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Australian Orthoptic Journal

Goldmann applanation tonometry audit

Persistent diplopia in Miller Fisher syndrome

Horizontal gaze palsy with progressive scoliosis

NDIS access requirements and vision impairment

Reduced vision and falls

Orthoptics and the war years

The first Sydney orthoptist

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Retrospective Audit of Goldmann Applanation Tonometry Measurements in a Consultant-Led Glaucoma Clinic

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ABSTRACT

Goldmann applanation tonometry is the gold standard for measuring intraocular pressure by indenting or flattening the corneal apex. Accuracy in performing Goldmann applanation tonometry is of high importance as changes to glaucoma treatment are often made based on this measurement. Clinical audits of Goldmann applanation tonometry are crucial for identifying variance within clinics and ensuring quality control. This study reports the finding of three routine clinical audits on a consultant-led glaucoma clinic, comparing measurements taken by orthoptists and medically trained ophthalmologists or registrars. Sixty-six percent of tonometry readings were within acceptable range (±2mmHg) at Audit 1 and this improved to 71% at Audit 3 ($p = 0.03$). Many factors affect applanation tonometry measurement and the findings of this audit suggest that hands-on training of orthoptic clinicians would be useful to ensure best practice in the technique and thereby reduce the number of erroneous measurements.

Keywords: applanation, tonometry, glaucoma, intraocular pressure

INTRODUCTION

Glaucoma is a group of ocular conditions whereby the defining feature is optic neuropathy, caused by increased intraocular pressure (IOP). Diagnosis is made based on numerous factors, including optic nerve head appearance and visual field loss, and may vary depending upon the glaucoma classification.[1] Raised IOP has been shown to be a significant risk factor for glaucomatous damage to the optic nerve and progression of the disease. The goal of glaucoma treatment is to lower the IOP to a targeted pressure at which there is a reduction in the risk of further damage to the optic nerve and therefore decreased impact on the visual field. This is particularly important as the prevalence of glaucoma is increasing and once diagnosed, requires lifelong monitoring.[2,3]

Goldmann applanation tonometry (GAT) is the gold standard for measuring IOP by indenting or flattening the corneal apex. It was described by Goldmann and Schmidt, based on the Imbert-Fick principle that the internal pressure of a sphere can be approximated by the measuring the force required to flatten a given wall area.[4] Major forces involved in IOP measurement with applanation include corneal rigidity, tear meniscus, IOP and tonometer force.[4] The GAT has a diameter of 3.06 mm and surface area of 7.35 mm^2 to neutralise confounding forces and expose the relationship between tonometer force and IOP.

Accuracy in performing GAT is of high importance as changes to glaucoma treatment are often made on the basis of this measurement.[5] Measurement variation arises due to many factors that are either clinician, instrument, or patient dependent. Patient-dependent factors include corneal thickness, corneal irregularity, direct or indirect globe pressure, eyelid squeezing, valsalva manoeuvres (patient holding their breath or having tight neckwear), ciliary muscle contracture occurring during prolonged accommodation, dilation of the pupil, excessive tear film and caffeine or water intake.[5-10] Technical factors include tonometer head wear and tear, instrument calibration, measurement interpretation, positioning of the tonometer head, variable fluorescein application, prolonged contact time and inter-observer variability. Repeated indentation of the cornea by one or different observers is also thought to lower IOP.8 Repeated IOP measurement by different observers can occur in multi-disciplinary ophthalmic clinics. The interobserver variability has been reported as low as 0.4 mmHg,[5] but more commonly between 1.2 and 2.3 mmHg.[7,8,11]

Due to the importance of accurate GAT measurements for the treatment and monitoring of glaucoma and the likelihood that variance can occur, clinical audits are an important method for ensuring quality control and

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the outcomes benefit both patients and clinical staff. Identifying discrepancies that may affect treatment outcomes is particularly relevant in shared-care clinics to ensure appropriate patient care.

METHODS

Between 2014 and 2016, three audits were conducted as part of routine clinical care, on a consultant-led glaucoma clinic at the Royal Victorian Eye and Ear Hospital (RVEEH). The focus of the audits were GAT measurements where applanation tonometry was conducted using Haag-Streit instrumentation (Bern, Switzerland). In the period between audits, orthoptic clinic staff were offered a non-mandatory professional development training opportunity.

Figure 1 shows the sequence of audits and training opportunities. The training session included information relating to common factors which cause over or underestimation of IOP, both patient-dependent and clinician-dependent reasons.

The patient cohort included new patients, short-term and long-term reviews and postoperative patients. The disparity in GAT readings between the medically trained ophthalmologists (consultants, fellows and registrars) and orthoptic clinicians was investigated. In addition, an attempt was made to understand the possible reasons why the IOP was re-tested by the ophthalmologists. The possible reasons may have been that IOP differed from the previous visit; IOP was higher than the set target pressure; or a possible treatment change was needed based on the IOP. Intraocular pressure recordings were classified as either within acceptable range (±2 mmHg) or outside acceptable range.

The professional development training opportunity was part of the regular pre-clinical teaching session and the GAT component was presented to orthoptic clinic staff after Audits 1 and 2, conducted by a senior orthoptic clinician. During training, orthoptic clinicians were shown the findings of the audits. The primary aim of the professional development was to highlight the factors which affect IOP measurement, with a specific focus on the factors that can be controlled by orthoptists. These included patient positioning, corneal biomechanical factors, correct technique and specific reasons for over or underestimation of IOP. Prior to the second professional development session, orthoptic clinicians undertook a self-test task to assess whether they were applying these factors when performing IOP measurements. Statistical analysis was performed using IBM Corp SPSS version 24.0 (Armonk, NY). As data were not normally distributed, the non-parametric Wilcoxon Signed-Rank test was used for analysis.

RESULTS

Audit 1 was completed by examining patient histories over three clinics in November 2014, involving 11 orthoptists and 7 ophthalmology consultants. The total number of patient histories examined was 174. During the audit period, the IOP of 94 eyes were re-tested by ophthalmology consultants. Sixty-six percent (n = 62) of IOP measurements were within acceptable range; 30% (n = 28) were the same, 36% (n = 34) were within ±2 mmHg. Thirty-four percent of measurements (n = 32) were outside the acceptable range. Of the orthoptists' measurements that did not fall within the acceptable range, most were lower than that measured by the ophthalmologist as shown in Figure 2. The mean difference between orthoptist and ophthalmologist IOP was 1.4 mmHg, a statistically significant difference (ophthalmologist higher, 95%CI -0.78 to 1.94 mmHg, $p < 0.01$).

Retrospective Audit 2 was conducted over six clinics in June 2015, six months after the first professional development session, and 437 patient histories were examined. This audit involved 11 orthoptists and 8 ophthalmologists. During the audit period, the IOP measurements of 122 eyes were re-tested by an ophthalmologist and the differences in IOP ranged from -11 to +5 mmHg (Figure 3). Sixty-four percent (n = 78) of IOP measurements were within acceptable range; 21% (n = 26) were the same and 43% (n = 52) were within ±2 mmHg. Thirty-six percent of measurements (n = 44) were outside the acceptable range. The mean difference between orthoptist and ophthalmologist IOP of 0.4 mmHg was not statistically significant (ophthalmologist higher, 95%CI -1.00 to 0.92 mmHg, p = 0.08).

The final audit (Audit 3) of 370 patient histories was conducted two months after the second professional development session and the differences in IOP measurement are shown in Figure 4. This audit involved 9 orthoptists and 12 ophthalmologists. During the audit period, the IOP of 78 eyes were re-tested by an ophthalmology consultant. Seventy-one percent of IOP measurements (n = 55) were within the acceptable

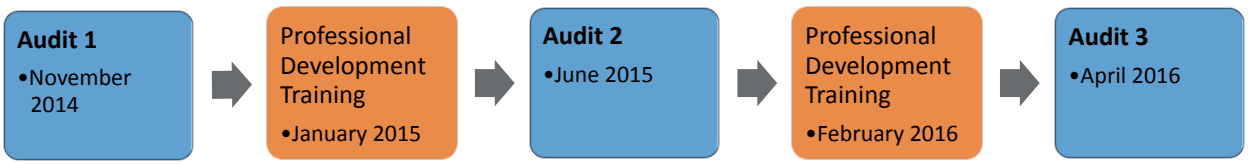

Figure 1. Sequence of audits and training opportunities.

range; 32% (n = 25) were the same, 39% (n = 30) were within ±2 mmHg. Twenty-nine percent of measurements (n = 23) were outside the acceptable range. The mean difference between orthoptist and ophthalmologist IOP of 0.4 mmHg was not statistically significant (ophthalmologist higher, 95% CI -0.30 to 1.14 mmHg, p = 0.09).

Figure 5 shows the proportion of IOP measurements which were either identical, within tolerance or outside tolerance when comparing orthoptists and ophthalmology consultants across all three audit periods. The number of IOP measurements which were within acceptable range improved from 66% to 70.5% from Audit 1 to Audit 3, a statistically significant difference (p = 0.03)

DISCUSSION

This collection of real-world clinical audits suggests that there is no clinically significant difference between IOP measurements by orthoptists and ophthalmologists using GAT in a sub-specialty glaucoma clinic. There was a trend towards lower readings by orthoptists, however there were outliers in both directions with several patients having IOPs recorded 10 mmHg higher or lower when re-tested by an ophthalmologist. It must be noted that a population statistics approach in analysing the findings of the audit hides individual cases where marked differences in IOP measurement are important and would affect treatment decisions.

This retrospective collection of audits contrasts with previous studies that have been prospective and controlled. Previous clinical studies have used a very limited number of observers, the same instrumentation and compliant, healthy patients. The audit findings are highly pertinent to actual clinical situations. In this study, the initial GAT measurement could have been taken by five different orthoptists and the second reading repeated by seven different ophthalmologists, ophthalmology fellows and registrars. The audited GAT measurements used one reading from each observer, whereas in controlled studies a number of measurements are usually taken and the mean or median value is used. It has been shown that using the median value of three consecutive GAT readings reduces inter-observer variability by 11% compared with one single observer measurement, which could account for some variability seen in our audits.[7] Garway-Heath[12] reported that two GAT measurements taken by the same observer on the same patient, using the same instrument under the same conditions in a short period of time, yielded a difference between 2.2 and 5.5 mmHg. Our real-world results suggest that similar results can be achieved by different observers using different equipment.

Other studies have repeated GAT measurements within a very short time-period (minutes) and the time intervals have been consistent. For the patients in this audit, the interval between readings could vary from 10 minutes to over an hour. This duration could impact the patient's IOP if for example they have had caffeine intake, been reading for prolonged periods in the waiting area causing ciliary muscle contracture, or have been exposed to environments affecting moisture content of the cornea, as well as possible short-term diurnal variation. Some of the patients in this audit may have had pupil dilation after the first GAT measurement, thereby affecting the second measurement. This information was not recorded as part of the data gathering process.

