternative solution for near telescope use is to add power behind the telescope, about M^2xL. This telescope was made for a cellist who wished to see his music at 80 cm. The carrier lens had a +1.25 D near addition for this distance, while the upside-down bifocal segment behind the 2.2x bioptic telescope was an addition of $2.2^2x1.25 \approx +6$ D, less the +1.25 already in the lower section. A +4.5 D near add in the bifocal was our final solution. The conductor was slightly blurred.

- Simple Galilean telescopes are lightweight, Mx_{max} of ~3x, often of inexpensive design. Intraocular telescope implants[31] are available but involve large incisions, risk being dislocated in the eye from a bump or fall, permanently change spatial vision so that patients feel shorter (the floor seems closer), steps become uncertain and hand-eye coordination is disrupted. Spectacle mounted or bioptic telescopes offer greater safety and flexibility of use at a fraction of the cost.
- Keplerian telescopes have prism inversion, are longer, heavier and usually more expensive.
- Porro prism binoculars may be heavier than roof prism systems because of glass volume but are less expensive to manufacture.

Design complexity can include prism phase correction in roof prism systems, quality glass components with multiple coatings. Sealed nitrogen filled cavities eliminate condensation and provide dust protection and add to image brightness and clarity but at a cost.

- Mx_{max} = 10x (limit of stable hand-held control). Hand-held monoculars of 6x and 8x with fast spiral focus are practical options.
- Image enlargement, then field of view are the two essential parameters in prescription.
- Predict goal visual acuity and the necessary steps of magnification.
- Trial with low-level magnification to maximise fields of view first.

Procedure

- Fixed focus 1.7, 2.2 and 2.5x Galilean telescopes will need a near cap on the objective lens for close-up use, but focusable Galileans 3x and 4x are available.
- Keplerian telescopes of 2.8x9 and 4x12 are small, multi-purpose focusable types. These can be used with a finger ring and concealed in the hand. (Figure 17)
- Vector 5x21 binoculars focus 2 m to ∞, while Pentax Papilo 6x has a close focus to 50 cm. Use a near cap over one objective for versatile hand held use if rapid alternate range focus is required for monocular use.
- Some ready-made Galilean telescopes on spectacle bars use lightweight diffractive optics.
- Mobilux Far is a 2.5x distance Galilean telescope > 4 m, with a flip-in lens for conversion into a hand-held magnifier of 3.2x for 20 cm with LED illumination.
- Image brightness depends on exit pupil diameter and Mx, usually optimised by manufacturers' designs.
- Many other telescopes are available from international suppliers. Inexpensive telescopes may be best for children if regular replacement is needed. Remember that quality and price mean better optical performance and reliability. (Figures 18A and 18B)

Figure 17. Finger rings are fitted around the telescope barrel of small Keplerian telescopes for hand-held security

19. Illumination and sun filters

Retinal efficiency is often improved with higher retinal illuminance and/or high contrast. For patients with glaucoma and/or AMD, high levels of task illuminance help greatly.

Conversely, cataract, albinism and monochromasy patients may be disabled by even moderate lighting levels. Patients with retinitis pigmentosa have long adaptation times, frequently taking 10-15 minutes to adapt to indoor illumination even during the day. Consider photochromic tints for outdoor use, but photochromic lenses may not be dark enough for in-vehicle use because the activating UV illumination is filtered by vehicle windows. Try these tips:

- Reduce room lights and increase television brightness and colour contrast, but pull back curtains and lift blinds inside the house during the day.
- Suggest reading in a sunroom with back to a window. At night or during winter, add illuminance to near tasks such as reading using multiple tube fluorescent ceiling luminaries. Other options are:
  - Use table or floor-stand angle poise lamps with PL fluorescent lamps positioned over the forehead to give a bright page.
  - Recall the 'inverse square law'—one-quarter lamp distance = 16x illuminance.
  - Prescribe higher add near-only glasses for reading in bed, with higher illuminance bed lamp lighting. Try the 'Itty-bitty book light'.
  - Many hand and stand magnifiers are provided with battery-operated bulbs and LED lighting. Choose the most convenient device for the task concerned (for use only at home, or pocket carriage required?). LEDs give long battery and bulb life if portability is an issue. Mains supply handles are available or use rechargeable batteries.
  - Suggest that the patient purchase an inexpensive lux meter to test illumination levels and surprise themselves. It is difficult to judge absolute levels of illumination by eye, because of adaptation.
  - Always request UV 385 coatings on spectacle lenses, and trial blue blocking filters (511, 523 and 550 nm cut-off) for glare control and comfort out of doors.
  - Clip-on filters, sunbars, behind-the lens shades can all help when glare sensitivity is severe.
  - Multiple filters in combination do not give fully additive absorption. Two adjacent 25 per cent filters do not give 50 per cent absorption.
  - Check or compare tint density against a plain white background to show patients, or with a commercial lens densitometer for prescription specification. BPI[32] is a specialist tint supplier to the optical industry in Australia and provides good information on the clinical indication for its tint range.

A B

Figure 18. A and B: Lightweight Ocutech focusable Keplerian bioptic telescopes of 6x and 3x are available and suitable for longer duration wear. Their benefit is convenience for classroom use, theatre or ballet, gallery walking and sports. Smaller Galilean systems are less conspicuous in tinted carrier lenses but provide only half the comparable field width. Smartphone image zoom is often preferred for the quick view of direction signs or bus or tram numbers.

Figure 19. Smartphone demonstration of CCTV benefits is a first choice for practitioners, particularly if paired with a conventional television. While suited to the technologically adept patient, conventional CCTV magnifiers with their large dials, well-marked controls and easy 'switch and go' operation may be the preference of older patients.

Figure 20. The OrCam is a portable camera and a pocket computer attached to the spectacle frame. It has text and face recognition, storing familiar objects (and people) for later recall.

20. Electronic magnification, voice input/ output and Braille

- Closed circuit television (CCTV) magnifiers offer more conventional posture and image contrast reversal. Even higher magnification than optical limits is possible and with some models, interfacing of television cameras and computer screens helps. For some patients, cost is the limitation. All patients should be offered a demonstration so that they know what is available. Often, CCTV is a practical vocational option.
- CCTV also provides image contrast enhancement and reversal that reduces glare. Longer reading duration may be possible than with optical magnifiers because of more comfortable postural demands.
- Small, portable CCTV systems are available but may not offer adequate image enlargement despite their expense. Compare vision with illuminated stand magnifiers to judge cost-benefit comparisons.
- Changes in cost and specification means that obsolescence occurs rapidly, so rely on suppliers for demonstration stock only, or refer out for home trials.
- All Australian suppliers provide home trials of large aids and quality training and support. Refer with information about diagnosis, vision ability and vocational need. Do not presume that a device will be 'too expensive' for a patient.
- CCTV and other electronic device demonstration may not be a good use of consulting room time unless an optometric assistant is available in a larger practice.
- Determine the level of image enlargement required using logMAR chart comparisons. Use sentence charts to determine fluent reading with a +2.5 D near add, then calculate necessary ER for goal VA.
- Measure image enlargement on the screen using a centimetre ruler. One centimetre under the camera will appear as 20 cm on the screen for a 20x CCTV ER. Final ER depends on screen-to-eye distance compared with page-to-eye distance using spectacles as above.
- All CCTV vendors offer a wide range, some that interface with computers for convenient, split-screen presentation.
- As a first step in the CCTV process, demonstrate the inexpensive smartphone App 'VisionAssist'. This has screen enlargement, lighting, contrast reversal and font/background colour options. It can be HDMI linked to a large screen TV to match CCTV screen size. App developers suggest this will replace conventional CCTV, but probably it will not be a competitor for convenience and simplicity. (Figure 19)

The OrCam,[33] an exciting new product from Israel, is a portable camera-based system that clips to spectacles and uses a bone conduction speaker as it reads aloud words or objects pointed to by the wearer. The system learns to recognise faces and objects such as traffic lights and can read print in newspapers and on signs. It attaches to a small pocket computer by a cable. It shows great promise in enabling the severely vision impaired to both read and to move about more freely. (Figure 20)

OrCam was developed by computer scientists and artificial intelligence specialists in Israel. It is based on technology used in the company's MobilEye, an automotive camera system used to recognise objects such as pedestrians and cyclists and keep a car in a lane on a freeway. The OrCam is unique in that as the number of objects being recognised and stored grows, the system minimises the additional computer power required to remember them.

To recognise an object or text, the wearer simply points to the object with his or her finger and the camera and computer interprets the scene, adding to a library of recognition objects. The computer can identify the object when captured again by the camera.

The unit was released in Australia in June 2013 and sells for about $2,500.

Braille

Braille is a method of using a 3 x 2 matrix of raised dots to represent language characters. Originally, Braille was 'written' by indenting heavy paper with a hand-held stylus. Today, embossers that interface with computers produce Braille from text files directly. Despite technology advances such as text-to-voice output, Braille has an enduring function in the communication of the blind and severely vision impaired.

- Braille is a form of tactile communication, but all of us use tactile markings. We feel for objects daily in the dark, when we have soap in our eyes, when we adjust the electric blanket at night, and when we surreptitiously check that our buttons are done up.
- Learning Braille is not impossible for the motivated older person who particularly wishes to maintain independence. Begin by using simple Braille tools—a Braille watch, Braille timers and Braille labels. Recommend learning Braille numerals for lift buttons.
- Consider referring a younger patient with progressive vision loss to an agency that offers assessment and training in Braille.

Portable Braillers such as Humanware's Braille Note have both nine-key Braille keyboards and QWERTY keyboards. Some have refreshable 32-cell Braille displays, and all are capable of full computer integration. All have speech output.

21. Personal mobility issues and driving with low vision

Orientation and mobility is a developed and specialised discipline available at Guide Dogs Associations and other blindness agencies. Safety of patients willing to resume independent pedestrian mobility is important.

For active younger patients, referral is essential if visual field losses are substantial. For the older patient with AMD, peripheral vision may be adequate for mobility in familiar home surroundings, whereas the support of a trusted companion (carer or relative) is beneficial for shopping and outdoor mobility.

Rehabilitation advice for safe pedestrian mobility is critical if patients are to travel independently and continue to live at home. Orientation and mobility (O and M) instructors are skilled in helping vision impaired people to use their remaining senses to detect landmarks and determine safe travel routes.

Aged care assessment is necessary to ensure safety at home, in the bathroom and even on familiar steps and stairs.

Basic mobility aids

- A 'long' cane is adjusted in size to the lower end of the breast bone. It is used systematically to scan the path ahead and is an invaluable aid—particularly for unassisted travel. It moves above the ground in an arc that encompasses the travel route. It touches the ground at the far right and left of the travel path, in synchrony with each footstep but on the opposite side of the leading foot. This gives the user adequate time to detect a change in surface texture or a drop-off, such as curb or gutter.
- Symbol canes are secondary mobility devices and a signal to others that a user has a vision impairment. A four-part folding model can be stored in a bag or briefcase. A symbol cane can be used as a long cane if necessary but it lacks rigidity.
- Support ('walking') sticks are painted white and signify that the user is vision impaired as well as having a balance or support difficulty. These should be long enough to come up to the bump of the hip and be used on the side of the better leg. Modern walking sticks have a handle that offers full support for palm and wrist.
- For people with additional balance difficulties, support sticks are available with a four-prong base. Walking frames with wheels and a seat are more elaborate alternatives to simple sticks.
- Ultrasonic guides and guide dogs can be provided for those people who need specialist mobility support. If patients have special mobility needs, discuss these with a mobility specialist at a rehabilitation agency.

O and M instructors and physiotherapists are trained in providing support sticks and helping patients them effectively. They also demonstrate:

- How to be guided by a sighted person—'sighted guide techniques', explaining the role of the sighted carer.
- How to use public transport safely and efficiently.
- How to let others know that a person has a vision impairment

Driving

Driving a private motor vehicle is illegal if a patient fails to meet the uniform statutory requirements of all Australian states for VA of 6/12 in the better eye, a normal VF and no diplopia. Despite a patient's protestations that 'I can see well in the distance', driving when these conditions are not met is a danger to patients, their passengers and other road users.

When patients do not meet these requirements general medical practitioners are required by law to report drivers to the licensing authorities for licence review. These laws differ from state to state; check with your local OAA division for further information.

Drivers will be asked to supply evidence that they meet the requirements or risk having their driving licence revoked. Optometrists are often asked to complete these declarations and supply clinical information regarding vision status. Vision difficulty does not mean automatic licence cancellation. Authorities have the ability to issue limited or restricted licences to drivers under special circumstances.[34]

Many patients—particularly older drivers—recognise their vision limitations and choose not to drive at night or in rainy weather, sometimes voluntarily surrendering licences. Recommend that they do not drive at school drop-off and pick-up times. Understand the sacrifice many drivers make to give up their independence, particularly if they live in remote locations or are poorly served by public transport. The greatest impact may be on their access to friends, medical care, shopping and attendance at church and social functions.

On the other hand, remind these patients that if they fail to meet the statutory requirements for acceptable vision, they void their motor vehicle insurance and may suffer severe financial loss if required to pay compensation for an accident caused by failing to see adequately.

Driving with Bioptic telescopes

Bioptic telescopes are not recognised or acceptable for Learner's Permits without approval of Medical panels of the various state road authorities. For patients with an existing licence, if vision can be improved to 6/12, driving may be possible. Other vision requirements will need to be met (fields normal, no cataracts and so on) and advice to the GP regarding resumption of driving must be given.

The acceptance of bioptic telescopes for driving in Australia is far from certain. We have no occupational therapist specialists trained in this aspect of driver rehabilitation, there is no infrastructure or organisational support for this disability and driving, and medical review boards have considerable reluctance to approve bioptic use. This is despite bioptic telescope acceptance for driving in 43 states of the USA.

As optometrists, we are seen as having a financial interest in the prescription of devices and our advocacy may be dismissed. Approaches from user groups such as the Albinism society may lead to more success.

Clinical studies regarding driving with bioptic telescopes are appearing.[35,36] There are precedents for bioptic driving in Australia.

For older patients with AMD, vision must be better than 6/24 with glasses only and cognitive functions must be acceptable. Limited and restricted licences are available. Again, discuss this with the GP and relatives if possible, being mindful of safety issues for all concerned.

22. Balance and falls prevention

Medical practitioners and physiotherapists test patients to evaluate balance and the risk of a fall, and determine whether additional help is needed with balance. For frail patients the risks are obvious. If ready access to medical advice is not available, one simple test you can apply is the 'Get Up And Go' test.

For safety's sake, stand next to the patient at all times. Sit the patient comfortably in a straight back chair, then ask the patient to rise (without using the arms of the chair, if possible), stand still momentarily, walk forward about four paces, then turn around, walk back to the chair and sit down.

Less than satisfactory performance includes:

- poor sitting or standing balance
- difficulty rising or sitting again
- instability and slowness
- hesitancy
- swaying and stumbling.

Any risk of a fall is abnormal, and slowness will be obvious. The longer this test takes compared with the time taken for a younger person is an indication of how likely your patient is to fall. Expert advice is required for the proper evaluation of this deceptively simple test.

Other tests challenge orientation and balance. Specialised falls clinics set up in geriatric hospitals and rehabilitation centres collaborate with general medical practitioners in assessing patients' rehabilitation needs. One of their regular tests is the Melbourne Edge Test because poor contrast vision is a well-established threat to seeing steps and stairs.

We have a responsibility to alert a patient's general medical practitioner to the nature and extent of VI and its consequence for safe mobility. Falls are a constant risk for the elderly and vision impaired alike. Falls have catastrophic consequences for health and well-being. Suitable advice and mobility aids reduce the risk of falling.

23. Hearing impairment

In Australia, about one in five of people aged 65 years and one-third of all aged 74 years have presbycusis or age-related hearing impairment. This is permanent and not amenable to medical or surgical repair; presbycusis is an added disability that compounds vision loss. It occurs slowly, progresses gradually and affects both ears about equally. It varies from mild to severe, causes social handicap and reduces quality of life. Tolerance for loud sounds is often reduced. Some people may also experience tinnitus or 'ringing' in the ears. Voice recognition is especially affected. Examples include:

- Difficulty hearing high-pitched speech sounds such as the consonants s, f, th, p and sh, and understanding speech when in noisy surroundings or in a group of people.
- Telephone listening is impaired; the television may need to be louder than levels preferred by other family members.
- Deaf patients withdraw from conversation with family and friends, relinquish previously enjoyed pastimes and possibly become suspicious that they are the subject of 'whispered' conversations.

What can be done to help our hearing impaired patients?

LV patients with severe hearing impairment are more than doubly disadvantaged. Most of us lip read to 'fill in the gaps' in our hearing. Even young myopes report not hearing well when they do not wear glasses, even though their hearing is normal. Vision impaired people loose this ability to lip read. Optometric care may be restricted to carefully correcting the distance refraction because use of telescopes for face inspection is not part of our social etiquette.

Figure 21. The bionic ear (cochlear implant) was developed in Melbourne and revolutionised the management of patients with profound deafness. The grey transducer above the ear attaches magnetically to an implanted transceiver under the skin. About 22 electrodes are implanted in the cochlea. The 'bionic team' of engineers and ophthalmologic surgeons is working on the bionic eye.

Encourage patients to seek specialist advice for hearing support if you consider that this would be a benefit. Follow up with clinical advice to your patient's GP.

- Recommend an accurate audiology assessment to determine the extent of impairment and prescribe suitable hearing aids. Often these are free. Government support for the provision and payment of hearing aids is available for eligible patients. (Figure 21)
- Training in the appropriate use of hearing aids and devices is the second step in the process. Special listening devices help patients use the telephone, hear the doorbell, enjoy films and manage meetings. Inexpensive around-the-neck microphone and amplifier systems are available for use at home.
- Educate family and friends so they adopt efficient communication strategies, such as first gaining attention, facing patients, speaking more slowly and clearly, reducing background noise and not being long-winded.

Ask sighted helpers to clean aids regularly and attend to battery changes when necessary

24. Alternative strategies for daily living tasks

Medicare imperatives leave us with little time to provide the following counselling services from our own consulting rooms. Qualified occupational therapists who have completed in-service training at a blindness rehabilitation agency are our allies in this matter. Referral with clinical notes about the patient's diagnosis, vision abilities and vocational needs will start the rehabilitation process. Developing allegiances with blindness agency staff is supportive of patients and a reliable way to generate referrals back to the practice.

Most rehabilitation agencies have home-help advisors and specially trained occupational therapists to assist patients to develop new strategies for ADL. Some patients adapt to these easily while others, often older people set in their ways, find it difficult to change habits.

Activities of daily living are broad in their scope but cover a wide range of skills essential for independent living. Blindness and rehabilitation agencies have staff skilled in assessing a person's independence needs and training them to meet these effectively, often using adaptive devices and alternatives strategies that do not rely on vision.

Tasks include:

- Managing banking
- Using talking clocks and Braille watches
- Identifying medications and managing personal care such as shaving and make-up
- Maintaining a safe environment from mats and rugs, power cords, household chemicals
- Coping with kitchen tasks such as identifying food packets, opening cans and packets, cutting and slicing, using ovens and other appliances
- Managing maintenance sewing tasks such as sewing on a button
- Dining out
- Participating in sports and keeping active.
- Patients can borrow audio tapes of novels, magazines, textbooks and other printed information from blindness agencies and many municipal libraries.
- Write letters on white writing paper with bold black lines more widely spaced, using a black felt pen. Their own handwriting becomes easier to read. Recommend using a writing frame or signature template. Blindness agencies supply these items.

Two special items are important for welfare and personal safety.

Telephones

Special telephones are now available for a range of needs. Seek advice from the disability service of your telephone supplier.

- Larger black numerals on a white background may be the easiest to see. Remind patients that the central numeral 5 has a raised dot and is the reference point to locate surrounding numbers.
- Mobiles and fixed-line telephones have the same keypad layout, except for memory and function keys. Calculators have the 1, 2 and 3 keys at the bottom of the pad and the 7, 8 and 9 keys at the top, which is the opposite to the telephone.
- In Australia, call Telstra Call Connect (12456) to connect people directly without the need to look up numbers. Set memory functions to call emergency, family and friends.

Money

Good techniques for the handling of money are essential.

- Identify coins by feeling their size and their characteristic milled edges with a fingernail. Australian gold coins have segmented milling and vary in size with value. Sort coins at home first, carry in different wallet or purse compartments. Inexpensive coin holders are available.
- Australian bank notes increase in width and length as they increase in value, and vary in colour. Limit the denominations of notes carried to $20 and $5 notes (or $50 and $10, depending on a patient's financial need).

Continued Page 26

25. Axioms for essential

1. What is the problem?
Greet the patient, ask the questions, and then determine the specific needs the patient has to see more effectively.
Establish a rapport, develop a plan of procedure but make no promises yet.

2. Record the events and chronology of vision impairment
Ask about diagnosis and medical treatment, associated medical conditions.
Judge whether aspirations for care are realistic (for example, will driving ever be feasible?)

3. Assess clinical impairment
Measure:
- Distance and near VA (logMAR)
- Contrast sensitivity (letters, edges)
- Visual fields (Amsler, perimeter, macular sensitivity); is eccentric viewing a practical option for benefit?

Which of these losses is most disabling?
Is additional medical care needed?

4. Correct the ametropia
Prescribe spectacles that offer clearest distance vision.
Use closer test distances for VA <6/60.
Consider tinted lenses or multiple pinhole spectacles if glare is disabling, and consider the need for protective lenses if only one eye.
Do conventional near spectacle adds help for arms' length tasks such as eating meals?

5. Identify the patient's important tasks
Divide these into distance tasks (> 2 m), intermediate (2 m - 50 cm) and near (< 50 cm).

Low vision care is challenging but rewarding. It benefits both the patient who knows that some vision is still functional and the practitioner who facilitates and delivers these benefits.

Discuss the challenges with colleagues; try other strategies if one does not work. Vision can never be perfect again so understand our limitations and congratulate patients on what they can achieve.

procedures and low vision devices

6. Distance tasks. Start by exploring closer viewing distances.
Sit closer to television, sit in front row of church, theatre or concert.
Consider 2 - 3x bioptic spectacle mounted telescopes for golf or bowls. Try hand-held 4x - 8x monoculars for spotting tasks (street signs, mobility), but not for use while walking and field restrictions limit safety.
Prescribe exotic types for special needs. If telescope VA reaches 6/12, driving may be legal in some countries such as USA but not yet Australia.

7. Intermediate tasks (2 m – 50 cm)
Household, workshop and some recreation tasks such as Bridge, cards.
Is a closer viewing distance practicable? If not, use 2x spectacle mounted telescopes with near caps or clip on 1.7x to 2.5x loupes.
Suggest large print playing card, adapt the task for better vision (for example, reading stands), consider 'special purpose' spectacles if warranted.

8. Near tasks (< 50 cm). Our four main optical options are:
- Spectacle magnifiers and high near additions. Use as high-add bifocals, lookovers with prism, Noves and aplanatic doublets. These require short viewing distances but offer hands-free use and wide fields of view.
- Hand or pocket magnifiers. A benefit when close viewing distances are not appropriate, for occasional spot reading, require a steady hand, some have additional illumination.
- Stand magnifiers. These fix the magnifier-to-page distance, useful for complex tasks or frail users with hand tremors, require appropriate reading glasses for image placement, may not deliver expected enlargement and may restrict field to less than lens aperture. Many have additional lighting. May not offer binocular viewing.
- Near telescopes. Speciality telescopes of 2 - 4x can be spectacle-mounted for vocational tasks, require precise fitting and alignment, may be less useful for reading. These offer fixed working distances unless adjustable, but shallow depth of field. Linear extent of field is much less than the equivalent spectacle near add would supply. Optical 'lever' effect–magnification of image movement–takes some adjustment and can cause mild nausea.

Finally, remember the large range of CCTV magnifiers and other electronic aids such as personal voice message recorders, mobile telephone use for image capture and enlargement, Daisy players (audio books) and Braille and other tactile options.
Computer screen enlargement, voice recognition and text-to-voice are also available.

9. Revisit the issue of general lighting and task illumination
Glare is disabling for corneal or lens opacity patients. Suggest hats with brims to shield eyes from overhead glare, graduated tints in spectacles, clip-on sunglasses, photochromic lenses if glare outdoors only is the problem. Consider multiple pinhole for intractable difficulties, using fibreboard or painted lenses with black side to the eye. The ever-reliable typoscope and signature template are simple, inexpensive and very helpful.
Increase task illuminance using table lamps directed over the shoulder.
Suggest mounting multiple fluorescent lights over extended work spaces.

10. Review these evaluations, provide advice in manageable lumps
Tackle the most important task first, reiterate advice often, explain also to a near relative or carer of frail elderly patients.
Consider mobility and safety needs, refer for additional advice.
Review patients following delivery of devices and aids to ensure that the originally expressed need is being met. Train patients how to use special purpose near aids and telescopes.
Do not ignore vision alternatives, such as books on tape, radio or telephone support groups.

11. Address orientation and mobility
Is independent mobility possible and safe?
Refer for advice from a mobility agency.

12. Address vocational concerns
Are there special issues for schooling? Advise parents and teachers.
Is employment still possible?
Refer to rehabilitation agencies if job retraining or reassignment is necessary.

13. Address welfare and ADL issues
Eligibility for age, disability pensions?
Is welfare or municipal help required? Can the patient continue to live independently?
Refer to blindness or welfare agency.

14. Be patient, review and reinforce new LV skills regularly, but also ...

15. Practise the art of graceful retreat
- Not all patients are suitable.
- Not all can be helped, especially if vision loss is recent and/or progressing.
- Understand anger and frustration; it is not personal or about blaming you.
- Do not discourage vision alternatives.
- Watch carefully for signs of adaptation, then try again after a suitable interval.

- Recommend folding notes of different denominations into different shapes (halves or thirds), both to prevent new notes sticking together and to help identify them. Use a wallet that has several sections for each denomination of banknote.

Where do we fail most to help patients?

In my practice, an important difficulty that people report is seeing faces. We have no immediate remedy other than to measure vision carefully and prescribe the best distance refraction, even though VA may not come up to 6/60. When a grandmother reports that she can no longer see her grandchildren's faces, the answer has to be 'approach magnification' – get closer to the children—and give them a hug.

Advise family members to be accepting if their personal space is invaded by someone with VI wanting to see them better. Understand the difficulty of not knowing who it is your patient is looking at across a room.

Try to give patients the confidence to ask their friends to identify themselves when first meeting. Small 'vision impaired' badges are available from blindness agencies and can be worn in circumstances where less personal contact is made, such as when shopping.

26. Referral options for rehabilitation support

Most optical low vision care is conveniently provided in the optometry private practice. This is cost effective for the patient and the community. There are specialist low vision clinics in most states of Australia and the ACT as well as blindness agencies that cater for the more complex circumstances outside the role of the optometrist, such as the special educational, vocational and recreational needs of VI people. They also provide advice regarding welfare issues, disability pensions and access to other benefits. Travel passes for public transport are available to eligible people.

Most states also have speciality mobility and guide dog agencies that offer training with the long cane and travel with the assistance of a trained guide dog. Encourage patients to consider using rehabilitation and mobility support if you judge that they would benefit; most optometry patients will have never thought about this. Provide a history of any ophthalmological diagnosis and treatment when referring patients for rehabilitation support.

The major blindness agencies in NSW and Victoria amalgamated in July 2004 to streamline their approach to services delivery. All can be contacted in the *Yellow Pages*.

Remember that many older vision impaired patients have general health issues that affect their ability to seek vision rehabilitation. They may be under specialist medical care for other ailments, so suggest referral through their local general medical practitioners as a first step.

Good interaction between optometrist and GP in these matters is in the best welfare interest of patients. This ensures that a coherent and appropriate management strategy is implemented. It provides valuable information to the GP regarding the nature and extent of vision impairment.