It has been previously shown that there is a statistically significant relationship between GAT measurement error and age of tonometer prism, the number of times the tonometer is used daily and the range of calibration endpoints.[13] There can be up to 12 tonometers used on any given glaucoma clinic at the RVEEH. It is worth noting that a large number of tonometer prisms were replaced in 2015. As the audit GAT measurements were conducted on different tonometers and factors such as tonometer head wear and tear, repeated use, differences in slit lamp illumination and calibration (tonometers are calibrated on the same day, monthly at the RVEEH) may affect the GAT reading, this may account for some variation in IOP recorded

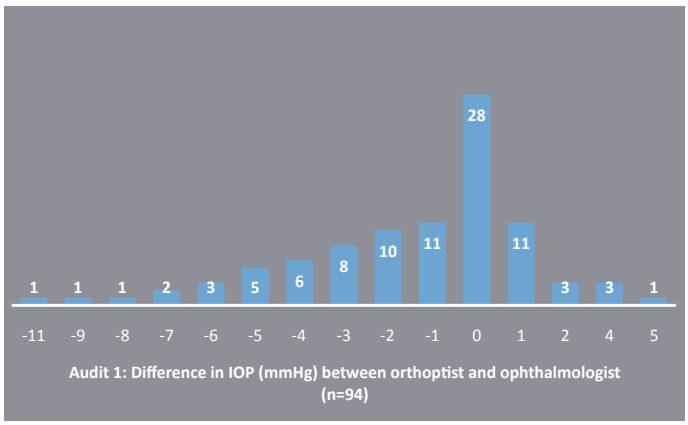

Figure 2. Range of difference in IOP measurement between orthoptists and ophthalmologists (Audit 1).

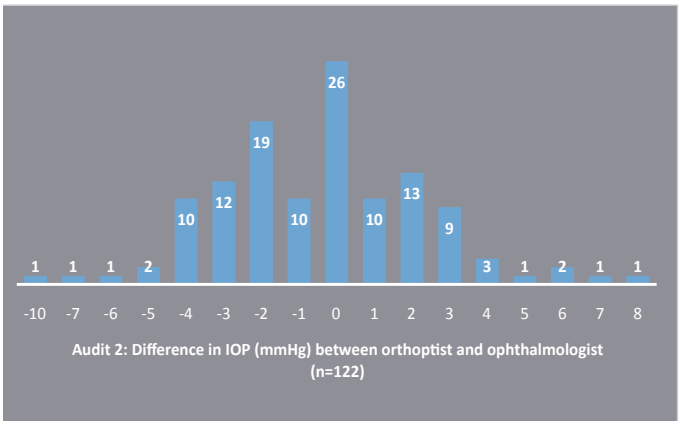

Figure 3. Range of difference in IOP measurement between orthoptists and ophthalmologists (Audit 2).

by orthoptists compared ophthalmologists, ophthalmology fellows and registrars.

The authors acknowledge that operator technique can also be a factor. It is worth noting that there has been a reduction in opportunity for orthoptists on non-glaucoma clinics to perform GAT, as tonometry using iCare rebound tonometry (iCare Finland Oy, Helsinki) is becoming increasingly used in clinics due to ease of use and improved time efficiency. Orthoptists at the RVEEH are performing less GAT measurements than in previous years, particularly since ten general clinics closed. This in turn impacts teaching of final year students who receive less opportunity to practice GAT, thereby affecting some of the new graduate workforce who become employed at the RVEEH. The difference between orthoptist and ophthalmologist IOP was statistically significant only in Audit 1, and it is theorised that orthoptist education and training in improved technique was at least partially responsible for the improved results in Audit 2 and 3. In addition, the number of GAT measurements re-tested fell over time, decreasing to 21% at Audit 3, compared to 54% at Audit 1. It is difficult to postulate the exact reason, however it may be due to improved staff confidence after participating in training.

The professional development sessions appear to have made some impact to orthoptist IOP measurement performance, and it is believed that hands-on clinical training is the most effective way to further improve and maintain these results. This will be implemented using a newly acquired teaching arm, connected to the Haag-Streit slit lamp enabling the teaching clinician to observe the mires as they appear to the clinician. This will be useful for both training and quality control purposes in the hospital. A close working relationship between the university and clinic-based elements of orthoptic graduate training is important to ensure that high quality training for orthoptic students leads to positive skill improvements and patient outcomes.

IOP measurement is useful in many situations where orthoptists are involved, including glaucoma diagnosis and monitoring as well as assessment of patients with uveitis, retinal vascular disease or post-surgery. Despite inherent limitations to audit data. such as retrospectivity, lack of controls, incomplete records, instrument and personnel variation, the information yielded is valuable and can be used to inform clinical practice. It was found that GAT performed by orthoptists appears to be similarly reliable to that performed by ophthalmologists in most patients, and agreement can be improved with orthoptist training. It is recommended that individual patients with unexpectedly high or low IOP, or where IOP is particularly critical to a treatment decision, should have the measurement repeated.

CONCLUSION

Our audit results found that orthoptists can achieve similar Goldmann applanation tonometry measurements to ophthalmologists in the majority of patients in a glaucoma sub-specialist clinic. Sources of error and potential benefits from further training were identified. The presence of a few outlier patients with a marked difference between orthoptist and ophthalmologist IOP measurement reinforced the need to re-test unexpectedly high or low readings, and in situations where an important treatment decision is being made. It is important to maintain the skill of Goldmann applanation tonometry through vigilance and care during training and clinical practice.

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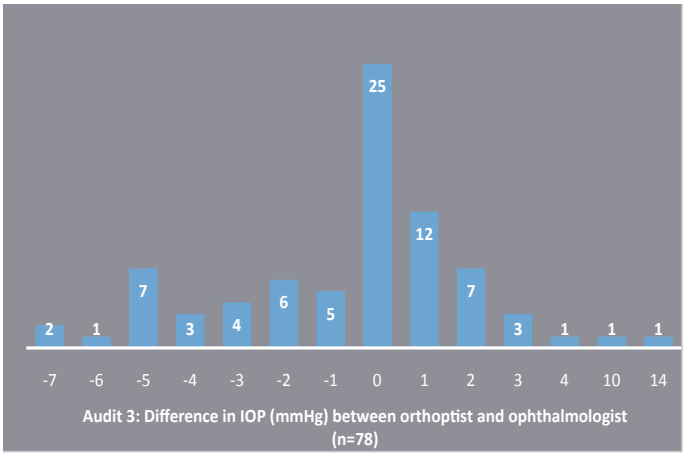

Figure 4. Range of difference in IOP measurement between orthoptists and ophthalmologists (Audit 3).

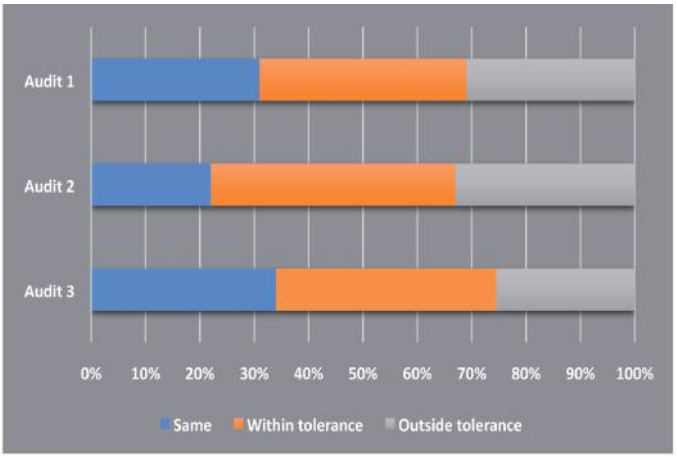

Figure 5. Proportion of IOP measurements within or outside tolerance for all audits.

REFERENCES

1. Casson RJ, Chidlow G, Wood JP, et al. Definition of glaucoma: clinical and experimental concepts. Clin Exp Ophthalmol 2012;40(4):341-349.
2. Dandona L, Dandona R. What is the global burden of visual impairment? BMC Med 2006;4:6.
3. Gleeson D. The multidisciplinary glaucoma monitoring clinic a the Royal Victorian Eye and Ear Hospital. Aust Orthopt J 2013;45:15-18.
4. Goldmann H, Schmidt T, Über Applanationstonometrie. Ophthalmologica 1957;134:221-224.
5. Tonnu PA, Ho T, Sharma K, et al. A comparison of four methods of tonometry: method agreement and interobserver variability. Br J Ophthalmol 2005;89(7):847-850.
6. Chandrasekaran S, Rochtchina E, Mitchell P, Effects of caffeine on intraocular pressure: The Blue Mountains Eye Study. J Glaucoma 2005;14(6):504-507.
7. Dielemans I, Vingerling JR, Hofman A. Reliability of intraocular pressure measurement with the Goldmann applanation tonometer in epidemiological studies. Graefes Arch Clin Exp Ophthalmol 1994;232(3):141-144.
8. Kaufmann C, Bachmann LM, Thiel MA. Comparison of dynamic contour tonometry with Goldmann applanation tonometry. Invest Ophthalmol Vis Sci 2004;45(9):3118-3121.
9. Tran T, Niyadurupola N, O'Connor J, et al., Rise of intraocular pressure in a caffeine test versus the water drinking test in patients with glaucoma. Clin Exp Ophthalmol 2014;42(5):427-432.
10. Whitacre M, Stein R. Sources of error with use of Goldmann-type tonometers. Surv Ophthalmol 1993;38(1):1-30.
11. Thorburn W. The accuracy of clinical applanation tonometry. Acta Ophthalmol (Copenh) 1978;56(1):1-5.
12. Garway-Heath T, Kotecha A, Lim S. Tonometry and IOP fluctuation. In: Shaarawy TM, Sherwood MB, Hitchings RA, Crowston JG, editors. Glaucoma Volume 1: Medical Diagnosis and Therapy. Philadelphia: Saunders Elsevier; 2009. p. 103-113.
13. Berry V, Drance SM, Wiggins RL, Schulzer M. A study of the errors of applanation tonometry and tonography on two groups of normal people. Can J Ophthalmol 1966;1(3):213-220.

Persistent Diplopia in Miller Fisher Syndrome: A Case Report

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ABSTRACT

Miller Fisher syndrome is a rare variant of Guillain-Barre syndrome characterised by ataxia, ophthalmoparesis and areflexia. This case report describes a 57-year-old Caucasian woman who presented with acute diplopia, progressive areflexia and ataxic gait. Past ocular history reported an intermittent childhood esotropia. Clinical examination found a left esotropia, limited abduction on both right and left gaze, small amplitude nystagmus and mild left ptosis.

After a two-year follow-up, her areflexia and ataxia were completely resolved. However, diplopia and strabismus were still present. As generally those with Miller Fisher syndrome show complete resolution of their symptoms, it was hypothesised that the persistent diplopia was likely to be related to a childhood intermittent strabismus which precluded total remission. A period of temporary fusion disruption may have led to decompensation of a pre-existing heterophoria, precipitating an acute acquired concomitant esotropia.