A final word

Magic and faith healing are outside the ambit of optometrists. Patients may be referred to you and come with great expectations that vision will be restored, driving will be possible again and rapid reading at a normal distance will be regained. For the most part, these are not realistic expectations so we need to advise patients gently of this at the outset.

What helps patients most is a careful assessment of their diagnosis (showing them fundus images can be salutary), a discussion of prognosis (again), assessment of particular disabilities and a summary of how you might help them. Never criticise previous consultants or alternative therapies when patients are holding expectations that these will be curative. Stating what you can do, how it might help and offering trials in the clinic is the starting point.

Not everyone can be helped. Explaining our role and interaction with other practitioners is informative, particularly for family members who may accompany patients to your practice. Referrals to other practitioners (call them 'experts') or other disciplines can be supportive.

If the prognosis for optometric management is poor, if patients have unrealistic goals, are poorly motivated, have dementia or other intellectual impairment, then withdraw gracefully. Leave the door open for a patient to return when circumstances change or acceptance of VI improves.

Admitting that you cannot help a patient is not failure: rather, it is honest advice regarding the limitation of our expertise in a particular instance.

Financial disclosure: East Melbourne Optometry & Low Vision Centre is the Australian agent for Ocutech telescopes.

References are available from j.megahan@optometrists.asn.au, subject: Low Vision Primer Johnston

OAA Bookshop

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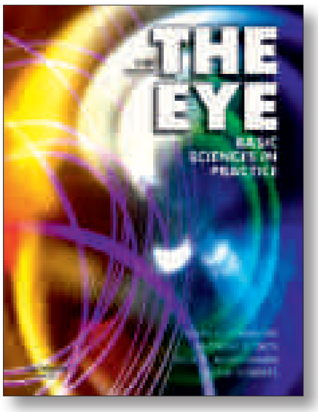
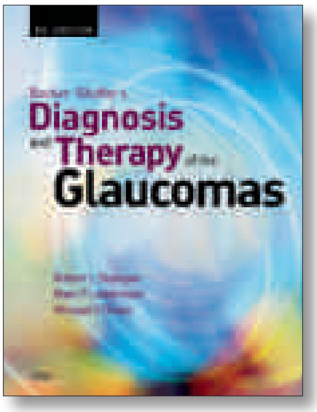


The Eye: Basic Sciences in Practice (BO503)



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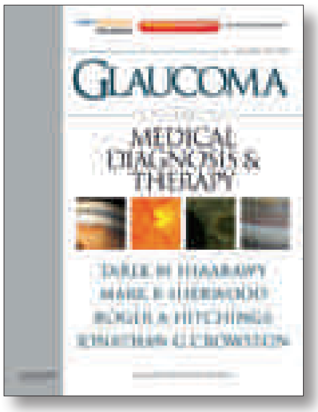
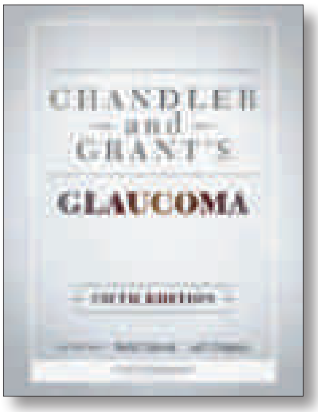


Glaucoma Expert Consult Premium Edition Enhanced Online Features, Print, and DVD 2-Volume Set (BO808)



Chandler and Grant's Glaucoma (BO056)

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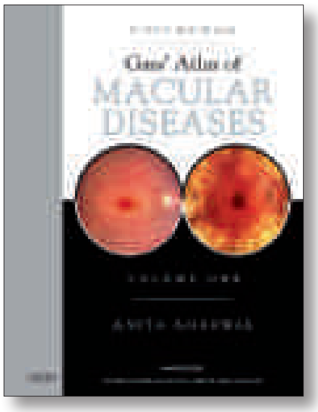

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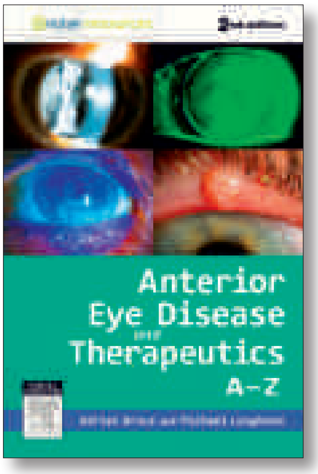

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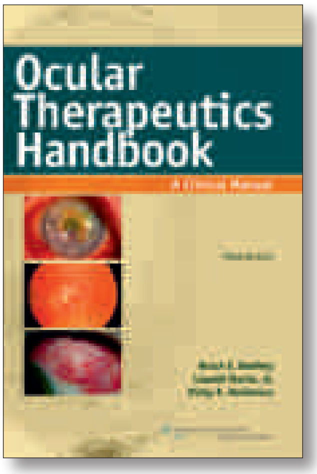
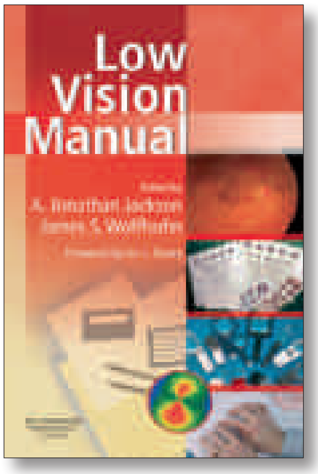


Ocular Therapeutics Handbook (BO461)



Low Vision Manual (BO765)

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Optometrists know there are many reasons someone may develop low vision. It may not be 'the big four' of cataract, glaucoma, diabetic retinopathy and macular degeneration, low vision could also be the result of corneal dystrophy, vascular incident or retinal detachment.

Your tool kit for examining these patients will contain more than your standard consulting room set-up; it will include three things: a current knowledge of service providers and support groups, common sense and a willingness to make a difference.

Fortunately, this accounts for the majority of optometrists in practice. Even though optometrists are in a key position to offer valuable treatment and advice, many consider low vision daunting. As the rapidly evolving world of low vision care continues to grow, it is important for optometrists to remember these basic facts and that you can have a positive impact on patients in need.

10942 Low vision assessment

Optometrists should be aware that since 2004, there has been a Medicare item number available to charge when they are managing patients with low vision. This item can be charged in addition to another appropriate Medicare item—for example, 10900 or 10914.

According to the Medicare Benefits Schedule Book, Medicare service item 10942 covers:

Testing of residual vision to provide optimum visual performance involving one or more of spectacle correction, determination of contrast sensitivity, determination of glare sensitivity and prescription of magnification aids in a patient who has best corrected visual acuity of 6/15 or N.12 or worse in the better eye, or horizontal visual field of less than 120 degrees within 10 degrees above and below the horizontal midline, not being

Prepare a support plan

Patients will take comfort and reassurance from being looked after and it is important to present a clear and simple management plan to address their likely ongoing needs. Such a plan can be copied for carers, family members or staff at residences and nursing homes, or shared with a patient's general practitioner and ophthalmologist. A low vision service provider will be interested to know what has been arranged prior to them meeting a patient, and will appreciate a detailed referral including refraction and acuities, field plots and any other relevant information.

Consider including the following

- Information about their particular eye conditions, for example, Optometrists Association patient brochures or MD Foundation.
- Recommendations of measures to preserve eye health, for example, information on nutritional supplements for MD, or material about optimal UV and glare protection—hats, fit-overs and so on.
- A review or appointment schedule, and details of what will happen at future appointments. A patient may be reassured to know that, for example, the scheduled six-monthly examinations may include perimetry, retinal photographs or OCT scans to help monitor their condition.
- Referral to an ophthalmologist where appropriate. It can be communicated that ophthalmologic assessment is often important, regardless of whether any improvement in vision is possible and that other ocular diseases must always be considered.
- Referral or report to the patient's GP. This is an opportunity to express any concerns regarding psychological issues and mental health.
- Referral to a low vision service provider. Explain that a low vision service team may include a specialist optometrist, orientation and mobility officer, occupational therapist and trained counsellor.
- Referral to any appropriate local low vision support groups. It may be possible for you to establish such a group of your own patients.
- A final comment that the patient can book in to see you at any time if they have concerns, and that it is important they contact you the same day in the event of sudden changes in vision. Often, we assume patients understand such simple things and we find that we are wrong.

and referrals

patients all the support they need

a service associated with a service to which item 10916 or 10921 to 10930 applies, payable twice in a 12-month period.

Fee: $35.55 Benefit: 85% = $30.25

The procedures listed in the OMBS item 10942 descriptor are all familiar tests. Optometrists should use this consultation item in the provision of low vision care to patients, which will allow them to more fully determine their patients' visual capabilities and limitations. If nothing else, these procedures will provide the optometrist with more information to share with the patient and with a referred eye-care professional or low vision service provider for additional assistance.

Preserve best visual acuity

We know that many patients with low vision, including some who are legally blind, still require some form of optical correction to achieve their best visual acuity and best functioning. For these patients, as with all patients, spectacles, contact lenses or other vision aids must be maintained and updated. Additionally, low vision aids still need to be replaced from time to time. Each visit from a low vision patient offers the opportunity to discuss new developments and devices.

Optometrists can also use each return visit as an occasion to discuss the patient's eye condition and discuss their prognosis. Reinforcing simple tips can make a great difference to a patient with low vision, such as the importance of improving lighting and contrast, enlarging reading material where possible and controlling glare.

Anti-VEGF treatment

Many patients are undergoing anti-VEGF treatments with an ophthalmologist and they often appreciate discussions with informed optometrists about these treatments. This is not to overlook the fact that optometrists are perfectly placed to monitor the ocular health of a patient, regardless of whether this forms a shared-care relationship with an ophthalmologist. Six- or 12-monthly reviews are often appropriate to monitor a patient's optical and non-optical needs. In scheduling these consultations, bear in mind that typically, you will need to allow low vision patients a little more time to discuss their vision needs and diagnoses. Importantly, patients with low vision should not be given the impression that nothing more can be done for them.

Organisations providing low vision service

Many patients will benefit from a referral to a low vision service provider. Most low vision service providers include a multidisciplinary team that is able to assist patients with full-scope service, encompassing the provision of visual aids, orientation tips and training as well as the supply of a range of assistive technology to complete routine daily tasks. Service providers may also facilitate patient support groups or provide counselling for those struggling to accept their diagnosis. For some patients, simply meeting or witnessing the lives of others who face similar problems can be very valuable.

Most low vision service providers are accessible to optometrists and patients alike via websites, but many organisations look to optometrists to make appropriate referrals and recommendations to patients. It is important to be aware of these organisations, where they are located and what they can provide for patients.

This will take a few clicks online, a phone call or a visit to a facility to learn more about what patients can access.

Support groups

Vision aids and resources as well as counselling and access to social groups are also often provided by smaller organisations within each state and territory.

It is important for optometrists to consider mentioning condition-specific organisations for patients affected by specific ocular or medical conditions. These groups provide a wealth of information to patients about their specific condition of interest and the services that are available to them.

All patients can feel overwhelmed and may be unsure of where to access trustworthy information. An informed, caring health professional can enrich a patient's life.

Optometrists are frequently called on to assist with blind pension and taxi concession applications, and can inform patients about companion cards and other services such as theatre audio description access in major cities.

Too much information can be overwhelming, especially in the early stages of developing eye disease or vision loss. There are steps optometrists can take to ensure this information will not be lost and that it is delivered in a thoughtful way that can be retained and revisited by patients in their own time.

A low vision patient support plan is a considerate way to incorporate the names, contacts, resources and important details of your patients' conditions. This is all part of the rapport building that begins when patients enter your practice.

Support groups

Australia

Macular Disease Foundation Australia
www.mdfoundation.com.au
Retina Australia
www.retinaaustralia.com.au
Glaucoma Australia
www.glaucoma.org.au
Diabetes Australia
www.diabetesaustralia.com.au
Keratoconus Australia
www.keratoconus.asn.au

New Zealand

Macular Degeneration New Zealand
www.mdnz.co.nz
Retina New Zealand
www.retina.org.nz
Glaucoma New Zealand
www.glaucoma.org.nz
Diabetes New Zealand
www.diabetes.org.nz
Keratoconus New Zealand
www.kcnz.co.nz

Psychosocial issues

problems your instruments won't detect

Breaking bad news and screening for depression are skills you need

Dr Gwyneth Rees
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Dr Bonnie Sturrock
BAPsych(Hons) DPsych(Clinical) MAPS
Clinical Psychologist and Research Fellow
Centre for Eye Research Australia, The University of Melbourne, Royal Victorian Eye and Ear Hospital

Delivering bad news

Delivering bad news to patients with low vision can be a difficult task for optometrists but patients need to be well informed about their eye condition and prognosis, in order to have an accurate and realistic expectation of what is to come. From there, patients can take the necessary steps to prevent further deterioration, gain appropriate treatment and put into place aids for practical day-to-day challenges. Optometrists have a responsibility to educate their patients about their eye condition and its treatment. In many cases, this will mean confirming to them that their condition is permanent and that they will continue to experience vision loss.

This information may be met by intense, negative reactions from patients, including shock, disbelief and grief. The way in which the news is delivered can impact on patients' level of anxiety,[1] psychological adjustment to their condition,[2] and satisfaction with care.[3]

Many practitioners receive little or no formal training on how to communicate this information and to deal with its emotional implications.[4,5] Some basic practical steps for effective delivery can be remembered by a simple ABCDE mnemonic.[6] (Table 1)

Impact of vision loss on well-being

Loss of sight evokes strong emotional reactions. Qualitative studies have described in detail the range of feelings resulting from vision impairment including fear, worry, frustration, isolation and embarrassment.[7-9] These emotional reactions are often a response to the detrimental impact of vision loss on everyday activities and quality of life. This is a normal response to a difficult life change. Many individuals learn to cope with these challenges and continue to lead full and independent lives. For others, the functional loss and distress can lead to depression.

Research clearly shows that vision impairment is a risk factor for depression.[10] It is estimated that rates of depression are two to five times greater in older adults with low vision than in sighted individuals of a similar age.[9-13]

Depression has been shown to exacerbate disability and further reduce levels of functioning by reducing motivation, initiative and resiliency.[14,15] Even minimal depressive symptoms that do not meet the full diagnostic criteria are associated with functional decline not accounted for by eye disease or other medical problems.[16] Depressive symptoms are also likely to be a barrier to uptake and effective use of low vision rehabilitation services.[17]

Screening for depression

Early identification and management of depressive symptoms is critical. Nevertheless, depression is often undetected and untreated in patients with vision impairment.[14,18,19] Lack of identification of depression in those with vision impairment may be due to factors such as poor recognition of depressive symptoms,[20] the difficulty in distinguishing chronic depression from a normal part of the grieving process associated with vision loss or challenges in doctor-patient communication concerning emotional health in older adults and those with sensory impairments.[21,22]

Indeed, patients with vision impairment and depression have been identified as a group in which depression is least likely to be recognised by their GPs.[23] As such, the need to identify depression in high-risk groups has been recognised internationally and the UK National Institute of Clinical Excellence (NICE) has recommended routine depression screening for people with functional impairment within health-care settings.[24]

Eye health practitioners and rehabilitation workers are key care providers for people with vision impairment and can play a vital role in detecting depression.[25] It has been suggested that these practitioners could screen for depression and refer patients for psychological services when necessary.[25,26]

In a previous survey of eye health practitioners and low vision rehabilitation staff, we found infrequent use of depression screening tools in eye-care settings,[27] yet staff reported concerns about their patients and a desire to identify their psychosocial needs.[27] Following a staff training program,[28] depression screening has been implemented within Vision Australia's low vision rehabilitation service. Our screening tool of choice is the Patient Health Questionnaire-2[29] (Table 2), a two-item measure that has been well validated and is widely used as a first-line screening instrument.

Patients who screen positive are provided with a referral to their GP for more detailed assessment and treatment if required.

A dvance preparation
- Arrange for a suitable environment, comfortable and free from distractions, in which to speak with the patient.
- Explore what the patient already knows about their eye condition.
- Organise a supportive, meaningful other person to accompany the patient.
- Prepare yourself emotionally.

B uilding a therapeutic environment/relationship
- Provide adequate seating for the patient and family members.
- Sit relatively close to the patient.
- Use appropriate body language, provide eye contact and lean forward.
- Be open and honest.
- Validate the patient's pain and suffering.

C ommunicating well
- Use direct language: 'Your retina has been damaged by macular degeneration.'
- Put it in lay-persons terms: 'The problem you have means that your vision cannot be improved with new glasses.'
- Avoid the use of medical jargon, acronyms or euphemisms.
- Use matter-of-fact language: 'You no longer meet the driving standard.'
- Allow for silence.

D ealing with patient and family reactions
- Determine how the patient and family are feeling by asking direct questions: 'How are you feeling about this news?'
- Use active listening and paraphrase their understanding of the news: 'What I'm hearing of your understanding is ...'
- Express empathy: 'I can't even begin to understand how you must be feeling right now.'
- Allow the patient to express their emotions: 'I understand you are feeling sad about this news. It's OK to cry—please take your time.'
- Examine the patient's way of coping in the moment and validate this: 'I understand this may be hard for you to believe.' Denial, blame, disbelief and acceptance are parts of the overall process.

E ncourage and validate emotions
- Ensure you know how the patient is feeling by asking direct questions: 'What effect has this news had on you emotionally?'
- Acknowledge feelings and provide validation: 'It sounds like this news has come as a great shock—it's understandable that you feel like this.'
- Explore the emotional needs of the client: 'Would you like to receive some further support around how you are feeling about your eye condition?'
- Provide referrals to the GP, who can organise psychological support services when appropriate.
- Process your own feelings.

Table 1. ABCDE

Patients are also provided with information about depression and vision loss and sources of support. We are currently evaluating patients' uptake and evaluation of this referral pathway. Clearly, depression screening will be worthwhile only if it leads to accessible and effective treatments.

In our training program, we found the following tips to be useful for eye-care staff considering implementing depression screening.

Over the past two weeks, how often have you been bothered by any of the following problems?

- Little interest or pleasure in doing things
- Feeling down, depressed or hopeless

0. Not at all
1. Several days
2. More than half the days
3. Nearly every day

Scores of ≥ 3 have a sensitivity of 83 per cent, specificity of 92 per cent for major depression.[30]

Table 2. The Patient Health Questionnaire-2

- Bring up the issue of depression. Keep in mind that many people will not raise their concerns unless invited to do so. Talking to someone about depression will not make them depressed, rather, it is reassuring to know that they are understood and can be helped.
- Ask open questions: 'In addition to looking at your eyes, I am interested in how things are going for you overall.'
- Normalise emotions: 'We know that vision loss can have an emotional impact and it's important to manage this. How have you been feeling?'
- Make observations: 'You sound pretty sad; perhaps we can find you some help for that.'
- Ask direct questions: 'Depression is pretty common in people with vision loss, but once it's picked up there are effective treatments. Would you say depression has been an issue for you?'

Contain discussions

Many practitioners fear that asking about feelings will lead to long discussions for which they don't have time. It is possible to discuss feelings within a short consultation. Often the best approach for this is to set expectations early. Let the patient know your role, its limitations and your time limits. For example: 'We only have a few more minutes before I need to go to my next appointment, but I want to check with you about how you are feeling. We have some new patient resources that you might find helpful if you have been feeling a bit low. How are things with you?' If you need to interrupt, politely ask permission: 'Can I stop you there? You are sounding quite distressed. I'm not trained in counselling skills, but I am able to provide you with details of services that can help you manage this. Would you like to talk to someone further?'

Provide a referral

- Involve the patient in the decision-making process for referral.
- Provide the patient with information and resources to raise their awareness of the issue and sources of support.
- Normalise their feelings and the referral: 'You are going through a difficult experience; most people with vision loss find it tough and it is natural to need extra support at this time.'
- Helping the patient to plan when and how they will take up the referral, for example, when they will call their GP for an appointment, is more likely to lead to use of the referral.

We encourage optometrists to consider how best to identify distressed patients in their practice and to develop local referral processes to ensure that these patients gain access to services to prevent or treat depression.

References are available from j.megahan@optometrists.asn.au, subject: Psychosocial issues, Low Vision Primer.

Update on technology advances in

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The past decade has seen considerable shifts in the way we all use technology. For people with low vision, this is not necessarily a new phenomenon. For some time, low vision specific technology has been used to facilitate access to print and electronic information.

The newer phenomenon is that an increasing number of technological products available to the wider population are now integrating features that help those with low vision. This article gives a brief overview of the technology specifically designed for people with low vision as well as the 'mainstream' technologic devices that can also serve as low vision aids.

Desktop video magnifiers

Desktop video magnifiers are versatile and effective tools, granting those with low vision accessibility to reading and writing materials. Traditionally, these devices use a video camera to magnify text positioned on a moveable tray. Although the basic concept of the video magnifier remains unchanged, in the past 25 years, we have seen improvements in image quality, features, aesthetics and design.

Desktop video magnifiers now employ high-definition LCD and LED technology in widescreen format. Text can be magnified to very high levels (75x) without distortion. Magnifiers can be customised to please any individual's viewing preferences. Numerous brands are now available in Australia at competitive prices, including Enhanced Vision, Freedom Scientific, Humanware, Optelec, Telesensory and Zoomax.

As demand for smaller products has grown in recent years, desktop video magnifiers have diversified. The traditional X-Y moving tray is sometimes replaced with a small camera unit that takes up much less desk space. For example, the Acrobat LCD 3-in-1 Electronic Magnifier from Enhanced Vision, Freedom Scientific's Onyx Deskset portable video magnifier or the SmartView 360 video magnifier from Humanware. These types of video magnifiers feature moveable camera heads so that distant objects can also be magnified on the screen. The technology is particularly helpful for low vision students who need to view whiteboards or presentations. (Figure 1)

Figure 1. The Humanware Smartview 360 features a moveable camera head for near and distance viewing Photo: Humanware

Hand-held video magnifiers

A wide range of hand-held video magnifiers is available. These have become very popular in recent years, particularly as prices have gone down. Increased portability means that a person with low vision can take advantage of the benefits of electronically magnifying and enhancing the contrast of printed material when they are on the go, for example, reading labels while shopping, or reading bus timetables or restaurant menus.

A number of hand-held models, such as the 'i-loview 7 HD' and Enhanced Vision Pebble (Figure 2), offer a distance viewing option. A standard feature for many models is the freeze frame or snapshot function, where an image can be captured and then magnified for viewing. This is handy for the person with low vision trying to read print that is not presented at eye level, for example, product and price labels on the top shelf of a hardware store.

Some hand-held video magnifiers, including the Zoomax Snow (Figure 3) can be connected to a large, flat screen television. This allows the person with low vision to magnify the print to even larger sizes, similar to those found with traditional desktop video magnifiers described above.

Merging magnification technology with scanning technology

In efforts to reduce visual fatigue and even motion sickness that can be experienced by users of video magnifiers, some low vision technology manufacturers have incorporated text scanning (optical character

and accessibility

A look at the latest innovations and improvements in low vision products that can improve your patients' quality of life

recognition or OCR) technology into video magnifiers, such as the Da Vinci by Enhanced Vision and the ClearView+ Speech by Optelec. Not only is the text magnified, it is also scanned and read aloud and automatically scrolls while the text is highlighted so that the individual can process the print both visually and aurally.

Computer access

Video magnifiers primarily assist in reading print information. While they can be used for handwriting tasks, computers are the tool of choice for many people with low vision who need to generate material. There is a long tradition of computer systems having in-built accessibility features for people with low vision. For example, the Microsoft Windows operating system has allowed the user to adjust the contrast and size of fonts and icons for many years.

While this feature provided inconsistent results, for some, it was adequate. Most people needed more, which led to the development of customised screen magnification software solutions. These products allow everything on the computer screen to be magnified, regardless of the application running. They feature 'font smoothing' functions which prevent text from appearing pixelated at higher levels of magnification. They also allow greater customisation of colour contrast settings, as well as the size and contrast of the mouse point. Brands commonly used in Australia are ZoomText (by AI Squared) and MAGic (by Freedom Scientific).

In recent years, Microsoft and Apple have considerably improved the in-built magnification and contrast features of their computer operating systems. Both now offer a full-screen magnification option that is beneficial to the person with low vision.

Figure 2. Enhanced Vision Pebble

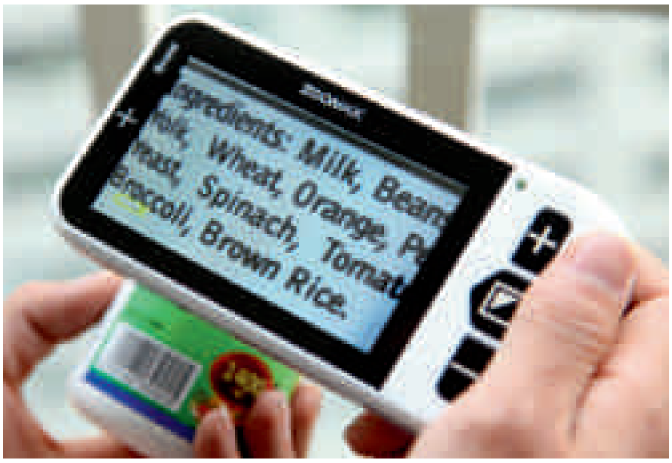

Figure 3. Zoomax Snow

Smartphones and tablets

The improvements in the low vision accessibility features found in computer operating systems today can also be found in another technological tool prolific in today's society, the smartphone.

For the less technologically-interested person with low vision, the basic big-button mobile phones with large screen fonts are a popular option. Featuring high-contrast type, these phones are easy to use and relatively inexpensive. Even big-button fixed-line phones have features that enable it to read back numbers and names in the address book or caller ID. (Figure 4)

For those requiring feature-packed devices, popular smartphones such as the Apple iPhone and newer Android phones do not leave the person with low vision behind. They feature full-screen magnification for those who need it, in addition to the facility to invert colour contrast settings. Of use to many with low vision, the pinch and zoom finger-thumb gestures used on these touch screens allow for easier web browsing with the ability to magnify content on the screen as required. The Apple devices have a beneficial in-built 'Reader' function in the Safari web browser.

Tapping this button removes all the visual noise from a web page so that only the content is visible, without all the advertisements and graphics—an example of 'mainstream

Product	Price incl GST
Zoomax Snow	$430
Enhanced Vision Pebble	$650
Freedom Scientific Ruby	$950
i-loview7 Full HD (near and distance)	$1,299
Compact 5HD (near and distance)	$1,769

Price guide for hand-held video magnifiers

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Technology update

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Figure 4. Oricom Pro-610 big-button cordless phone

accessibility' benefitting all, regardless of their level of vision.

These zoom and magnification features are standard in the Apple iPad and other tablets. The larger screens allow more content to fit, which many people with low vision find easier to access. E-book readers, such as the Kindle and iBooks on the iPad include functions to enlarge the size of the text, to invert the text so that it is white text on a black background (reducing glare) and even to read the text aloud.

One of the most exciting developments in smartphone and tablet technologies is the diverse array of apps that are becoming available. There are now apps that allow the phone or tablet to be turned into a video magnifier (VisionAssist, by Slinkyware), a barcode scanner for identifying everyday products in the pantry (GoScan by GS1 Australia), a scanner to scan and read printed materials (DocuScan Plus by Serotek Corporation), and a library of books that can have the print enlarged or converted to audio (iBooks by Apple).

These devices are becoming easier to use through further enhancements in voice recognition technology. While this is yet to take the place of using a computer keyboard for involved tasks, for simple tasks, such as sending a text message, operating by voice can save the person with low vision a lot of time and frustration. They no longer need to manipulate some sort of push button/scroll wheel/track pad/keyboard data entry.