Keywords: childhood intermittent esotropia, Miller Fisher syndrome, ophthalmoparesis, presistent diplopia

INTRODUCTION

Miller Fisher syndrome (MFS) is an acute inflammatory polyneuroradiculopathy[1] that is a diffuse damage with multiple nerve root involvement, characterised by sudden onset ophthalmoplegia, ataxia and areflexia.[1-3] The classical clinical triad was first described in 1932 by James Collier and subsequently reported in 1956 by Charles Miller Fisher as 'an unusual variant of acute idiopathic polyneuritis'.[3-4] With an annual incidence of 1/1,000,000,[2] MFS represents a rare variant of Guillain-Barre syndrome (GBS). It is observed in only about 1 to 5% of GBS cases in western countries,[3] with higher rates reported in Asian populations (19% and 25% in Taiwan and Japan, respectively).[1-3] The mean age of onset is reported to be 34 to 43.6 years,[1-3] with the male:female ratio of 2:1.[1-3]

A variety of infections can precede the onset of signs and symptoms,[5] with ophthalmoplegia and diplopia as the first manifestations, associated with ataxia and areflexia.[1-3] The main difference between MFS and GBS is that the cranial nerves are affected first.[3] The presence of the anti-GQ1b IgG antibody in serum is an excellent diagnostic marker for MFS.[1-3,5] Most patients show a benign monophasic evolution with a complete remission without residual deficits.[1-3]

This report describes a patient with persistent diplopia as the only residual symptom of MFS two years after the onset. This occurrence has rarely been reported in the literature, as resolution is usually complete after weeks or months, with a reported mean recovery time of 10 weeks.[1-3]

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CASE REPORT

March 2014:

A 57-year-old Caucasian woman presented to the Emergency Department of Careggi Hospital suffering from worsening diplopia for four days, along with a one-day history of progressive ataxic gait. Previous medical history included hypertension, well controlled with angiotensin-converting enzyme (ACE) inhibitors. She reported a gastrointestinal upset with high fever 10 days before the onset of diplopia. Patient recollection of past ocular history suggested an intermittent convergent strabismus and hypermetropic spectacle wear in childhood. She denied any previous episodes of diplopia or ptosis.

On examination, uncorrected visual acuity, measured with Snellen chart, was 6/9 in the right eye (RE) and 6/15 in the left eye (LE). Best corrected acuity was RE 6/6 with +1.00 DS and LE 6/7.5 with +1.75 DS. Near visual acuity, tested

with the Jager Chart, was J1 with a near addition of +2.75 DS in each eye. Pupils were round and equal, with bilateral, mild and sluggish pupillary reflexes. She showed a mild left eyelid ptosis.

Corneal reflections showed a primary position left esotropia (ET) larger for distance than near. Diplopia was horizontal, with an intermittent oscillopsia sensation in lateral gaze. Prism cover test (PCT) revealed 30$^{\Delta}$ ET at distance and 14$^{\Delta}$ ET' at near. Ocular movements revealed limited abduction on right and left gaze, with the left lateral rectus (LR) more severely affected. Small amplitude nystagmus was observed, respectively right-beating in right gaze and left-beating in left gaze. The Hess chart showed underaction of both lateral recti, left more than right, with the development of muscular sequelae, and slight underaction of both superior recti (Figure 1).

Neurological examination reported ataxia and areflexia. Initially, blood tests and computed tomography (CT) scan were normal but, suspecting Miller Fisher Syndrome, neurologists requested medical resonance imaging (MRI) with gadolinium contrast. This demonstrated enhancement of the cisternal segment of both oculomotor and abducens cranial nerves, without any cerebral tissue involvement. Specific anti-GQ1b IgG dosage demonstrated high serum values. Lumbar puncture showed an increased protein level in the cerebrospinal fluid (CSF). She immediately received intravenous immunoglobulin (IVIg) in a regimen of 0.4 g/kg bodyweight daily for five consecutive days, reporting a mild improvement on walking and marching, but no improvement of her diplopia. Prior to discharge she was advised on a penalisation therapy using an opaque foil over the left eye to avoid diplopia.

May 2014:

Two months later ataxia and areflexia were gradually improved, pupillary reflexes showed a quick reaction to light, but eye movement anomalies were basically stable with unchanged diplopia. The orthoptic clinical picture was similar to the first visit, except for the resolution of ptosis. The large-angle esotropia meant that prism therapy was not yet appropriate, so occlusion was continued with the opaque foil, planning a six-month follow-up if all remained stable.

September 2014:

The patient reported a subjective improvement of diplopia, especially at near where she could read with single vision without discomfort. However, she reported persistent diplopia at distance. Considerable recovery was observed in elevation of both eyes, but horizontal movements were still abnormal, with insufficient abduction right and left. PCT revealed LET for distance (14$^{\Delta}$) and an esophoria with a good fusion recovery at near fixation (8$^{\Delta}$). The Hess chart highlighted a concomitant strabismus, with an improved underaction of both LR. There was no residual elevation defect (Figure 2).

Given the smaller strabismus angle, a prism correction to restore binocularity and align the visual axes was planned. A 14$^{\Delta}$ base-out (BO) prism was the minimum correction required to re-establish binocular single vision (BSV). This was first prescribed as a 14$^{\Delta}$ BO temporary Fresnel prism, but the patient did not like either the aesthetic effect or the quality of vision, so she chose glass prisms. This was prescribed with her distance refractive correction: RE +1.00 DS 7$^{\Delta}$ BO, LE +1.75 DS 7$^{\Delta}$ BO, while she did not need prisms at near as she had BSV.

September 2016:

The latest evaluation demonstrated unchanged ocular movements and orthotropia with her prismatic correction. A recent brain MRI with contrast showed decreased nerve intensity enhancement. As her MFS appeared completely resolved, she received strabismus surgery involving bilateral medial rectus recession and lateral rectus resection, under topical anaesthesia with adjustable sutures. A positive post-surgical outcome was obtained, she was straight for both

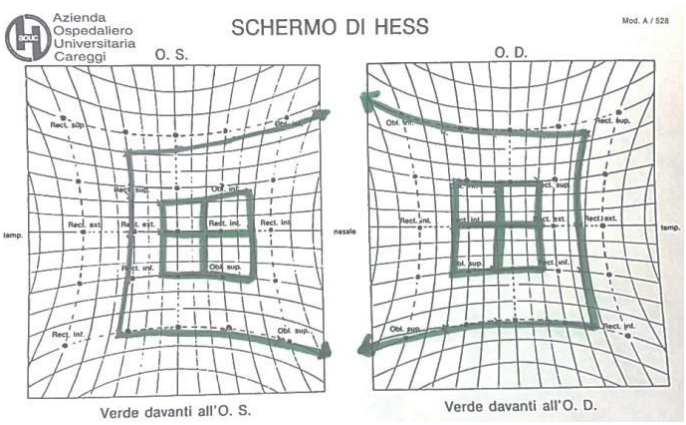

Figure 1. Hess chart demonstrated bilateral lateral recti underactions, left greater than right, and mild bilateral superior recti underactions, left greater than right.

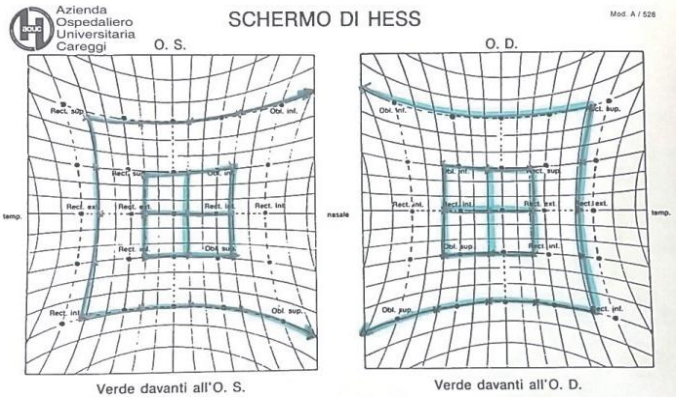

Figure 2. Hess chart demonstrated improvement of lateral recti underactions and resolution of the superior recti underactions.

distance and near, without diplopia. Informed consent was obtained from the patient for publication of this case report.

DISCUSSION

Miller Fisher syndrome is a variant of Guillain Barre syndrome characterised by cranial nerve involvement and the triad of ataxia, areflexia and ophthalmoplegia.[1-3] Berlit and Rakicky reported that diplopia was the first symptom in 38.6% of cases and ataxia in 20.6%. Areflexia affected a high percentage of patients (81.6%) but not necessarily as the onset presentation.[3] The most common ocular finding is bilateral external ophthalmoplegia,[1-3] which can present as unilateral, incomplete, isolated form.[1-2,6-8]

More recent case publications reported internal ophthalmoplegia, with[9] or without[10] external involvement or other neurological defects. Mydriasis has been reported as present in 35 to 50% of cases.[11] Various other ophthalmic conditions have been reported: ptosis, lid retraction, internuclear ophthalmoplegia, divergence paralysis, nystagmus, convergence anomalies, acute angle closure and demyelinating optic neuropathy.[1,6,9,11] Berlit and Rakicky, followed by other authors, reported that the clinical signs are preceded by infections in 71.8% of cases, which generally occur 8 to 10 days before.[1-3,5] Our patient reported a gastrointestinal upset with high fever 10 days before the onset of symptoms. Her first symptom was diplopia and her ophthalmoplegia could be defined as 'bilateral but asymmetric', affecting the left eye more than the right; 'external but incomplete', involving abducens and oculomotor cranial nerves, but excluding its inferior branch; and 'partial internal', showing equal pupils, but sluggish response to light.

MFS diagnosis is based on patient history and clinical features, supported by the diagnostic marker of high levels of serum anti-GQ1b IgG antibody.[1-3,5,12] It is suggested that the ophthalmoplegia is so frequent because the GQ1b ganglioside is highly enriched in the ocular cranial nerves and the ciliary ganglia.[9] Other diagnostic findings are the presence of albuminocytological dissociation in the CSF,[1,3-4,12] normal findings on CT and enhancement of ocular and/or facial cranial nerves, without brainstem abnormalities on MRI.[13-14] The differential diagnosis, in addition to GBS, includes Bickerstaff's brainstem encephalitis, brainstem stroke, Wernicke's encephalopathy, polyneuropathies, neurosyphilis, botulism and anticonvulsant intoxication.[6] The rapid onset of ophthalmoplegia can help to distinguish MFS from chronic diseases such as mitochondrial myopathies, oculopharyngeal or myotonic dystrophy, thyroid ophthalmopathy and myasthenia gravis.[6,15] In our case, clinical pictures, positive serological tests and characteristic MRI findings lead quickly to the diagnosis.

MFS generally has an excellent prognosis; first improvements begin within two to four weeks after the onset of neurological symptoms and may be almost complete within six months.[1,3,11,13,16] The treatment of choice for MFS is IVIg; a combination of Ig with methylprednisolone or plasmapheresis are also indicated.[1-3,17] Our patient immediately received IVIg, reporting a complete resolution of her systemic condition within two months. However, ocular motility demonstrated only a mild, partial improvement.

Concurrent to the neurological management we conducted an orthoptic two-year follow-up, which demonstrated a persistent diplopia, an outcome rarely reported in the literature. It is hypothesised that along with the MFS ophthalmoplegia, the ocular comorbidity of her childhood intermittent heterotropia has exacerbated the binocular imbalance. When heterophoria fails, it gives rise to strabismus and either diplopia or suppression. After the onset of ophthalmoplegia, her fusional reserves likely became inadequate. Fusional vergence did not support binocular vision even after total neurological recovery, causing a permanent decompensation of a pre-existing esophoria.

Once orthoptic stability was achieved after six months, a prismatic correction was prescribed, improving her health-related quality of life. After two years of persistent impairment, strabismus surgery was suggested. The postoperative realignment of visual axis and the disappearance of diplopia have produced a positive and satisfactory outcome

CONCLUSION

This interesting case of persistent diplopia two years after resolution of the other signs and symptoms of Miller Fisher syndrome emphasises the importance of considering past ocular history and comorbidity when assessing ocular motility and binocular status. It appears that the unstable binocularity was likely due to childhood strabismus exacerbated by the neurological complications of Miller Fisher syndrome. Once the neurological condition had resolved, the patient was treated for the acquired concomitant esotropia with excellent results and satisfaction.