Voice recognition in Apple iOS devices (through the Siri app) and in the new Microsoft Surface tablet are very useful for the person with low vision.

From custom-designed readings aids, such as video magnifiers to smartphones and tablets, we are seeing more options available to people with low vision in the realm of technology. While the levels of choice do not always closely match those of their fully-sighted counterparts, technology, particularly mainstream technology, is heading in the right direction.

Vision Australia offers people with low vision advice and support on suitable technology options. The Low Vision Clinic service operates throughout metropolitan and regional areas of Victoria, NSW/ACT and Queensland. For more information contact Vision Australia, 1300 84 72 66 or visit www.visionaustralia.org.

Orientation and mobility

Basic human guide techniques

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Orientation and mobility (O&M) specialists work with people of all ages who are blind or have low vision. They offer travel training and instruction in the use of mobility aids, orientation to the environment, vision education and development of sensory awareness.

One aspect of an O&M program is 'human guide' training, previously known as 'sighted guide' technique. Human guide is a technique that enables a person with a vision impairment to move through an environment with the assistance of another person. Human guide can be provided by a friend, family member, colleague or any other person who has the skills and confidence to guide the person with a vision impairment.

Human guide can be offered and provided in any environment where a person with a vision impairment is moving, including the home, road crossing environments, shopping centres and workplaces. This article provides specific information about the basic human guide technique as a refresher for optometrists and practice staff who need to assist a patient with severe vision impairment.

Human guide

To provide human guidance the first thing you should do is inform the person with the vision impairment that you are approaching them. Then ask if the person requires assistance to move through the environment.

If the person with the vision impairment acknowledges that they require assistance:

- The guide touches the back of their hand against the back of the vision impaired person's hand. (Figure 1)
- The person with the vision impairment slides their hand to just above the elbow of the guide and grips the arm so that their fingers are on the inside of the arm and the thumb is on the outside. (Figure 2)

The guide's arms should be by their side in a vertical, relaxed position. The person with the vision impairment holds their arm at a 90-degree angle to hold onto the guide. To facilitate smooth and safe walking, the guide and the person with the vision impairment should have their shoulders parallel to each other, with the guide positioned slightly in front of the person with the vision impairment.

When travelling using the human guide technique, the person with the vision impairment will be able to sense any changes in direction and speed of their guide's travel through feedback via their grip on the guide's arm. They should respond according to this feedback, for example, slowing their walking pace to match that of the guide. The guide should monitor how the person they are guiding is managing the technique and respond to any hesitation or anxiety in the person being guided.

The guide should take responsibility to ensure the spaces they are walking through can accommodate the two body widths, and inform the person being guided of environmental features, such as steps and crowded spaces.

Every person with a vision impairment requires different amounts of information about the environment they are moving through and, following a discussion about individual preferences, the guide should adjust information provision accordingly.

Figure 1

Figure 2

Other techniques

There are other human guide techniques specific to situations, including moving through narrow spaces such as doorways, seating, and ascending and descending stairs. Further information about other techniques can be obtained from a range of rehabilitation service providers.

Further information

Orientation and Mobility Methods. Techniques for Independent Travel (2009). Lil Deverell, Sharon Taylor and Janet Prentice. Available from Guide Dogs Victoria.

Essential Mobility website: www.essential-mobilty.com.au

Orientation and Mobility Association Australasia is the professional association of orientation and mobility specialists in Australasia: www.omaaustralasia.com.

AMD after anti-VEGF

Dramatic advances

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Anti-vascular endothelial growth factor (anti-VEGF) pharmaceutical agents have revolutionised the treatment of wet AMD (Figure 1). There is no doubt these therapeutic agents are having a significant impact on controlling disease progression and improving visual acuity to some degree for many patients. Just how effective the treatment is in improving functional vision and quality of life, and for how long, is less apparent. It is important that we understand which patients are eligible for treatment, exactly what level of functional visual acuity they are left with, how many remain vision impaired and how many remain in need of low vision services.

Prevalence of vision impairment caused by wet AMD

It is estimated that more than 180,000 Australians have vision impairment (visual acuity worse than 6/12 in both eyes that cannot be corrected) and that AMD is a leading contributor to the problem.[1] AMD is the leading cause of legal blindness (visual acuity worse than 6/60 in both eyes that cannot be corrected or visual field constriction to within 10 degrees of fixation in the better eye) in Australia and other economically developed countries.[1,2]

Based on data collected prior to the introduction of anti-VEGF therapeutic agents, about 107,000 Australians are estimated to have vision impairment due to AMD.[2] Although only about 20 per cent of all cases of AMD are the wet (neovascular) form rather than the dry (atrophic) form, wet AMD is by far the predominant cause of vision impairment.[3,4]

The estimated total number of Australians with wet AMD affecting at least one eye is about 108,000 and the number with wet AMD who are vision impaired is about 62,000.[2] Given the association of wet AMD with age and the ageing of our population, this public health problem is expected to increase dramatically over the coming decades.[2,5]

New treatments for wet AMD

Currently, the three main anti-VEGF pharmaceutical agents used to treat wet AMD are ranibizumab (Lucentis, Novartis), becavizumab (Avastin, Roche)* and aflibercept (Eylea, Bayer). They are intravitreally injected.

Lucentis is a humanised antibody fragment that binds all VEGF isoforms and is designed specifically for ophthalmic use. It was the first of these agents to be approved by the Therapeutic Goods Administration (TGA) for treating wet AMD and gained reimbursement through the Pharmaceutical Benefits Scheme (PBS) in 2007.

It is a costly treatment, about $2,000 per injection, and seems to require continual monthly dosages, making it highly burdensome to government, patients and practitioners. To combat the cost in patients who are not eligible for Lucentis through the PBS, practitioners have been using Avastin off-label—in other words, without TGA approval for treating AMD.

Avastin is a full-length antibody approved for treating some systemic cancers and is considerably less expensive than Lucentis, about $50 per injection. More recently in 2012, Eylea, an engineered protein that binds VEGF, was developed for intravitreal injection and approved and PBS listed for treating wet AMD. While Eylea is similar in cost, its main benefit is a longer serum half-life compared with Lucentis, thus potentially requiring fewer dosages—every other month.

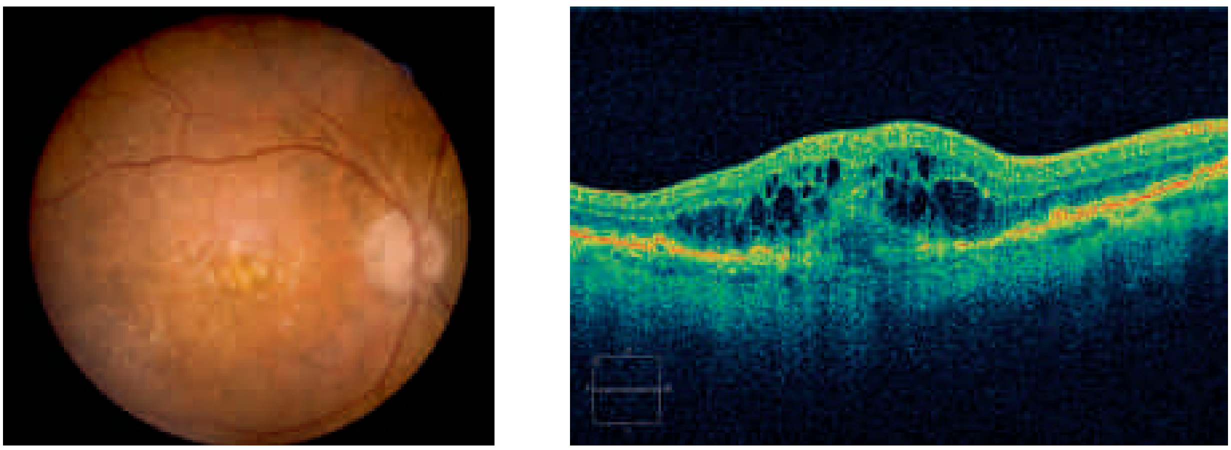

Figure 1. Wet (neovascular) age-related macular degeneration: fundus photograph and optical coherence tomography scan

Images: Roman Serebrianik, Australian College of Optometry

in treatment for AMD offer hope but support and services remain vital

Who is eligible for treatment?

There are about 18,000 new cases of wet AMD per year in Australia.[6] There is no consensus on when to commence anti-VEGF treatment but the UK National Institute for Health and Clinical Evidence (NICE) guidelines suggest treatment should start when visual acuity is 6/12 to 6/96, the lesion is less than 12 DD in size, there is no permanent structural foveal damage and there are signs of progression.[7]

This seems to be generally consistent with what is occurring in Australian practice, although some practitioners are now also treating recent onset subfoveal choroidal neovascularisation (CNV) in eyes with visual acuity better than 6/12. The PBS does not stipulate a particular level of visual acuity. Based on the NICE criteria and the eligibility criteria of research trials, about 68 per cent of new cases of wet AMD may be eligible for treatment with anti-VEGF agents,[8] leaving 32 per cent ineligible.

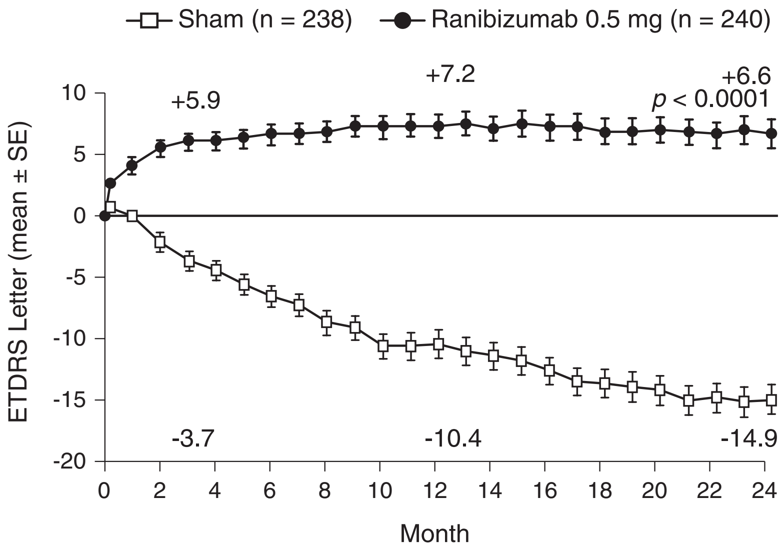

Figure 2. Monthly treatment with Lucentis compared with sham—change in visual acuity for findings from the MARINA study. From Cruess et al 2012,[9] adapted from Rosenfeld et al 2006[12]

How effective is the treatment?

Several randomised controlled trials have been conducted and systematically reviewed, which demonstrate the effectiveness of Lucentis,[9,10] including the landmark 'Anti-VEGF Antibody for the Treatment of Predominantly Classic Choroidal Neovascularisation in AMD' (ANCHOR)[11] and 'Minimally Classic/Occult Trial of the Anti-VEGF Antibody Ranibizumab in the Treatment of AMD' (MARINA) studies.[12] After 24 months, monthly Lucentis (0.5 mg) appears to stabilise or improve visual acuity in 90 per cent of patients (loss of less than three logMAR lines or 15 letters), as well as reduce retinal thickness and promote resorption of fluid.[12]

The average improvement in visual acuity with Lucentis is one to two logMAR lines (6.6 letters) in treated eyes compared with a worsening of three lines (14.9 letters) in untreated eyes (Figure 2).[12] Just 15 per cent (compared to 48 per cent treated with sham injection) remain legally blind after two years, but about 10 per cent will get worse and 58 per cent will still have mild to moderate vision impairment (visual acuity worse than 6/12, in other words: below the driving standard).[12] It should also be noted that outcomes in clinical practice are typically not as favourable as outcomes in controlled clinical trials, where participants are selected according to specific criteria, and usually have a narrower range of disease severity.

Comparative effectiveness trials, in particular the 'Comparison of AMD Treatment Trials' (CATT) and 'alternative treatments to Inhibit VEGF in Age-related choroidal Neovascularisation' (IVAN) studies, have demonstrated that the less expensive Avastin (1.25 mg monthly) is as effective as Lucentis (0.5 mg monthly) with regard to improvement in visual function.[10,13,14]

There are still some concerns that there may be a higher incidence of serious ocular and systemic adverse events with Avastin than with Lucentis, albeit low with both agents.[14-16] The results of ongoing trials are expected to determine whether this is actually the case. Likewise, early trials, in particular the 'VEGF Trap-Eye: Investigation of Efficacy and Safety in Wet AMD' (VIEW 1 and VIEW 2) studies, suggest that Eylea (2 mg dosed every two months after three initial monthly doses) produces similar efficacy outcomes as Lucentis (0.5 mg monthly).[17] As yet, there are no concerns that Eylea causes more adverse events than Lucentis.

Regardless, the outcomes and risks associated with each of these agents are unknown beyond a few years. It is possible that vision outcomes might become suboptimal after a period of time due to the natural progression of the disease, effects of anti-VEGF undertreatment, or drug tachyphylaxis or tolerance.[18]

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AMD after anti-VEGF

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How are new treatments influencing the prevalence of visual impairment?

While we await population-based studies to understand the true impact of anti-VEGF agents, some researchers have estimated that Lucentis treatment decreases the incidence of legal blindness by 72 per cent and the incidence of vision impairment by 37 per cent over two years.[8] In addition, a study of blindness registration in Denmark showed a significant reduction of 50 per cent in the incidence of legal blindness attributable to AMD between 2000 and 2010.[19] Although the underlying reasons might be more complex, the bulk of the reduction occurred after the introduction of anti-VEGF therapeutic agents in 2006.[19] Regardless, the anticipated ageing of our population is likely to outweigh the benefits of anti-VEGF treatments in reducing the risk and prevalence of vision impairment from AMD.[20]

Study findings taken together are very encouraging and suggest positive outcomes for wet AMD treated with Lucentis, Avastin or Eylea, at least over two years. There is still much room for improvement. While we may see less severe vision impairment, the prevalence of mild to moderate impairment will remain increasingly high. Many patients with wet AMD will remain in need of low vision support. Many can be assisted in primary care, in your practice.