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REFERENCES

1. Mori M, Kuwabara S, Yuki N. Fisher syndrome: clinical features, immunopathogenesis and management. Expert Rev Neurother 2012;12(1):39-51.
2. Teener JW. Miller Fisher's syndrome. Semin Neurol 2012;32(5):512-516.
3. Berlit P, Rakicky J. The Miller Fisher syndrome. Review of the literature. J Clin Neuroophthalmol 1992;12(1):57-63.
4. Fisher M. An unusual variant of acute idiopathic polyneuritis (syndrome of ophthalmoplegia, ataxia and areflexia). N Engl J Med 1956;255(2):57-65.
5. Heckmann JG, Dutsch M. Recurrent Miller Fisher syndrome: clinical and laboratory features. Eur J Neurol 2012;19(7):944-954.
6. Anthony SA, Thurtell MJ. Leigh RJ. Miller Fisher Syndrome mimicking ocular myasthenia gravis. Optom Vis Sci 2012;89(12):e118-e123.
7. Rigamonti A, Lauria G, Longoni M,et al. Acute isolated ophthalmoplegia with anti-GQ1b antibodies. Neurol Sci 2011;32(4):681-682.
8. Smith J, Clarke L, Severn P, Boyce R. Unilateral external ophthalmoplegia in Miller Fisher syndrome: case report. BMC Ophthalmol 2007;7:7.
9. Man BL. Total internal and external ophthalmoplegia as presenting symptoms of Miller Fisher syndrome. BMJ Case Rep 2014 doi:10.1136/bcr-2014-205554.
10. Terry Lopez O, Sagarra Mur D, Gutierrez Alvarez AM, Jimenez Corral C. Internal ophthalmoplegia as the initial symptom of Miller-Fisher syndrome. Neurología 2014;29(8):504-505.
11. Ramakrishnan S, Kulkarni GB, Mustare V. Neuro-ophthalmological manifestations in three cases of Miller Fisher syndrome and a brief review of literature. Neurol India 2015;63(6):975-977.
12. Lo YL: Clinical and immunological spectrum of the Miller Fisher syndrome. Muscle Nerve 2007;3(5):615-627.
13. Das PP, Biswash S, Karim E, et al. Miller Fisher Variant of Guillain-Barre Syndrome: A case report & clinical review. BSMMU J 2012;5(1):69-71.
14. Garcia-Rivera CA, Rozen TD, Zhou D et al. Miller Fisher syndrome: MRI findings. Neurology 2001;57(10);1755.
15. Keane JR. Bilateral ocular paralysis: analysis of 31 inpatients. Arch Neurol 2007; 64(2):178-180.
16. Overell JR, Willison HJ. Recent developments in Miller Fisher syndrome and related disorders. Curr Opin Neurol 2005;18(5):562-566.
17. Mori M, Kuwabara S, Fukutake T, Hattori T. Plasmapheresis and Miller Fisher syndrome: analysis of 50 consecutive cases. J Neurol Neurosurg Psychiatry 2002;72(5):680.

Two Brothers with Horizontal Gaze Palsy with Progressive Scoliosis

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ABSTRACT

Horizontal gaze palsy with progressive scoliosis (HGPPS) is a rare autosomal recessive disorder, which results in complete absence of horizontal eye movements. Convergence is typically intact and pendular low amplitude nystagmus is a common presentation in patients with this condition. In 2015, the first reported Australian cases presented to an Ophthalmology Department in Melbourne. The two Chinese siblings were diagnosed with HGPPS and an absence of all forms of horizontal gaze, including saccadic, smooth pursuit and vestibule-ocular responses. The patients demonstrated the presence of pendular nystagmus, however convergence remained unimpaired. The two sibling's rare genetic findings are compared with similar presentations located in literature worldwide.

Keywords: horizontal gaze palsy, progressive scoliosis, nystagmus, convergence, ROBO3

INTRODUCTION

Horizontal gaze palsy with progressive scoliosis (HGPPS) is a rare autosomal recessive disorder caused by homozygous or compound heterozygous mutations in the ROBO3 gene on chromosome 11.[1] HGPPS is a congenital disorder resulting in complete absence of horizontal eye movements including saccadic, smooth pursuit and vestibulo-ocular responses.[1-8] Convergence is intact and patients may have low amplitude horizontal pendular nystagmus.[1-11] HGPPS was first reported in 1974 though it was not until 30 years later that the gene responsible ROBO3 was discovered.[7,10,11] As of 2016, there have been 33 different ROBO3 mutations described that are related to HGPPS.[12] They can be from either consanguineous or non-consanguineous pedigrees and may or may not be associated with strabismus. The majority of these cases have been documented in patients from Middle Eastern, African and European backgrounds. On reviewing the literature, it is noted that this case report of two brothers of Hokkien descent, aged eight and six years who have migrated from China, may be the first published cases in Australia.

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CASE REPORTS

After recently arriving in Australia, two brothers, aged 8 years and 6 years, presented to the eye clinic after being referred by their paediatrician with a query of congenital bilateral VI cranial nerve palsy with horizontal nystagmus. It was also documented by the paediatrician that they were being managed for scoliosis. Both brothers were born to non-consanguineous parents and are the youngest two of four siblings. The older two female siblings have no signs of horizontal gaze palsy or scoliosis. Both brothers had normal cognitive function and were learning English as a second language.

The older brother had visual acuity of 3/9.5 each eye using a LogMAR chart. There was no movement on cover test at distance or near. He had horizontal, low amplitude, pendular nystagmus. Ocular movements showed no saccadic, pursuit or doll's head movement on horizontal gazes, though vertical movements, both elevation and depression, were intact. Convergence near point was 4 cm. Fusion was not demonstrable using a 20 PD base-out prism and stereo acuity was 200" of arc on the Lang II. Fundus examination was normal and there was no significant refractive error on retinoscopy.

The younger brother had visual acuity of 3/6 each eye using single optotype Kay Pictures. There was no eye movement on cover test at distance or near. He had horizontal, low amplitude, pendular nystagmus. Ocular movements showed no movement on horizontal gazes, though vertical movements were intact. Convergence near point was 4 cm. Fusion was not demonstrable with a 20 PD base-out prism

Table 1. Comparison of published HGPPS cases

Ethnicity	Horizontal eye movements	Vertical eye movements	Convergence	Nystagmus	Strabismus	Reference
Turkish x 3	Absent	Restricted	Not stated	Horizontal, head tremor	Straight	Dretakis & Kondoyannis 1974[10]
Chinese x4	Absent	Normal	Intact	Pendular, low amplitude horizontal	Straight	Sharpe et al 1975[11]
Irish/German	Absent	Normal	Not stated	Pendular horizontal, left head tilt	Straight	Chan et al 2006[4]
English/Irish	Absent	Normal	Intact	Low amplitude	15$^{\Delta}$ esotropia	Chan et al 2006[4]
Saudi x 5 Sudanese x 1	Absent	Normal	Intact	Three of the six had nystagmus	Straight	Abu-Amero et al 2009[1]
Indian	Absent	Normal	Intact	Not stated	Straight	Ng et al 2011[15]
Turkish	'Limited'	Normal	Intact	Horizontal pendular	40$^{\Delta}$ esotropia	Volk et al 2011[8]
Turkish	Absent	Normal	Intact	Horizontal, pendular, slight rotational	24$^{\Delta}$ exotropia	Volk et al 2011[8]
Saudi	Absent	Normal	Intact	Nil	Microtropia	Volk et al 2011[8]
Turkish	Absent	Normal	Intact	Horizontal	14$^{\Delta}$ exotropia	Volk et al 2011[8]
Serbian	Absent	Normal	Intact	Small amplitude, horizontal, pendular	Straight	Abu-Amero et al 2011[2]
Afghani x 4	Absent	Normal	One had no convergence	One had no nystagmus	Mild esotropia	Abu-Amero et al 2011[3]
Iraqi	Absent	Normal	Intact	Upbeat	Straight	Samolades et al 2013[7]
Moroccan x 4	Absent	Normal	Intact	Low amplitude horizontal	Straight	Handor et al 2014[5]
Saudi	Absent	Normal	Intact	Nil	35$^{\Delta}$ esotropia	Khan & Abu-Amero 2014[14]
Turkish	Limited	Normal	Intact	Nil	40$^{\Delta}$ exotropia	Bozdogan et al 2017[12]
Cape Verdean x 2	Absent	Normal	Intact	Nil	Straight	Mendes Marques et al 2017[6]

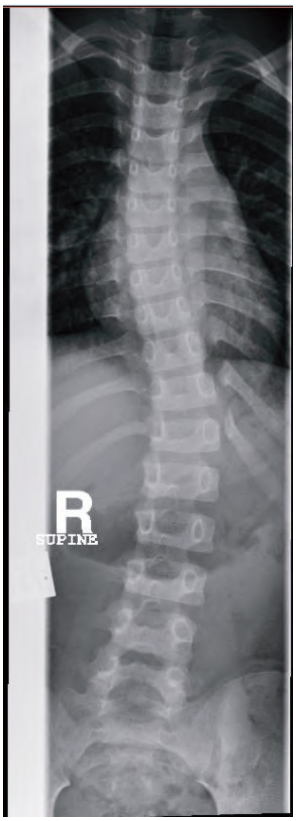

Figure 1. MRI demonstrating scoliosis of the older brother.

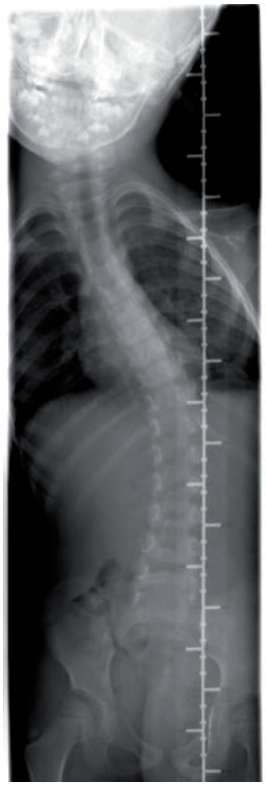

Figure 2. MRI demonstrating scoliosis of the younger brother.

and he only reported seeing monocular control picture on the Lang II stereoacuity test. He also had a mild left head tilt, which was due to his scoliosis. Fundus examination was normal and there was no significant refractive error on retinoscopy.

Genetic testing found that both parents are carriers of the faulty ROBO3 gene. There was no other history of any symptoms in other family members. It was confirmed that the older brother had a homozygous mutation of the ROBO3 gene with the nucleotide change being c.955G>A. The younger brother has not yet undergone genetic testing, as a negative genetic test would not alter his treatment and it was concluded by geneticists that both brothers had inherited the same diagnosis. It is unknown therefore, whether or not both boys have the same phenotype.

Spinal magnetic resonance imaging (MRI) of the older brother demonstrated 'mild biconcave scoliosis, convex to the right in the mid thoracic region and to the left at the thoracolumbar region,' as shown in Figure 1. Spinal MRI of the younger brother demonstrated 'biphasic scoliosis with the cervical curve convex to the right apex at the level of C7 and the more diffuse thoracolumbar curve convex to the left, maximal at the level of T12,' as shown in Figure 2.

Magnetic resonance imaging of the older sibling indicated slight asymmetry in volume of the pons with the right side appearing slightly smaller than that of the left. There was a small cleft in the dorsal pons. It was also found that he had spina bifida occulta at the level of sacral vertebra S1. The younger child's MRI was reported as 'unremarkable due to motion defect'. This project was approved by the Monash Health HREC (Project No. RES-17-0000-186Q) and consent obtained from the siblings' parent.

DISCUSSION

One of the very earliest cases of HGPSS documented four siblings of Chinese Hakka ethnicity. They were examined after immigrating to Toronto, Canada.[11] It was noted in this publication that all four children had full ocular movements in early childhood. The youngest was reported to have full ocular movements when examined at two years of age. By four years of age he had been diagnosed with scoliosis and partial limitation on lateral gazes. When examined again 10 years later at age 14 years, he had complete paralysis of horizontal gaze with pendular nystagmus.[11] However, as the first examination was not performed by an ophthalmic specialist, it could be suggested that the gaze paralysis may have been present at birth and not detected by either the family or general physicians given the difficulties of examining children.[9,11] No other authors have mentioned this progressive gaze paralysis.

Strabismus, either esotropic, exotropic or hypertropic deviations, was discussed in several of the reported cases.[1-4,8,9,12-14] Our brothers had no apparent deviation on cover test. One case described a 12-year-old boy from consanguineous parents who at four months of age had a 14 PD esotropia which increased to 40 PD at 2½ years old with a left micro hypertropia. With an initial diagnosis of bilateral Duane's retraction syndrome type 3, a bilateral medial rectus recession was performed to correct the strabismus. Although, his inability to abduct or adduct either eye remained. This boy had some intermittent head nodding and amblyopia. His sister who at 2½ years of age apparently had a 1 PD esotropia with binocular vision, which had changed to a 24 PD exotropia by the time of the authors' examination at 9 years of age.[8] Table 1 presents the strabismus and ocular findings of the other reported cases.

Most of the reported cases demonstrated normal convergence, as did our brothers. However, one was a child with no convergence and no nystagmus.[3] This child had marked kyphoscoliosis, curvature of the spine in both coronal and sagittal planes.[3,5] This differs to our brothers who both had biconcave scoliosis. A few other cases were

reported where no nystagmus was evident, though no authors have presented explanations on this point.[1,6] There was also one case of upbeat nystagmus which occurred in a 27-year-old man.[7]

The greater number of cases, including our brothers, had hypoplasia of the pons and cerebellar peduncles with both or either anterior and posterior midline clefts of the pons and medulla. ROBO3 mutations may disturb brainstem morphogenesis by failing to promote decussation of long motor and sensory tracts in the pons and medulla. Impaired decussation of pontine oculomotor pathways could explain the absence of all horizontal eye movements. This gene encodes an axon-guidance protein, which is responsible for midline crossing of neurons in the medulla.[8,9,16,17] It can be hypothesised that convergence is intact due to the genetic mutation not affecting the midbrain vergence pathway in the majority of cases. The paramedian pontine reticular formation is the horizontal gaze centre, innervating the abducens nucleus. From the abducens nucleus, lower motor neurons via the ipsilateral abducens nerve innervate the lateral rectus muscle, and interneurons via the contralateral medial longitudinal fasciculus (MLF) innervate the oculomotor neurons controlling the medial rectus. Vertical gaze is intact due to the vertical gaze centre being located in the midbrain reticular formation which control the lower motor neurons in the oculomotor and trochlear nuclei.[18] Vestibular input to both horizontal and vertical gaze pathways is direct from the vestibular nuclei to the abducens, oculomotor and trochlear nuclei via the MLF, which indicates that the MLF fibres are not affected in this condition as vertical doll's heads are still intact.[18]

The ROBO3 gene mutation has been described as the likely cause of HGPPS. There has been one other case reported with the identical c.955G>A nucleotide change to that found in our case,[19] however this paper did not describe any clinical signs. One case has been described where the ROBO3 gene had no mutations, nor any other chromosomal deletion or duplication.[2] An 8-year-old boy of a non-consanguineous Serbian family presented for ophthalmic, neurologic and orthopaedic examinations. He was born at term, healthy and the third son, his parents and siblings had no ocular motility restriction or scoliosis. His cognitive and motor skills were normal. On ophthalmic examination, he had low amplitude pendular nystagmus, absence of horizontal gaze movements, with vertical movements and convergence intact. Progressive scoliosis was also noted, and relevant orthopaedic treatment was commenced. His spinal x-ray showed thoracolumbar kyphoscoliosis with both anterior and posterior clefts in the medulla and a posterior cleft in the pons. On genetic testing, no ROBO3 mutations were detected. It was hypothesised that some environmental or epigenetic factor might interfere with the action of ROBO3 or its protein product in the developing brainstem, or a phenotype identical to HGPPS might be caused by mutations of a gene other than ROBO3.[2]

As HGPPS is a rare condition not commonly seen in ophthalmology clinics, it can be misdiagnosed as a bilateral Duane's retraction syndrome type 3, though the differential clinical sign would be the absence of lid retraction.[8] Bosley-Salih-Alorainy syndrome, or Athabascan brainstem dysgenesis syndrome, may also be a differential diagnosis as a comparable congenital horizontal ocular motility abnormality, though these patients do not have scoliosis and usually have associated bilateral deafness, cardiovascular and cerebrovascular malformations.[1,2] Horizontal gaze restriction has also been described in Moebius syndrome, though this is usually associated with facial weakness.[2]

Few of these cases have been followed up long-term; two described cases of HGPPS in older patients. A 17-year-old Iranian female presented for scoliosis surgery as did a 22-year-old female from Turkey.[12,17] The 22-year-old had developmental delay, though it was unclear whether this was related to her being from a consanguineous pedigree. Patients with developmental delay were also described in other cases though there appeared no consistent pattern, so it is difficult to conclude that this is a distinct sign of HGPPS.[3,4,8,9,12]

It is of interest to look towards the future and the effect HGPPS may have on our two brothers. Older adults have been described. One 55-year-old from India, from a consanguineous pedigree, with HGPPS who presented with stroke, was diagnosed with ischaemic heart disease and given appropriate cardiac medication.[15] A 55-year-old female from Japan with HGPPS presented with a history of acute left hemiparesis. Computerised axial tomography (CT) and MRI were performed and showed a left putaminal haemorrhage and brain stem hypoplasia with uncrossed corticospinal tracts.[16] It is unclear if these cerebral vascular events had any relation to HGPPS or the ROBO3 mutation.

CONCLUSION

It has become clear that horizontal gaze palsy with progressive scoliosis may present with many different ophthalmic signs, possibly due to different nucleotide mutations. These two boys of Chinese descent are the first reported cases in Australia and can be added to the growing list of documented cases.

REFERENCES

1. Abu-Amero KK, al Dhalaan H, al Zayed Z, et al. Five new consanguineous families with horizontal gaze palsy and progressive scoliosis and novel ROBO3 mutations. J Neurol Sci 2009;276(1-2):22-26.
2. Abu-Amero KK, Faletra F, Gasparini P, et al. Horizontal gaze palsy and progressive scoliosis without ROBO3 mutations. Ophthalmic Genet 2011;32(4):212-6.
3. Abu-Amero KK, Kapoor S, Hellani A, et al. Horizontal gaze palsy and progressive scoliosis due to a deleterious mutation in ROBO3. Ophthalmic Genet 2011;32(4):231-236.
4. Chan WM, Traboulsi EI, Arthur B, et al. Horizontal gaze palsy with progressive scoliosis can result from compound heterozygous mutations in ROBO3. J Med Genet 2006;43(3):e11.
5. Handor H, Laghmari M, Hafidi Z, Daoudi R. Horizontal gaze palsy with progressive scoliosis in a Moroccan family. Orthop Traumatol Surg Res 2014;100(2):255-257.
6. Mendes Marques NB, Barros SR, Miranda AF, et al. Horizontal gaze palsy and progressive scoliosis with ROBO 3 mutations in patients from Cape Verde. J Neuroophthalmol 2017;37(2):162-165.
7. Samoladas EP, O'Dowd J, Cardoso-Almeida A, Demetriades AK. Horizontal gaze palsy and scoliosis: a case report and review of the literature. Hippokratia 2013;17(4):370-372.
8. Volk AE, Carter O, Fricke J, et al. Horizontal gaze palsy with progressive scoliosis: three novel ROBO3 mutations and descriptions of the phenotypes of four patients. Mol Vis 2011;17:1978-1986.
9. Bosley TM, Salih MA, Jen JC, et al. Neurologic features of horizontal gaze palsy and progressive scoliosis with mutations in ROBO3. Neurology 2005;64(7):1196-1203.
10. Dretakis EK, Kondoyannis PN. Congenital scoliosis associated with encephalopathy in five children of two families. J Bone Joint Surg Am 1974;56(8):1747-1750.
11. Sharpe JA, Silversides JL, Blair RD. c. Familial paralysis of horizontal gaze. Associated with pendular nystagmus, progressive scoliosis, and facial contraction with myokymia. Neurology 1975;25(11):1035-1040.
12. Bozdogan ST, Dinc E, Sari AA, et al. A novel mutation of ROBO3 in horizontal gaze palsy with progressive scoliosis. Ophthalmic Genet 2017;38(3):284-285.
13. Bakbak B, Kansu T. Infantile esotropia with cross-fixation, inability to abduct, and underlying horizontal gaze palsy with progressive scoliosis. J AAPOS 2014;18(6):622.
14. Khan AO, Abu-Amero K. Infantile esotropia with cross-fixation, inability to abduct, and underlying horizontal gaze palsy with progressive scoliosis. J AAPOS 2014;18(4):389-391.
15. Ng AS, Sitoh YY, Zhao Y, et al. Ipsilateral stroke in a patient with horizontal gaze palsy with progressive scoliosis and a subcortical infarct. Stroke 2011;42(1):e1-3.
16. Yamada S, Okita Y, Shofuda T, et al. Ipsilateral hemiparesis caused by putaminal hemorrhage in a patient with horizontal gaze palsy with progressive scoliosis: a case report. BMC Neurol 2015;15:25.
17. Rohani M, Almasi M, Soltan Sanjari M. Familial horizontal gaze palsy with progressive scoliosis. Pediatr Neurol 2016;64:103-104.
18. Bae YJ, Kim JH, Choi BS, et al. Brainstem pathways for horizontal eye movement: pathologic correlation with MR imaging. Radiographics 2013;33(1):47-59.
19. Jen JC, Chan WM, Bosley TM, et al. Mutations in a human ROBO gene disrupt hindbrain axon pathway crossing and morphogenesis. Science 2004;304(5676):1509-1513.

Disparity between the Australian National Disability Insurance Scheme Access Requirements and the Needs of People with Vision Impairment

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ABSTRACT

When a person of any age has vision impairment the impact of this on their everyday life may be lessened with appropriate support. To ensure this support meets the person's needs it is essential that the criteria used to assess the person's vision impairment are valid and align with the nature of the support being offered. Australia's new National Disability Insurance Scheme (NDIS) relies on eligibility criteria known as access requirements that include two clinical vision measurements - visual acuity and visual fields. However, to align with the stated NDIS goals, these access requirements should also reveal the functional impact of the person's vision impairment. The disparity between the current access requirements for vision impairment and the intended NDIS goals, particularly those for children with vision impairment will be explored in this paper, including a comparison to existing global approaches and suggestions for future development.