I urge you to follow up your patients undergoing intravitreal anti-VEGF treatment—they need you. Provide advice on the treatment, the importance of compliance, counselling on driving where applicable, basic low vision support and refer to a colleague with low vision expertise or a low vision agency when required.

* EDITOR'S NOTE
Avastin is not indicated for the treatment of wet AMD; its use in this treatment is considered 'off label'. The product information for Avastin explicitly states that treatment of various ocular disorders is 'unapproved'. There are officially only two registered treatments for wet AMD, Lucentis and Eylea.

References are available from j.megahan@optometrists.asn.au, subject: AMD after anti-VEGF, Low Vision Primer.

Common optical de

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Life expectancies in Australia have been on an upward trend for many years. Today, the average male and female can expect to live 79.5 and 84.0 years, respectively.[1] Significantly, the number of people over the age of 85 years has increased by 170 per cent over the past two decades.[2] The implication for optometrists is that as a result of age-related eye disease, 9.4 per cent of Australians aged 55 years and older are visually impaired and may benefit from optical low vision aids (LVAs).[3] This figure will increase dramatically over the next decade.

Patients with mild to moderate low vision (< 6/12 to 6/60) may benefit from low to medium powered optical LVAs. Those with more pronounced low vision (< 6/60 to 6/240) will find optical LVAs more challenging and may choose a combination of optical and electronic LVAs. Those with severe low vision (< 6/240) may choose to use substitution technology, such as audio tapes and Braille. Success is often a matter of motivation and the poorer the vision, the more motivation is required.

Common optical devices

There are essentially four classes of optical LVAs: spectacle magnifiers, hand magnifiers, stand magnifiers and telescopes. The vast majority of LVAs are used for near vision tasks. Only telescopes can be used for both near and distance tasks.

Spectacle magnifiers

Spectacle magnifiers incorporate lenses with an equivalent near addition of +4 DS or more. They use relative distance magnification to increase the retinal image size as the reading material is brought closer. Worn like conventional reading glasses, they provide a large field of view and are hands-free. Spectacle magnifiers are available in single vision and bifocal form. They correct underlying ametropia and when incorporating base in prism, spectacle magnifiers can facilitate binocular vision with additions of up to +12 D. The disadvantages are reduced and potentially uncomfortable working distances, shadows on the object plane, weight and difficulties sustaining binocular single vision.

Figure 1A. Hyperocular lens

Figure 1B. Hyperocular lens fitted to existing spectacles

vices and assistive technology

Magnifiers and telescopes can help your patients function at a higher level

Binocular additions are useful when the visual acuities (R and L) differ by ≤ 2 lines; however, prism is required to assist convergence. As a general rule, the amount of prism required to facilitate binocularity is the power of the addition +2 Δ BI to each eye—for example, for a +8 D addition, 10 Δ BI R and L is required. In higher powers, this may prove impractical due to lens thickness and weight. Of course, prism can be either worked or achieved through decentration. When adds higher than +12 D are required, prescribe monocularly.

Bifocal spectacle magnifiers

Conventional bifocal high additions are available up to +8 D. Self-adhesive bifocal segments can be applied in any position and are available from +8 D up to +40 D (Keeler LVA12 from UK).

Hyperocular lenses

Hyperoculars are aspheric, full aperture, bi-convex injection-moulded lenses, available from 4x to 12x in both ready-made and uncut form. They are generally prescribed monocularly and do not correct astigmatism. Adhesive equivalents can be considered for patients who have high astigmatism. These lenses can be fitted onto existing spectacles. They can be removed and reapplied if there is a change in refraction (Figures 1A and 1B).

Ready-made 'low vision' spectacles

Eschenbach (bino comfort, noves bino) and Coil have a range of binocular off-the-shelf prismatic half-eye spectacles (+4 D to +12 D). Monocular options are available up to +48 D. The Eschenbach Noves series utilises thin lightweight diffractive optics and magnifications up to +24 D (Figures 2A and 2B).

Figure 2A. Eschenbach Noves series

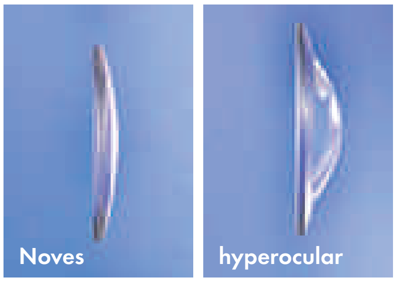

Figure 2B. Noves vs hyperocular

Ready-made bifocal glasses are also available in a wide range of powers, suitable for distant and near tasks, or intermediate and near viewing (Figure 3).

Headborne and clip-on magnifiers

These appliances increase the lens-to-eye distance and therefore, the overall working distance; however, the field of view decreases proportionally. Binocular clip-ons are available up to 3x, and monoculars from 4x to 7x.

TIPS on spectacle magnifiers

- Off-the-shelf spectacle magnifiers are available in a wide range of powers. A pair of 'strong new' glasses is often the desired option requested by many low vision patients. It is useful to stock some ready-made spectacle magnifiers or clip-on loupes for demonstrations. This is also a good opportunity to discuss other low vision aids if the short working distance is rejected.
- It is important for practitioners to always stress the importance of the reduced working distance at the time of prescribing and dispensing. Intolerance of spectacle magnifiers is often based on this.

Hand-held magnifiers

Hand-held magnifiers are acceptable and familiar to most patients. They are generally inexpensive and lightweight, and available in illuminated and non-illuminated forms. They are useful for spot reading and can be used with or without glasses.

Magnification is affected by the eye-to-lens working distance, accommodation and the spectacle reading addition used. When used by an unaccommodating emmetrope, maximum magnification is achieved when the lens to working plane distance is equal to the focal length of the magnifier. Patients may use their reading glasses with the

Continued page 40

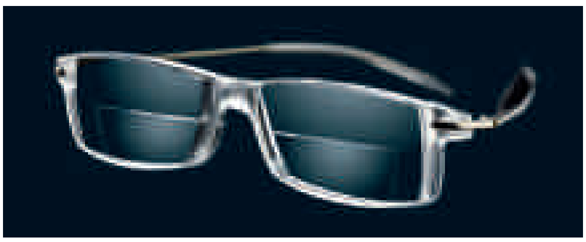

Figure 3. Ready-made bifocal glasses

Assistive technology

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magnifier and the resultant magnification will be greater when the eye to magnifier distance is reduced. A hand magnifier held at the wrong distance simply does not provide the stated magnification. Hand magnifiers require a greater degree of manual dexterity to use effectively than stand magnifiers do. Any deficit in hand-eye co-ordination may decrease reading speed.

The field of view is increased as one reduces the eye-to-magnifier distance. Whereas a long eye-to-magnifier distance might be used successfully with a low power magnifier, it will significantly reduce the field of view with higher power magnifiers.

Tips on hand-held magnifiers

- When prescribing hand magnifiers to presbyopes, practitioners should instruct patients to place the magnifier on the page and slowly lift it up until the image is clear. The lens should be parallel to the page with the most convex side toward the patient.
- Practitioners should demonstrate how field of view increases as page and magnifier are brought closer to the eye, and the benefits of utilising optimal illumination.
- When reading with a hand magnifier, material should be held rigid, as on a clipboard. It may be useful to demonstrate how to fold a newspaper, reducing its flexibility and exposing only one column.

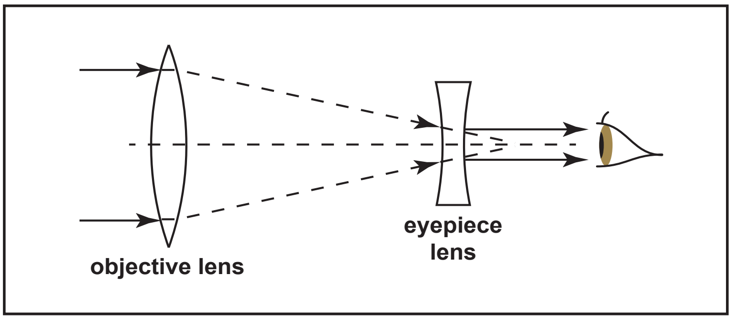

Figure 4A. Galilean system

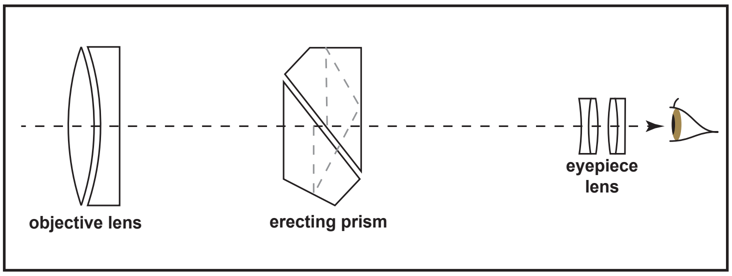

Figure 4B. Keplerian system

Figure 5. Low-powered binocular telescopic spectacles

Stand magnifiers

Stand magnifiers are commonly prescribed for patients with hand tremor, poor motor control or in cases where the user needs to read for longer periods of time. The convex lens is mounted at a fixed distance from the reading material, a distance that is usually slightly less than the focal length of the magnifier. Accommodation or a near addition of +2 D to +3 D is usually required. Low-powered magnifiers with an open stand enable the patient to perform tasks beneath the lens. When using an external light source, reflected glare from the lens surface can be a problem. This can be solved by using stand magnifiers with built-in illumination and avoiding external glare sources

Stand magnifiers come in a wide range of powers from +5 D to +60 D. They can be large, heavy and bulky, especially when manufactured in lower powers. They also need to be placed on flat surfaces and mains-operated illumination systems can be expensive. Elderly patients leaning over a stand magnifier can experience postural problems, which can be solved using a reading stand or posture incline desk.

TIPS on stand magnifiers

- When prescribing a stand magnifier, it is important to match the aid to the patient's existing reading correction, as they will invariably be using their reading spectacles when they go to use the magnifier.
- If the patient needs to lift the stand magnifier to focus, it suggests the near addition is insufficient. If the near add is too strong, the vision becomes worse when lifting the magnifier.
- Practitioners should also advise on closer eye to magnifier distance to optimise the field of view.
- A reading stand, incline desk or clipboard can be used to support the reading material, reduce eye to magnifier distance and improve posture.

Telescopes

Hand-held telescopes are prescribed as distance aids and used for spotting tasks such as reading bus numbers. Field of view reduces and image vibration increases as magnification increases. Therefore, it is important to prescribe the least amount of magnification required to meet the patient's needs. Achieving an endpoint acuity of 6/12 (0.30 logMAR) is usually adequate for most distant tasks.

Spectacle-mounted telescopes can be prescribed for near or intermediate tasks, including playing board games, cards and reading music. They provide a longer working distance than spectacle magnifiers but have a restricted field of view.

Two telescopic systems are used in low vision: Galilean and Keplerian (astronomical).

Galilean telescopes (Figure 4A) contain a convex objective lens and a concave eye piece. They are shorter and lighter than Keplerian telescopes, have a narrower field of view and are available in powers up to 4x.

The Keplerian system (Figure 4B) consists of convex objective and eyepiece lenses. They produce inverted images and require erecting prisms. They have longer optical paths, larger fields of view, better image quality and a wider range of magnification (up to 10x hand-held) but they are heavier and more expensive.

Figure 6. Daylight Ultraslim

Figure 7. Daylight Ultraslim in use

Telescopes can be mounted or clipped onto spectacles for prolonged viewing, such as watching theatre performances or while bowling. Alternatively, low-powered binocular telescopic spectacles using the Galilean system are available in ready-made form (Figure 5). It is rare to prescribe a telescope for watching television as in most cases the same effect, with unrestricted field of view, can be achieved by sitting closer to the television.

TIPS for telescopic systems

When prescribing a telescope, practitioners should include training with the following instructions:

- How to hold the telescope and which eye should be used
- How to align the eye, telescope and target
- How to steady the telescope using the eye socket (keep the elbows in)
- How to focus and maximise the field of view
- Spotting practice–locate large objects that can be seen with the naked eye, and then view detail
- Tracing practice–follow a stationary line, for example, a street curb or outline of an object
- Tracking practice–follow a moving object, for example, a moving bus
- Scanning practice–search for an object that can not be seen without the telescope.

Other useful optical devices

Magnifying lamp

Classed as a variable focus stand magnifier, the lens is mounted on a support stand. The user can select the distance between the

Continued page 42

Figure 8. Multilens bar magnifier

Figure 9. Chest magnifier with adjustable cord

Assistive technology

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object plane and the lens. Neither a near addition nor accommodation is required. Recently, Daylight brought out an ultra-slim magnifying lamp with flicker-free white light and a large high-quality lens +4 D (Figure 6). Extra lenses are also available in +5 D, +8 D and +15 D. This type of magnifier is particularly useful for crafting or writing where hands-free is essential to the task (Figure 7). Unfortunately, this type of magnifier is available only in lower powers.

Visolette/bar magnifiers

Visolette/bar magnifiers are designed to be placed flat on the object. They facilitate binocular viewing, have exceptional light gathering properties, and are aberration-free. Unlike many hand or stand magnifiers, the field of view is unaffected by eye-to-magnifier distance. Patients can use a normal working distance with their own reading spectacles. Simple visolettes are available only in low magnification (up to 3x), whereas higher magnification can be achieved with multilens systems (3.6x) (Figure 8). These magnifiers are commonly used by patients with mild degrees of vision loss, and by children. They are easy to use, durable, unaffected by hand tremor, available with LED illumination and inexpensive.

Chest magnifier/embroidery magnifier

This low-power (+2.6 D to +3.2 D) device is commonly prescribed for knitting and needlework. It has an adjustable cord so the magnifier can be worn at different heights to suit individual needs (Figure 9). Some of these magnifiers come with LED illumination and an extra +12 D magnifying 'button' lens for spot reading or threading needles.