Keywords: vision impairment, National Disability Insurance Scheme, eligibility criteria, functional vision

INTRODUCTION

Australia's new National Disability Insurance Scheme (NDIS) is a scheme that takes a lifetime approach, investing in people with disability early to improve their life outcomes.[1] The intent is to provide support funding for people with disability from birth to 65 years of age, including those people with vision impairment. The NDIS supports needs in accordance with realistic life goals, where this support is reasonable and necessary. This paper will explore the NDIS eligibility criteria (also known as access requirements), currently being applied when people with vision impairment wish to enter the scheme, and questions whether these requirements align with people's needs, particularly in the case of children. Other global approaches to vision impairment, such as those adopted by the World Health Organization (WHO) and by the United Kingdom (UK) and the United States of America (USA), will be compared to the approach taken by Australia. The need for further development of the NDIS access requirements to ensure better alignment with the stated NDIS goals, and to specifically meet the needs of children with vision impairment will be highlighted.

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National Disability Insurance Scheme

In response to longstanding scrutiny and criticism of existing disability support schemes, the NDIS became a reality for Australians with disability in 2012. The NDIS was described as a new way of providing community linking and individualised support for people with permanent and significant disability, their families and carers.[2] Through the NDIS, support for Australians with disability will be offered according to the impact of their impairment on their functional capacity.[3] This applies specifically when the impairment substantially reduces functional capacity and/or psychosocial functioning in communication, social interaction, learning, mobility, self-care and/or self-management.[4] The person's eligibility for entrance into the scheme will depend on meeting certain prescribed NDIS access requirements.[1]

NDIS access requirements for people with vision impairment

When applying for NDIS funding, people with vision impairment are required to provide information on their diagnosis, and evidence of the impact of their visual condition.[1] The National Disability Insurance Agency (NDIA), the new organisation responsible for implementing the NDIS, has stated that automatic entrance into the scheme is granted when the person has been assessed and diagnosed by an ophthalmologist as having permanent blindness[1] in both eyes, and when the following clinical standards are met:

1. Corrected visual acuity on the Snellen Scale that must be less than or equal to 6/60 in both eyes; or

2. Constriction to within 10 degrees or less of arc of central fixation in the better eye, irrespective of corrected visual acuity, ie visual fields reduced to a measured arc of 10 degrees or less; or

3. A combination of visual defects resulting in the same degree of visual impairment as that occurring in the above points.[1] It should be noted that the National Disability Insurance Agency (NDIA) has not provided further qualification regarding this combination.

Entry without further assessment is also granted by the NDIA when a person has dual sensory impairment or deafblindness that has been assessed as resulting in permanent and severe to total impairment of visual function and hearing, as determined by an ophthalmologist and an audiologist.[1] Again the NDIA has not provided specific clinical standards for vision or hearing in the case of dual sensory impairment. Certain people with vision impairment may not meet the NDIS access requirements outlined in points 1 to 3. For example, when a person has vision impairment within the range of 6/18 to better than 6/60, or when it is not possible to gain a definitive measure of visual acuity and visual fields because the person is limited in their capacity to participate in assessment; for example, when the person is a young child and/or has additional disabilities. When this occurs the NDIA states that the person's eligibility will be assessed using specialist evidence that details the impact of the condition on the person's life, including any impact on mobility, communication, social interaction, learning, self-care and self-management.[1] However, no further information on the requirements of this specialist evidence is currently available.

Concerns with the NDIS access requirements for vision impairment

The NDIS goal of aligning disability support funding with the impact of disability on the person's life[1] should be commended. However, it is reasonable to question whether this has been achieved in the current NDIS implementation. Several key concerns related to the access requirements have come to light, including whether these requirements actually reflect functional impact; whether these requirements can be successfully implemented across all age groups, especially in the case of children; and whether these requirements are judged acceptable by the people they are designed to support.

When the NDIS access requirements are explored, it is evident that there has been reliance on clinical measurements rather than measures of the functional impact of vision impairment. Communications with the NDIA revealed that the NDIS access requirements for vision impairment had originated from those used by the Department of Social Services (DSS), described in the Social Security Act 1991,[5] for the purposes of the Disability Support Pension (NDIA, personal communication, February 2017). These DSS criteria were limited to clinical measurements of vision.[5] No further information was forthcoming when Australian Government documents such as the NDIS Bill[3] and NDIS Act[4] were reviewed for information on the development and evaluation of the NDIS access requirements.

The current NDIS access requirements for vision impairment rely on visual acuity and visual fields. These clinical measurements are accepted as integral components of the ophthalmic examination[6,7] and are readily available for reporting purposes. However, Colenbrander[8] described the aim of such clinical measurements as elucidating the cause rather than predicating the impact of vision impairment. As such, the temptation to default to clinical measurements as evidence of the functional impact of vision impairment must be avoided. The application of clinical measurements has been criticised in the literature for failing to determine the functional impact of visual disability.[7,9,10] It is known that visual acuity and visual fields do not quantify functional vision,[7] nor do they adequately explain variations in everyday performance of people with vision impairment.[7]

There is no doubt regarding the relative ease that exists in applying the outcome of an adult eye examination to the current NDIS access requirements. However, in the case of children, it is perhaps erroneous to assume that clinical measurements will be readily available for NDIS application. Determining a child's clinical measurements may prove challenging, due to limitations imposed by the child's age, capacity to participate, and often the presence of accompanying disabilities.[11,12] Despite the best efforts of the clinician – usually an orthoptist – it may not be possible to reliably measure the child's visual acuity and visual fields. No advice is offered by the NDIA in this scenario, other than the application of 'specialist evidence', and as such, should be clarified.

It is also erroneous to assume that the current NDIS access requirements will align disability support funding with specific needs experienced by children when their vision impairment is congenital and/or early-onset in nature. Such needs are met by habilitation or the development of compensatory and visual efficiency skills that are unlikely to develop without support.[9] Some children may also need rehabilitation or the maintenance or relearning of skills already acquired prior to the onset of vision impairment.[9] The primary need for habilitation means the strategy for supporting children should not default to an adult-centric rehabilitation model, one that assumes a life of quality visual experiences prior to the onset of vision impairment. To be relevant, assessment must aim to capture the nature and impact of vision impairment on the developing child. A 'one size fits all' NDIS model for vision impairment is problematic for children.

It is vital that the NDIS access requirements are acceptable

to the people they are designed to support. The current NDIS access requirements describe a state of permanent blindness for a person with visual acuity of ≤ 6/60. However, this terminology and visual standard do not align with the descriptor or vision standard applied by the World Health Organization International Statistical Classification of Diseases and Related Health Problems version 10 (WHO ICD-10).[13] This NDIS standard assumes a state of sight or no sight, whereas people at this level of visual acuity are classified by the WHO ICD-10 as vision-impaired not blind. Further, it is generally accepted that a person with visual acuity of 6/60 is able to demonstrate a high level of functional visual capacity.[9] Hence, a cautious approach needs to be applied when using strong labelling such as permanently blind; such labelling can impact on the person's sense of self, and have societal and legal implications. Colenbrander[8] commented that a black and white dichotomy does not exist between those people with sight and those who are blind, so describing ≤ 6/60 as permanently blind is inappropriate, particularly by a disability support scheme.

Examining global approaches

To explore solutions to the concerns identified in relation to the NDIS access requirements, approaches adopted by other countries are worthy of review. Several countries have implemented systems that rely on eligibility criteria for disability support including the UK's Department of Health Certification of Vision Impairment (CVI)[14] and the Functional Vision Score (FVS)[6] prepared by the International Society for Low Vision Research and Rehabilitation[15] and implemented by the American Medical Association (AMA).

Both the CVI and FVS were examined for alignment with the NDIS goal of support for the functional impact of disability and approaches to eligibility criteria. Brief reference to non-clinical considerations appear in the CVI. Clinicians are advised when certifying a person with vision impairment that consideration should be given to how recently the person's vision had failed and how old the person was when this had happened, to include consideration of the potential difficulty of adaptation to recent visual loss and the general impact of advancing years.[14] However, no further instruction was provided on how this information should be applied to the certification process.

The FVS was described as a theoretical construct in which visual acuity and visual field measurements were translated to a single linear score.[16] This score was slightly modified when the person had other significant vision problems that were not reflected in their visual acuity and visual field measurements, such as glare.[15] The FVS was defined as a global ability estimate for the person, however the authors commented that a true assessment of a person's functional vision could only be determined by observing how the person performed in certain vision related activities.[15] Interestingly, the limited evaluative research available reporting on the application of the FVS showed strong alignment between self-reported, vision-targeted quality of life measures and the FVS, This was in contrast to the sole application of visual acuity and/or visual field measurements.[17] Despite this, Colenbrander[16] discouraged using a formula such as the FVS as a sole determinant for eligibility.

A comparison was made across the clinical standards used to define vision impairment by WHO ICD-10, NDIS and CVI. The FVS was not included in this comparison given that it produced an actual score without revealing comparable visual acuity and visual field standards. In defining vision impairment, the WHO ICD-10, NDIS and CVI all rely on visual acuity and visual fields as measures of impairment. However, alignment did not exist regarding the visual acuity standard nor the degree of visual field loss that qualified a certain level of vision impairment. For example, the CVI recognised a person as vision impaired with a combination of visual acuity of ≥ 6/18 with a gross visual field defect such as hemianopia,[14] whereas the WHO ICD-10 did not factor in visual field loss until a person had significantly reduced visual acuity of < 3/60 to ≥ 1/60, and visual field no greater than 10° in radius around central fixation.[13] The NDIS used a similar visual field standard but did not apply a visual acuity standard when the visual field was reduced to 10 degrees or less.[1]

A further disparity became apparent in the differing nomenclature used by the WHO ICD-10, NDIS, CVI and FVS when describing the degree of vision impairment. For example, the NDIS access requirements referred only to permanent blindness,[1] whereas the WHO ICD-10 referred to a range from mild vision impairment to blindness,[13] and the CVI described a person as either sight impaired or severely sight impaired.[14] Interestingly, the CVI also made reference to the impact of media opacities and aphakia, while the others did not. The CVI was also unique in that people with longstanding visual field loss were not included, presumably because such people were thought to have adapted to, and thus have compensated for, their visual field loss.[14] The FVS recommended ranges of deficit from mild to total deficit that could be applied to visual acuity and/or visual fields.[16]

All approaches were examined for alignment with the specific needs of children. Reference to children was made within the CVI, with the advice that children with congenital abnormalities causing vision defects should be certified as sight-impaired unless they were obviously severely sight-impaired.[14] However, no recommendation was made regarding visual acuity or visual field standards. The authors of the FVS clearly stated that the FVS was directed at adults with acquired vision loss, rather than children, and noted that any system that relied heavily on visual acuity and visual fields would be difficult to apply to children, unless the child had been able to fully participate in vision assessment.[16]

DISCUSSION

It is reasonable for people with vision impairment to assume that the criteria used to judge their eligibility for NDIS disability support are valid. To be valid, these criteria must be tailored to measure what they are intended to measure, that is, the impact of vision impairment on each individual's functional capacity.[1] Without an assurance that this impact is being measured, how can people with vision impairment be confident that NDIS support will align with their specific goals and needs? Further, the areas of uncertainty pertaining to the NDIS access requirements identified in this paper need to be clarified for the sake of all persons with vision impairment, and particularly for children and those professionals supporting them.

It is tempting to be critical of the NDIS access requirements for vision impairment. However, examination of approaches from WHO, the UK and the USA has shown that defining suitable eligibility criteria is not an easy task, and hence a reason why globally-ratified criteria are not currently available. This comparison has identified that a current global variation exists, that these approaches are not revealing the true functional impact of vision impairment on the person, nor can they be suitably applied to childhood vision impairment. Clearly, for Australia this is problematic given the aim of the NDIS is to support all people up to the age of 65 years to meet their life goals despite the impact of their vision impairment.[3]

In the event that it is possible to re-evaluate the NDIS access requirements for vision impairment, two recommendations are offered: that additional measures of visual function are included, and that the specific needs of children are considered.

To capture the true nature of a person's vision, assessment of their visual function should be broad. The NDIS access requirements, the WHO ICD-10 and the CVI include two visual measures, visual acuity and visual fields, but exclude additional measures that contribute to the broad understanding of the person's vision. One such measure that warrants inclusion is near vision. Without knowledge of a person's near vision, information is lacking regarding their potential for reading and near tasks, and the functional impact of vision impairment on these activities.[6,16,18] Other measures that should be considered include contrast sensitivity[18,19,20] colour vision testing and assessment for eye movement disorders.[6,18]

The International Council of Ophthalmology (ICO) has recently made recommendations for the revision of the WHO ICD-10. Within the new WHO ICD-11[16] due to be released in 2018, the ICO has included sub-categories for visual disability that include near vision; specific visual dysfunctions such as spatial neglect and agnosias; complex vision-related dysfunctions such as reading and orientation and mobility difficulties; the effects of non-visual disabilities such as dual sensory impairment; and the visual interactions from cerebral vision impairment, acquired brain injury and stroke.[16] These new ICD-11 subcategories are significant additions. These may be readily applied to childhood vision impairment and contribute to professionals achieving the broad but personalised assessment of visual function that is needed in the case of the NDIS.

Another measure that could support a comprehensive understanding of the functional impact of vision impairment is the Functional Vision Questionnaire for Children and Young people with Visual Impairment.[21] Although the development of this questionnaire is still in preliminary stages, the authors report that as a tool, it will allow a broader understanding of the impact of living with childhood vision impairment. Perhaps such a questionnaire should be included in the NDIS access requirements for childhood vision impairment.

In reconceptualising NDIS access requirements for vision impairment, the disability paradigm defined within the WHO International Classification of Function (ICF) could be considered. The ICF employs a biopsychosocial model of disability to represent disability as an outcome of interaction between health conditions and contextual factors, including environmental and personal factors.[22] The ICF is an approach that highlights the functional impact of disability,[22] and can be applied to children, adolescents and adults.

Regardless of the approach taken, re-evaluation of the NDIS access requirements for vision impairment should be considered. The next step should ensure that consultation represents all age groups affected by vision impairment, their families and those professionals who support them.

CONCLUSION

The Australian Government has shown commitment to disability support and willingness to engage with the disability sector through the recent implementation of the NDIS. However, disparity exists between the current NDIS access requirements and the functional abilities and needs of Australians with vision impairment. The NDIS access requirements must be revisited and clarified. Further, there is an urgent need to redefine the NDIS access requirements for childhood vision impairment. The issues raised, and the recommendations made in this paper, may provide a catalyst for discussions that begin to address these concerns.

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REFERENCES

1. National Disability Insurance Agency. National Disability Insurance Scheme [Cited 2017 1st Jul] Available from: http://www.ndis.gov.au/index.html.
2. Commonwealth of Australia. DisabilityCare Australia; May 2013 [Cited 2017 1st Jul] Available from: http://www.budget.gov.au/2013-14/content/glossy/NDIS_policy/download/NDIS.pdf.
3. Australian Government. National Disability Insurance Scheme Bill 2013. [Cited 2017 1st Aug] Available from: http://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r4946.
4. Australian Government. National Disability Insurance Scheme Act 2013. [Cited 2017 1st Aug] Available from: https://www.legislation.gov.au/Details/C2013A00020.
5. Australian Government Department of Social Services. Social Security (Disability Support Pension) FaHCSIA Determinations 2014. [Cited 2017 1st Aug] Available from: https://www.dss.gov.au/about-the-department/policies-legislation/legislation/social-security-disability-support-pension-fahcsia-determinations.
6. Blais BR. AMA Guides to the Evaluation of Ophthalmic Impairment and Disability: Measuring the Impact of Visual Impairment on Activities of Daily Life. Chicago: American Medical Association; 2011.
7. Colenbrander A. Causes vs consequences of functional loss, 2010. [Cited 2017 1st Aug] Available from: http://www.icoph.org/dynamic/attachments/resources/icd_11_causes_vs_consequences.pdf.
8. Colenbrander A. Aspects of vision loss – visual functions and functional vision. Vis Impair Res 2003;5(3):115-136.
9. Corn AL, Lusk KE. Perspectives on low vision. In: Corn AL, Erin JN, editors. Foundations of Low Vision: Clinical and Functional Perspectives, 2nd Ed. New York: AFB Press; 2010. p. 3-34.
10. Dawson N, Fitzmaurice K. Are clinical measures good indicators of performance of daily activities in vision-impaired children? Aust Orthopt J 2008;40(1):21-25.
11. Lueder GT. Pediatric Practice Ophthalmology. New York: McGraw Hill Medical; 2010.
12. Jones MM, Silveira SL, Martin FJ. Childhood blindness and low vision. In: Wright KW, Strube Y, editors. Pediatric Ophthalmology and Strabismus, 3rd Ed. Oxford: Oxford University Press; 2012. P. 10-15.
13. World Health Organization. International Statistical Classification of Disease and Related Health Problems ICD-10 2010. [Cited 2017 1st Aug] Available from: http://www.who.int/classifications/icd/en/.
14. United Kingdom Government Department of Health. Certificate of Vision Impairment; explanatory notes for consultant ophthalmologists, 2013. [Cited 2017 1st Aug] Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/213286/CVI-Explanatory-notes-in-DH-template.pdf.
15. International Society for Low Vision Research and Rehabilitation. Guide for the Evaluation of Visual Impairment. International Low Vision Conference VISION-99; San Francisco; 1999. [Cited 2017 1st August] Available from: http://pp.centramerica.com/pp/bancofotos/328-6099.pdf.
16. The Smith-Kettlewell Eye Research Institute. Classification and Coding Projects 2015. [Cited 2017 1st Aug] Available from: http://www.ski.org/project/classification-and-coding-projects.
17. Fuhr P, Holmes L, Fletcher D, Kuyk T. The AMA Guides functional vision score is a better predictor of vision-targeted quality of life than traditional measures of visual acuity or visual field extent. Vis Impair Res 2009;5(3):137-146.
18. Flom R. Visual functions as components of functional vision. In: Lueck AH, editor. Functional Vision: A Practitioner's Guide to Evaluation and Intervention. New York: AFB Press; 2004. p. 25-59.
19. Scheiman M, Scheiman M, Whittaker S. Low Vision Rehabilitation: A Practical Guide for Occupational Therapists. New Jersey: Slack Incorporated; 2007.
20. Wilkinson ME. Clinical low vision services. In: Corn AL, Erin JN, editors. Foundations of Low Vision: Clinical and Functional Perspectives, 2nd Ed. New York: AFB Press; 2010. p. 238-295.
21. Tadic V, Cooper A, Cumberland P, et al. Measuring the quality of life of visually impaired children: first stage psychometric evaluation of the novel VQoL_CYP instrument. PLoS One doi: 10.1371/journal.pone.0146225.
22. World Health Organization. International Classification of Functioning, Disability and Health (ICF) 2002. [Cited 2017 1st Aug] Available from: http://www.who.int/classifications/icf/en/.

The Impact of Reduced Vision on Falls for Community-Dwelling Older People: A Literature Review

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ABSTRACT

Aim: To explore detailed studies and reveal the complex relationships between the elements of vision and falls risk for community-dwelling older people.

Method: A thematic literature review was conducted of detailed studies published in a 10-year period and their direct references that reported on reduced vision as a risk factor for falls for community-dwelling older people.

Results: Seven publications were analysed based on the elements of vision they reported, including visual acuity, contrast sensitivity including low contrast visual acuity, depth perception and visual field. The literature suggests that contrast sensitivity including low contrast visual acuity is more informative regarding falls risk in this population, than the other elements of vision.

Conclusion: The relationship between reduced vision and falls for community-dwelling older people is an important and complex one. The lack of standard methods of assessing vision in falls research creates an opportunity to further explore vision as a risk factor for falls in this group.

Keywords: vision, falls, community-dewlling, older people

INTRODUCTION

Falls are a major health issue and the main reason for trauma related hospital admission in people aged 65 years and older.[1,2] Each year, between 30 and 44 percent of older people living in the community experience a fall,[3,4] and the consequences are costly. In 2001, the estimated total health cost of fall-related injuries in Australia was reported to be $500 million; a cost projected to reach approximately $1,375 million by the year 2051 if no further action is taken to prevent falls in older age.[5]

Falls in older people are multifactorial, resulting from the interaction between risk factors specific to the faller and the faller's environment. For older people, reduced vision has been reported in the literature to be a significant independent risk factor for falls in this population.[6] This literature review explores detailed studies of reduced vision (visual acuity, contrast sensitivity including low contrast visual acuity, depth perception and visual field) and reveals the complex relationships between reduced vision and falls risk for community-dwelling older people, defined as people who live at home or independently in a retirement village.

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BACKGROUND

A fall can be defined as 'an unexpected event in which the participant comes to rest on the ground, floor or lower level'.[7] Prevention of Falls Network Europe (ProFaNe) developed and recommended this definition due to the sizeable variation in definitions found in the studies reviewed by ProFaNe.[8] Consistent definitions are important for achieving consistent outcomes.

Recent Australian studies report that around 43 percent of older people living in the community (ie living at home or independently in a retirement village) have one or more falls each year.[3,7,9] Around 10 percent of older people fall at least once when in hospital,[10,11] and around 50 percent of older people living in residential aged care facilities fall at least once each year.[12,13]

For older people, risk factors for falling reported in the literature include advancing age, female gender, history of falls, medication use, medical conditions such as Parkinson's disease and stroke, reduced vision, impaired

gait, balance problems and hazards in the home, such as obstructed walkways, low bed height and upturned floor rug edges.[4,14-19,20,21] Also, the risk of falling is increased significantly when an older person has multiple risk factors compared to having no risk factors for falling (Chi-square = 62.7, P<0.001).[4]

The visual system plays an important role in keeping an older person on their feet. Along with other systems the visual system detects changes in balance.[22] Reduced vision that includes visual acuity, contrast sensitivity, depth perception and visual field, when reported in the literature is not always associated with falls in older people. The various elements of vision chosen to represent reduced vision and the different methods of measurement make it difficult to draw strong conclusions about the relationship between impaired vision and falls for older people.

Falls are costly to the individual, community and the health system. When community-dwelling older people experience a fall, the cost to the individual is often more than a financial one and this personal cost is an important factor to consider. The personal cost or consequences of falling for older people who live in the community are many, and include injury,[18,19,21,23-27] functional decline,[4,28] nursing home placement,[29] developing a fear of falling,[4,24,30] and in some cases death.[25,28,29]

To assist with effective falls prevention, falls risk assessment tools have been developed based on established risk factors. As multiple factors contribute to falls in older age, it is important to use a falls risk assessment tool which covers more than one risk factor for falling. Although the use of a single risk factor such as history of falls in the previous 12 months is a strong predictor of future falls,[31] this method is limited. Such a method of falls risk assessment does not allow for the investigation of additional risk factors, such as vision for example, which may be modifiable and therefore lead to the prevention of future falls. The aim of this literature review was to explore detailed studies and reveal the complex relationships between the elements of vision and falls risk for community-dwelling older people.