'High-tech' devices

Electronic video magnifiers are available as desktop workstations or portable units. Traditionally, they were considered only when conventional magnifiers could no longer provide a viable solution for the patient. They became a popular option for many moderate low vision patients as the price decreased and as the benefits associated with the wide range of magnifications (large field of view and comfortable working distance) were demonstrated.

Practitioners should assess the needs and priorities of each individual and provide advice on the advantages and disadvantages of these devices. The need for training and practice should be considered.

For more information on video magnifiers and other low vision technology, see page 32 of this issue of *Pharma*: 'Update on technology and advances in accessibility'.

Acknowledgements

We thank European Eyewear for providing images and product information. Image copyright belongs to Eschenbach Optik.

Figures 4A and 4B from Ocutech website.

1. Australian Bureau of Statistics. 4125.0–Gender Indicators, Australia, Jan 2012. Accessed May 23, 2013. http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by+Subject/4125.0~Jan+2012~Main+Features~Life+expectancy~3110
2. Australian Bureau of Statistics. 3101.0–Australian Demographic Statistics, Sep 2012. Accessed May 23, 2013. http://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0/
3. Department of Health and Ageing–Welcome to the Department of Health and Ageing. Accessed May 23, 2013. http://www.health.gov.au/internet/main/publishing.nsf/Content/71FBCE0AF8F09F2ECA25755C0000B2EE/$File/EYECompiledReport.pdf

LVA product information and suppliers

LVA manufacturer	Manufacturer's website	Type of LVA	Suppliers	Suppliers' website and contacts
Coil	www.coil.co.uk	High power spectacles Hand magnifiers Stand magnifiers Telescopes	Royal Society for the Blind Vision Australia Redbank Instruments	www.rsb.org.au www.visionaustralia.org.au www.redbank.net.au
Eschenbach Optik	www.eschenbach.com	High power spectacles Hand magnifiers Stand magnifiers Telescopes Other optical LVAs Electronic LVAs	European Eyewear Quantum Technology Vision Australia	graham.ee@bigpond.com phone 03 8805 1555 www.quantumrlv.com.au www.visionaustralia.org.au
Keeler LVA	www.keeler.co.uk	High power spectacles Telescopes	Designs For Vision	www.dfv.com.au
Schweizer		Hand magnifiers	Redbank Instruments Pacific Vision	www.redbank.net.au www.pacificvision.com.au
Allblax		Hand magnifiers	Aviva Optical	www.avivaoptical.com.au
Specwell		Telescopes	Royal Society for the Blind Vision Australia	www.rsb.org.au www.visionaustralia.org.au
Daylight	au.daylightcompany.com	Other optical LVAs	European Eyewear Vision Australia	graham.ee@bigpond.com phone 03 8805 1555 www.visionaustralia.org.au

Table 1.

Bionic eyes

Present realities, future aspirations

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Traditionally, most ophthalmic interventions have been targeted at delaying the progression of vision loss, such as ocular hypotensives for glaucoma and laser photocoagulation for proliferative diabetic retinopathy, with no ability to restore lost vision. Anti-VEGF treatments for neovascular AMD have changed this, with the ability to regain some vision if the intervention is applied urgently.[1] Until recently, it has not been possible to intervene in cases of long-standing vision loss, such as in diseases like retinitis pigmentosa and choroideremia.

Due to recent technological advances, this is about to change. The advent of techniques such as gene therapy,[2] stem cell implantation[3] and visual prostheses ('bionic eyes') has the potential to restore vision in people who have had profound vision loss for many years. Of these techniques, visual prostheses have had the greatest commercial advances, with the Second Sight Argus II bionic eye device now available for sale in the USA and Europe.

Visual prostheses convert visual information into electrical impulses, in a similar way that the cochlear implants have worked to restore hearing to the deaf. There are three main categories of visual prosthesis, classified by the location of the electrode array: cortical, optic nerve or retinal.

The first visual prostheses were cortical implants, developed in the 1930s after the German ophthalmologist Carl Förster discovered that direct electrical stimulation of the visual cortex caused blind patients to detect a spot of light, known as a phosphene.[4] There was little advancement in this area until the 1960s, when Australian inventor Graham Tassicker patented a photosensitive selenium cell that could be placed subretinally to evoke visual phosphenes.[5] This discovery reinvigorated the visual prosthetic research field and rekindled the idea of using a visual prosthesis to restore vision to the blind.

Three approaches

Cortical implants work by placing penetrating or surface electrodes directly in the primary visual cortex which, until recently, led to inherent limitations in resolution and long-term instability of cortical electrodes. Recent improvements in electrode configuration and material biocompatibility have improved the feasibility of these devices. One such cortical device is being developed in Melbourne by the Monash Vision Group (www.monash.edu.au/bioniceye).

Continued page 44

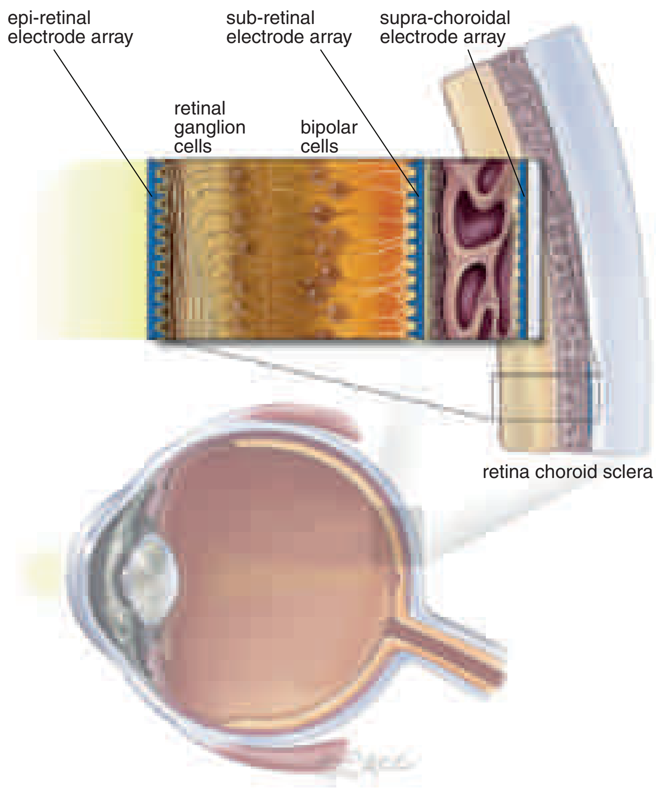

Figure 1. Potential locations for retinal visual prostheses
Image: Bionic Vision Australia

Bionic eyes

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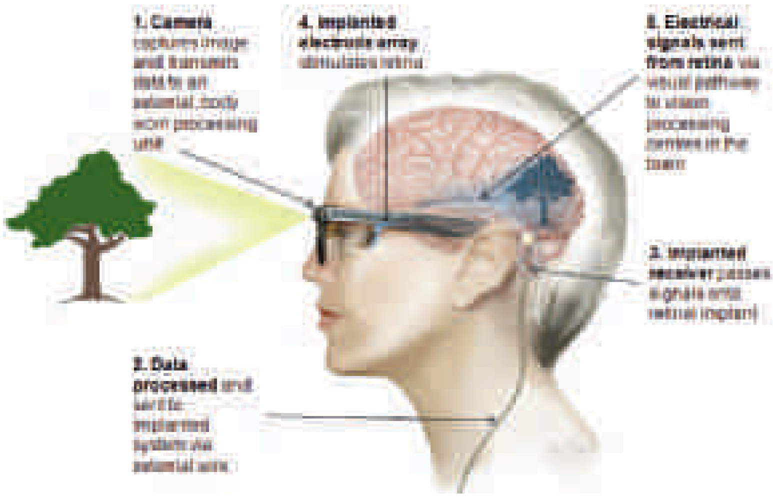

Figure 2. Schematic of a retinal prosthesis Image: Bionic Vision Australia

Another option for a visual prosthesis is direct electrical stimulation of the optic nerve. Two techniques have been developed, either using a cuff electrode activating numerous optic nerve fibres at once, giving the perception of large indistinct phosphenes,[6] or a more targeted penetrating micro-electrode array.[7]

The retinal approach, where the electrode array is placed in direct proximity to the retina, has proved most popular among research groups and has arguably seen the most advances. Until the 1970s, placement on the retina was not a viable option due to the complexities of retinal surgery but as surgical methods improved, the possibility of placing electrodes within the eye became a feasible option.[8] Retinal implants can be placed in different locations near the retina, variously epiretinally, subretinally or supra-choroidally (Figure 1).

The causes of blindness that may be able to benefit from bionic eye technology depend on the location of the implanted electrodes. Cortical prostheses stimulate the brain directly and so they do not need an intact globe or optic nerve.

As such, it is predicted that cortical implants will be able to work in most causes of blindness, including glaucoma and traumatic vision loss. The disadvantage with this method is that the device does not use the image processing capabilities of the retina. Also, due to the cortical topography and electrode limitations, it is theoretically more difficult to generate localised high resolution images.

On the other hand, retinal implants will use the remaining visual pathway (residual inner retina to cortex) to help in the processing of the electrically stimulated phosphene image. Retinal implants theoretically can be used only in patients who have some remaining inner retinal cells and optic nerve function, such as retinitis pigmentosa and choroideremia. Both of these retinal diseases specifically affect the outer retinal cells (photoreceptor layer), leaving the inner retina and optic nerve relatively intact.

Retinal prosthesis

The main components of the retinal prosthesis system consist of a camera mounted on a pair of glasses, an external computer microprocessor, a battery and a silicon chip with an array of electrodes for retinal stimulation (Figure 2). The video camera captures an image which is then transformed by the microprocessor into electrical signals. The signal will be coded so that information like edge detection and brightness can be relayed by adjusting variables such as the level of current, rate or duration of electrical stimulation.

The external processor then sends the signals, either by a cable or wirelessly, to the implanted electronic microchip where it stimulates an electrode array. This electrode array is placed near the surviving inner retinal ganglion cells, which are responsible for taking the signal from the electrode to the brain via the optic nerve.

Due to the form of electrical stimulation, the vision from a bionic eye implant will be perceived as spots of light, or 'phosphenes'. While the phosphenes will be able to be manipulated to improve the visual potential, it will not be the same as normal human vision. At this stage of research, the expected visual outcomes are still moderate.

It is unlikely that patients will be able to read again with the first generation of bionic eye implants; however, it is believed that there will be significant improvements in the level of functional vision. This would mean that patients would be able to identify objects, have improved orientation and mobility performance and enjoy safer independent travel.

Current clinical trials

There is a number of groups that are currently completing clinical trials into the safety and efficacy of visual prostheses. All trials currently involve patients with profound vision loss (bare light perception or worse in both eyes) from retinitis pigmentosa or choroideremia. The most advanced research comes from the Second Sight group in the USA, which now has commercial approval to sell its epiretinal 60 electrode device (Argus II) in both Europe and the USA. Second Sight has shown that this device can allow some patients to perform simple daily living tasks and read large letters.[9,10] Similar outcomes have been shown in subretinal implants by the Retina Implant AG group in Germany.[11,12]

Supra-choroidal implant

Both epiretinal and subretinal visual prostheses require a high level of ophthalmic surgical skill to implant and have had problems with long-term safety stability. Bionic Vision Australia has developed a supra-choroidal implant. The advantage of this positioning is that the surgery is less complicated and the device remains stable over time[13] as it is 'sandwiched' between the choroid and sclera.[16,17]

The supra-choroidal location also means that the device wires need to pass only from the intraorbital space into the supra-choroidal space, and not into the interior of the globe, which reduces the chances of endophthalmitis. We are currently undertaking the first human clinical trials of this supra-choroidal implant, which has shown great success to date and clinical findings will be published in the coming months.**

Bionic Vision Australia is developing two future devices, one with 96 electrodes and one with 256, which will provide increased resolution and improved patient outcomes. Novel stimulation strategy techniques such as current steering will further optimise the efficacy of these devices. While the Bionic Vision Australia device will not be the first retinal prosthesis to enter the market, it is hoped that when it is released, it will be a highly functional device that will deliver superior visual return to the patients.

Future work and challenges

The development of a bionic eye is one of the most difficult technological challenges that biomedical engineering has faced to date, requiring multidisciplinary input from engineers, surgeons, clinicians, material scientists and basic scientists. Devices must be hermetically sealed to keep biological fluids away from the electronics, electrically safe, and of appropriate size and shape to be implanted into the eye.

At the same time, they must be able to conduct electricity in a reliable and repeatable manner, requiring advanced power and wiring solutions. While the technological challenges are significant, the available resources and knowledge in the current scientific community mean that they are not insurmountable.

Another challenge facing visual prostheses researchers is the question of how best to assess functional outcomes following bionic eye implantation. At this stage of the technological development, it is unlikely that patients will be able to read a standard visual acuity chart. It is believed that the three most important aspects of improvement that will require quantitative measurement are independent mobility, functional vision in activities of daily living and reported improvements in quality of life.

For example, there have been reports of subjects with retinal prosthetic implants being able to correctly describe and name objects like a fork or knife on a table, geometric patterns and different fruits.[12] These measurable tasks relate directly to improvements in everyday visual functioning and will be vital to assess in future clinical trials. At present, there are no standardised assessment tests for recipients of bionic eye implants but it is hoped that an international collaboration in the future will determine the most effective and sensitive tests.[14]

The aims for future work in this area are to improve the visual prosthesis devices, by a combination of increasing the number of electrodes on the arrays and more advanced stimulation strategy and image processing of the video input. It is hoped that bionic eyes may become a widely clinically available option for people with profound vision loss.

* All authors are researchers for the Bionic Vision Australia program. Dr Ayton is the clinical research co-ordinator, Dr Luu is the surgical and clinical program manager, Dr Allen is the surgical program leader and Professor Guymer is the clinical program leader.

** Full details of the Australian trial can be accessed at www.clinicaltrials.gov/ct2/show/NCT01603576.

References are available from j.megahan@optometrists.asn.au, subject: Bionic eyes, Low Vision Primer.

Lighting essentials

Every patient's lighting needs are unique and should be assessed individually.

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Lighting is essential for our daily activities and is of particular importance to people with a vision impairment. Vision-impaired people often require two to three times the amount of light a sighted person needs.

Ocular condition, level of vision, age and pupil size of the person need to be considered, as well as the type and amount of lighting. There is great variation in the lighting needs of people with vision impairment; their preferences and performance should be evaluated on a case-by-case basis.

Lighting to assist people with vision deficiencies can be natural or artificial. There is a large variety of artificial sources of light. The type of lighting, light output, the location of the light source and the specific task for which it is intended all have a major influence on functionality and efficiency.

While the wattage of the light source is important, the inverse square law of illumination tells us that the position of the light source is more important. Illuminance is the amount of light falling on an object or surface, measured in lux. In accordance with the inverse square law of illumination, positioning the light source closer to the surface of the task increases the illuminance (Figure 1). For example, halving the source to surface distance will quadruple the illuminance.

When the light source is not perpendicular to the task surface, the cosine law of illumination applies and the illuminance is reduced. In most cases, the light source should be directed over the shoulder of the stronger eye and held close to the reading material to get maximum illumination.[1]

Types of lighting

Natural light

This light can be beneficial but consideration needs to be given to the possibility of glare issues. Suggestions for patients include:

- Keep windows clean
- Tinting of windows/blinds/curtains can be helpful
- Work with his or her back to a window.

Artificial light

Select the appropriate type of light for the task

- General–lighting necessary for moving about a room, minor visual tasks
- Direct–directed to work area efficiently with low light loss, for example, downlights
- Semi-direct–60-90 per cent of light emitted is directed to work area, for example, surface fluorescent
- Indirect–reflected from ceiling and walls (poor efficiency) for example, pelmet lighting
- Diffuse–light diffused with soft shadows for example, opal glass or a sphere pendant
- Task–high level of illumination required for specific tasks.

Colour temperature of light

Single globes or tubes are available for light fittings in 'warm white', 'cool white' or 'daylight'.

- Warm white–2800-3000 Kelvin (accentuating longer wavelengths; yellowish to reddish white in appearance)
- Cool White–4000-4500 Kelvin (accentuating shorter wavelengths; bluish white in appearance)
- Daylight–6500 Kelvin (full spectrum).

What lighting is beneficial for low vision?

General environment

- Even illumination throughout the general environment ensures a reduction in distracting shadows. Full spectrum fluorescent lighting serves this purpose well.
- Lights should be covered by a diffuser to minimise glare and reduce reflections.
- Light colours are preferable for ceiling and walls. Light switches should be

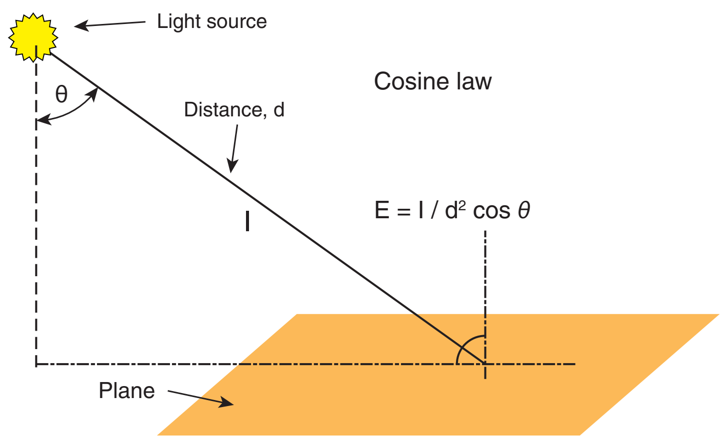

Figure 1. Illuminance = (intensity/[source to surface distance]2)*cos θ

	Efficiency	Colour temperature of light	Angle of light	Heat	Glare	Longevity
Incandescent	Poor	Warm	Direct	Yes	Variable	Poor
Halogen-variation of incandescent	Better than traditional incandescent	Warm or cool	Direct	Yes	Yes	Better than incandescent
Light emitting diode (LED)	Average	Warm or cool	Narrow/shadow/harsh	Yes	Yes	Excellent
Fluorescent	Excellent	Warm or cool	Wide/diffuse	Minimal	Minimal	Excellent
Compact fluorescent lamp (CFL)	Excellent	Warm or cool	Dependent on light fitting	Minimal	Minimal	Excellent

Table 1. Aspects of artificial light

situated at a standard height, in a suitable location and in a colour that stands in contrast to the surrounding area.

Task lighting

- The patient should not be positioned facing a light source. Focal light shining from behind is best.
- Task lighting should be used in conjunction with general room lighting for safety reasons. When the patient moves away from the task location, the general area should still be illuminated.
- Task lamps should have a wide shade surrounding the globe, the globe should be recessed, and have an adjustable arm to change angle of tilt (about 45 degrees) and so that it can be positioned close to the task to maximise illuminance.
- For safety reasons, the patient should be instructed not to use a globe that is higher than the recommended wattage.
- If a lamp and magnifier are separate entities, the lamp should be placed close to magnifier, so the light is shining under the magnifier on to task area.
- When prescribing magnification, consider the need for an illuminated magnifier and its colour temperature.

Table 1 indicates the various aspects of artificial light. Both fluorescent and compact fluorescent lamps (CFL) offer better options for a patient with vision impairment.

Where to obtain lighting products

Officeworks and specialised lighting shops like Beacon sell a combined low-powered magnifier and lamp. The cost varies between $50 and $80. The specialised lighting shops have the benefit of allowing the client to try before they buy. The same applies to globes with different colour temperatures; the customer may have a demonstration to find out which light is the most suitable.

Quantum (www.quantumrlv.com.au), Pacific Vision (www.pacificvision.com.au), Royal Society for the Blind (www.rsb.org.au), Vision Australia (www.visionaustralia.org) and European Eyewear (europeaneyewear@bigpond.com) all have a range of portable, compact, clamp style and standard lamps with a range of prices from $45 to $350. A variety of illuminated magnifiers of different strengths and colour temperature is also available.

Rooms and task areas in the home

A home lighting assessment may be beneficial to the patient, to see if the present lighting is adequate. An orthoptist or service provider who specialises in low vision can do this (Tables 2 and 3).

Lighting can have a considerable impact on activities of daily living, and in particular reading, for your patients with vision impairment. Lighting is a commodity that can be easily overlooked, but it is a simple and effective management strategy that you can suggest to your patients with low vision.

For further information, visit www.eyesightessentials.com.

1. Williams DR. Nonoptical and accessory devices. In: Brilliant RL. Essentials of Low Vision Practice. Boston: Butterworth-Heinemann; 1999.
2. Australian/New Zealand Standard. Interior and Workplace Lighting. Part 1: General Principles and Recommendations. AS/NSZ 1680.1. Sydney, NSW; Standards Australia/Standards New Zealand: 2006.

Room type	Recommended lux levels
Hall	300 lux
Bedroom	300 lux minimum
Bathroom	500-800 lux
Kitchen	1000 lux = meal preparation 600 lux = general area
Living room	300 lux minimum
Dining room	400-800 lux
Laundry	500 lux

Table 2. Luminance levels by room, recommended by Australian Standards AS1680.1-2006[2]

Class of task	Lux	Activity
Simple	160-300	Movement and orientation e.g. corridor
Moderate	240-400	High contrast/large detail e.g. class room
Difficult	600-800	Small detail e.g. office/kitchen
Very difficult	800-1200	Very small detail e.g. graphics

Table 3. Luminance levels by task, recommended by Australian Standards AS1680.1-2006[2]

Abstracts

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A depth-based head-mounted visual display to aid navigation

Independent navigation for blind individuals can be extremely difficult due to the inability to recognise and avoid obstacles. Assistive modalities, such as guide dogs and white canes provide a degree of situational awareness by relying on other factors, for example, touch or hearing, but there are no current options available that attempt to utilise a patient's residual vision.

A recent study published in the journal *PLoS One* describes the capacity for a depth-based, head-mounted display to assist with obstacle avoidance in partially-sighted individuals. In this study it was shown that skill using the system was rapidly acquired and allowed participants to accurately respond to objects in both their central and peripheral visual fields. The authors concluded that the simple nature of the display may allow it to be appropriate for the development of a novel aid for patients with low vision.

PLoS One; 2013; 8: 7: e67695.

Role of digital technology in reading accuracy in AMD

Improvements in digital technology have significantly altered how we read and access information. A study published by researchers from the University of Western Ontario in Canada has demonstrated that digital devices may have a use in visual rehabilitation for low-vision patients.

Patient satisfaction, reading accuracy and reading speed were compared for digital e-readers (Sony eReader, Apple iPad) and standard paper/print media for patients with stable wet AMD (n = 27). It was found that patients consistently read faster ($p < 0.05$) on the Apple iPad and Sony eReader with larger text sizes (size 24 or greater) when compared with paper. Patients chose the iPad to have the best clarity and the print paper to be easiest to use.

Digital devices with large display screens and that offer high contrast ratios can therefore be of benefit to patients with AMD who require larger text sizes to read.

Eye(Lond) 2013; 5: 639-643

Anxiety and depression in community-living older adults with low vision

A study conducted in the Netherlands has examined the association between low vision and clinically-relevant symptoms of anxiety and depression among community-living older adults seeking vision rehabilitation services. Symptoms of anxiety and depression were assessed with a standardised questionnaire (the Hospital Anxiety and Depression scale) in 148 persons with low vision and an age-matched reference sample (n = 5,729); all patients were 57 years of age or older.

Vision loss was shown to be substantially associated with both anxiety and depression; 14.9 per cent of patients with vision loss had clinically-relevant anxiety and 14.2 per cent had symptoms of depression. These percentages were more than twice as high as in the reference sample. Health-care professionals should consider the potential effects of anxiety and depression in their management decisions in order to improve the quality of care for older adults with vision impairment.

Am J Geriatr Psychiatry 2013; pii: S1064-7481

Trial frame refraction vs autorefraction

Trial frame refraction of low vision patients is recognised to be time consuming, taking approximately 15 minutes per patient. Over the past few decades, autorefraction has become an increasingly valuable tool in refractive error screening.

This study sought to determine whether there was a relationship between refractive error as measured by autorefraction and trial frame refraction among a sample of adults with vision impairment in a low vision clinic, and whether autorefraction may be a suitable replacement for traditional refraction.

A retrospective chart review of all new adult patients (n = 440) seen over an 18-month period at the university clinic was conducted. Values for autorefraction and trial refraction were statistically different but highly correlated for spherical equivalent power (r = 0.92) and cylindrical power (r = 0.80). Although the values of the cross-cylinders J(0) and J(45) were similar, they were poorly correlated (0.08 and 0.15 respectively). The range of differences in spherical equivalent power was large (-8.6 to 4.9).

The authors concluded that while autorefraction is highly correlated with trial frame results, the differences could be substantial, making autorefraction an unsuitable substitute for trial frame refraction for low vision patients.

Invest Ophthalmol Vis Sci 2013; 54: 1: 19-24

Symptoms of stroke related visual impairment

The presence or absence of visual symptoms in stroke patients has been found not to be predictive of whether vision impairment exists.

This prospective, multi-centre cohort study 'Vision in Stroke' sought to investigate the frequency and type of visual symptoms following stroke. A total of 915 patients underwent standardised referral/investigation protocols with detailed assessment of visual acuity, ocular alignment/motility, visual field and visual perception and quality of life scores.

Reported symptoms included diplopia, blurred vision, reading difficulty, field loss and perceptual difficulty. Sixteen per cent of patients had no visual symptoms; of these, 85 per cent had objectively measured visual impairment. Conversely, 6.5 per cent of patients with visual symptoms had entirely normal ophthalmic examinations.

It was concluded that visual symptoms may not be indicative of visual impairment, but instead may relate to other forms of impairment, such as in the domains of cognition or communication.

Strabismus 2013; 21: 2: 150-154

References: 1. Rosenfeld PJ *et al. Ophthalmology* 2005; 112: 1048–53. 2. Rosenfeld PJ *et al. N Engl J Med* 2006; 355: 1419–31. 3. Brown DM *et al. Ophthalmology* 2009; 116: 57–65. 4. Schmidt-Erfurth U *et al. Ophthalmology* 2011; 118: 831–9. 5. Singer MA *et al. Ophthalmology* 2012; 119(6): 1175–83. 6. Boyer DS *et al. Ophthalmology* 2009; 116: 1731–9. 7. Bhisitkul RB *et al. Invest Ophthalmol Vis Sci* 2012; 53: E-Abstract 3679. 8. Regillo CD *et al. Am J Ophthalmol* 2008; 145: 239–48. 9. Holz FG *et al. Ophthalmology* 2011; 118: 663–71. 10. The CATT Research Group *et al. N Engl J Med* 2011; 364: 1897–908. 11. Antoszyk AN *et al. Am J Ophthalmol* 2008; 145: 862–74. 12. Abraham P *et al. Am J Ophthalmol* 2010; 150: 315–24. 13. Rosenfeld PJ *et al. Ophthalmology* 2006; 113: 623–32. 14. Heier JS *et al. Ophthalmology* 2006; 113: 633–42. 15. Patel RD *et al. Semin Ophthalmol* 2011; 26(6): 372–9. 16. Shona O *et al. Clin Experiment Ophthalmol* 2011; 39(1): 5–8. 17. Mitchell P *et al. Br J Ophthalmol* 2010; 94: 2–13. 18. Approved Product Information for LUCENTIS® 2012. 19. Clinicaltrials.gov. Available at clinicaltrials.gov/ct2/results?term=ranibizumab+and+australia. Accessed 9 November 2012. 20. Chang TS *et al. Arch Ophthalmol* 2007; 125: 1460–9. 21. Schmidt-Erfurth U. *Expert Opin Drug Saf* 2010; 9: 149–65. 22. LUMINOUS study. Available at clinicaltrials.gov/ct2/show/NCT01318941. Accessed 9 November 2012. 23. Lalwani GA *et al. Am J Ophthalmol* 2009; 148: 43–58.