METHOD

A thematic literature review was conducted of detailed studies published in a period of 10 years and their direct references that reported on reduced vision as a risk factor for falls in older people. Limited to publications that featured the complex relationship between vision and falls risk in older people living in the community, seven publications were chosen for this review, the details of which are summarised in Tables 1, 2 and 3.

OUTCOMES

Visual acuity

Visual acuity allows for the appreciation of fin detail in daily activities. De Boer et al[32] included reduced visual acuity as a risk factor for falls in a prospective cohort study of 1,509 older adults (55-85 years of age). Participants were asked to record all falls over a 3-year period. In this study a fall was defined as an unintentional change in position resulting in coming to rest at a lower level or on the ground. The authors measured visual acuity using a non-quantitative method of a self-report of the ability to recognise faces at 4 metres with their glasses (Table 1). The authors reported that at the vision level of 'much difficulty or can't see' there was no association with

Table 1. Visual acuity and falls

Element of visual function	Method of assessment (both eyes open)	Level of visual impairment	Risk or Ratio (95% CI)	Faller type	Author
Visual acuity	Self-report of ability to recognise faces at 4 metres with own glasses	Much difficulty or can't see	Age-adjusted HR 1.45 (0.97-2.15) Not associated	Recurrent fallers	de Boer et al 2004[32] (3-year follow-up period)
	Retro illuminated Snellen chart at 6 metres with own glasses	6/12 or worse	Age-adjusted RR 1.3 (0.8-2.2) females RR 1.3 (0.6-2.8) males Not associated	Faller	Campbell et al 1989[14] (1-year follow-up period)
	Retro illuminated Early Treatment of Diabetic Retinopathy (ETDRS) chart	Per line missed	Age-adjusted OR 1.01 (0.98-1.05) Not associated	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Snellen style chart with own glasses	6/9 or worse	Age/sex-adjusted PR 2.1 (1.3-3.4) Significant association	Recurrent fallers	Ivers et al 1998[33] Retrospective (previous 12 months)
	Snellen style chart at 4 metres with own glasses	6/10 or worse	Age-adjusted RR 1.59 (0.85-2.98) Not associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Corrected visual acuity details described elsewhere	6/15 or worse	Unadjusted RR 1.5 (1.2-2.1) Associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)
	Self-report of ability to read small print in the newspaper	Much difficulty or can't see	Age-adjusted HR 1.20 (0.89-1.62) Not associated	Recurrent fallers	de Boer et al 2004[32] (3-year follow-up period)

HR hazard risk, RR relative risk, PR prevalence ratio, OR odds ratio. Faller ≥ 1 fall, Recurrent faller ≥ 2 falls. p<0.05 signifies statistical significance

falls (age-adjusted hazard risk 1.45, 95% CI 0.97-2.15).[32]

Campbell et al[14] included reduced visual acuity as a potential risk factor for falls, defined in the study as any accidental contact with the ground, in a sample of community-dwelling older people. The 12-month prospective study included 761 participants (465 females and 296 males) aged 70 years and older, with no mean age reported. Unlike de Boer et al[32] Campbell et al[14] used the 'gold standard' retro illuminated vision chart at 6 metres, the participants wore their best-corrected spectacles and their vision was tested with both eyes open. At the cut-off visual acuity level of 6/12 or worse, there was no association with falls in either female or male participants (Table 1). Lord and Dayhew[9] conducted a 12-month prospective falls risk study in a sample of 156 (99 females and 57 males) community-dwelling older people (mean age 76.5 years, standard deviation 5.1). A fall was defined in the study as any event which resulted in unintentional contact with the ground excluding major events such as stroke. At the cut-off visual acuity level of 6/10 or worse, Lord and Dayhew[9] also reported that there was no association with falls in their study (relative risk 1.59, 95% CI 0.85-2.98) (Table 1). Unlike Campbell et al,[14] Lord and Dayhew[9] excluded some fall types. Although both studies reported no association between reduced visual acuity and falls, having inconsistent definitions across studies makes comparisons difficult.

More recently, Freeman et al[15] included reduced visual acuity as a potential risk factor for falls defined in the study as unintentionally coming to rest on the ground or other level. The 2,375 participants were aged 65 years and over were followed up for 20 months in a prospective falls risk study. Neither the proportion of females and males, nor the mean age were reported. Similar to Campbell et al,[14] Freeman et al[15] also used a retro illuminated vision chart. At the visual acuity level of 'number of lines missed on the vision chart', there was no association with falls (age-adjusted odds ratio 1.01, 95% CI 0.98-1.05) (Table 1). Importantly, Freeman et al[15] used a similar definition of a fall to that used by Campbell et al,[14] strengthening the findings as it is likely that the two studies were measuring a similar outcome. Despite the similar definition of a fall being used, the time-period over which the data was collected was not; Freeman et al[15] 20 months and Campbell et al[14] 12 months. Differences in methods used across studies also make comparisons difficult.

In a prospective falls study by Nevitt et al,[18] 325 community-dwelling older people (266 females and 59 males) were followed up for 12 months. Participants were aged 60 years and over with most (43%) aged between 70 and 79 years of age. A fall was defined in the study as a fall resulting in contact with the floor or a chair or other lower object like a stair. 'Near falls' where the participants caught themselves before landing on the floor, or falls caused by major events such as being hit by a vehicle, were excluded. Reduced visual acuity was associated with an increased risk of multiple falls when the visual acuity was 6/15 or worse (unadjusted for age: relative risk 1.5, 95% CI 1.2-2.1) (Table 1). This result suggests that the level of visual acuity associated with an increased risk of falls may in fact be worse than suggested by Lord and Dayhew (6/10 or worse) who used a similar definition of a fall, although this association may have been lost when age-adjusted.

The Blue Mountains Eye Study conducted by Ivers et al[33] is a population-based survey with retrospective falls collection, in which 4,433 eligible residents took part. The participants were aged 49 years and over (35% aged 60 to 69 years) and 1,877 were female.[33] The authors of this study reported that visual acuity of 6/9 or worse was significantly associated with recurrent falls, defined as any fall which resulted in landing on the ground or on the floor.[33] Only limited details of the method of testing visual acuity were included in the publication making it unclear if the gold standard method was used (Table 1). Also, the retrospective recall of falls data may have led to a misreporting of falls and therefore an underestimation or overestimation of the association between visual acuity and falls in their study.

Contrast sensitivity

Unlike visual acuity which allows for the appreciation of fine detail, contrast sensitivity assists a person to safely mobilise. Contrast sensitivity is the ability to distinguish between an object and its background. It allows a person to negotiate kerbs and uneven foot paths by allowing them to detect the difference in surface positions when the contrast is low; that is, when one surface is similar in shade to the other.

De Boer et al,[32] Ivers et al[33] and Lord and Dayhew[9] reported that reduced contrast sensitivity at low levels of contrast, was significantly associated with an increased risk of falling (Table 2). Contrast sensitivity was measured in these three studies using similar methods and these methods required the participant to identify the orientation of a single line or set of lines at different levels of contrast.

Freeman et al[15] also included contrast sensitivity as a risk factor for falls and reported that at low levels of contrast it was not associated with an increased risk of falls (Table 2). The authors used a Pelli-Robson chart to measure contrast sensitivity, which unlike the method

used by the authors mentioned above, required the participant to identify same size letters at decreasing levels of contrast. There is no research evidence showing measures of contrast sensitivity using the Pelli-Robson test are equivalent to measures using the line orientation style test. As the population studied by Freeman et al[15] was similar to that studied by the authors previously mentioned, the difference in method may explain the difference in results, highlighting the importance of using standard methods of assessment.

Lord and Dayhew[9] reported that reduced low contrast visual acuity using a vision chart where the letters are of 10% contrast which is very close in shade to the background (Figure 1), had a strong association with multiple falls (relative risk 2.08, 95% CI 1.17-3.71, at 6/18 or worse) in their study (Table 2). This level of association was similar to that reported between reduced contrast sensitivity and multiple falls in the same study (relative risk 1.93, 95% CI 1.01-3.68, at ≤ 6/18 decibels of contrast sensitivity) (Table 2). It is then likely that these two tests are measuring the same thing.

Lord and Dayhew[9] also reported that reduced low contrast visual acuity was associated with multiple falls in their study and that reduced visual acuity was not (relative risk 1.59, 95% CI 0.85-2.98 at 6/10 or worse) (Table 1), suggesting that having good contrast sensitivity may be more important than having good visual acuity in preventing falls in older people. As the cut-off for visual acuity as a risk factor for falls in the low contrast visual acuity test was different than that of the visual acuity test in this study, it is unclear if the reported association between low contrast visual acuity and falls, is due to the use of the low contrast visual acuity test or the cut-off levels.

Tiedemann et al[34] included low contrast visual acuity in the development and validation study of the QuickScreen© falls risk assessment tool. The QuickScreen© is one of a few falls risk assessment tools that includes an assessment of vision, an important risk factor for falls in older people not routinely or properly assessed. The authors conducted a study on four large cohorts (three falls risk studies and one falls prevention study) of community-dwelling older people aged 65 years and over. In all four studies the participants reported the number of falls over a period of 12 months and the definition of a fall in the study was similar to that used by Lord and Dayhew[9] and Nevitt et al,[18] excluding some fall types.

Tiedemann et al[34] used the same low contrast visual acuity chart as Lord and Dayhew[9] where the letters are of 10% contrast and very close in shade to the background (Figure 1). The authors reported that this measure of vision was associated with multiple falls at a cut-off of 2.3

Table 2. Contrast sensitivity, depth perception and falls

Elements of visual function	Method of assessment (both eyes open)	Definition of visual impairment	Risk or Ratio (95% CI)	Faller type	Author
Contrast sensitivity	VCTS-6000-1 chart for near	Impaired at low level frequencies	Age-adjusted HR 1.75 (1.17-2.60) Significant association	Recurrent fallers	de Boer et al 2004[32] (3-year follow-up period)
	Pelli-Robson Chart	At 0.3 log unit correct	Age-adjusted OR 0.96 (0.86-1.07) Not associated	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Vectorvision CSV-1000 chart	At 6 cycles per degree	Age/sex-adjusted PR 1.2 (1.1-1.3) Significant association	Recurrent fallers	Ivers et al 1998[33] Retrospective (1-year follow-up period)
	Not described	Not described	No details Not associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)
	Melbourne Edge Test (distance)	≤ 18 decibels contrast sensitivity	Age-adjusted RR 1.93 (1.01-3.68) Significant association	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Low contrast visual acuity (visual acuity at 10% contrast)	6/18 or worse	Age-adjusted RR 2.08 (1.17-3.71) Associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Low contrast visual acuity (visual acuity at 10% contrast)	2.3 MAR Between 6/12 and 6/15	Age-adjusted RR 1.64 (1.21-2.21) Significant association	Recurrent fallers	Tiedemann et al 2010[34] (1-year follow-up period)
Depth perception	Howard-Dohlman apparatus	≥ 2.4 cm	Age-adjusted RR 2.26 (1.24-4.14) Associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Randot Circles test	> 457 seconds of arc (no depth perception)	Age-adjusted OR 1.10 (0.94-1.28) Not associated	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Described elsewhere	≥ 200 seconds of arc at 40 cms	Unadjusted RR 1.6 (1.2-2.6) Associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)

HR hazard risk, RR relative risk, PR prevalence ratio, OR odds ratio, MAR minimum angle resolution. Recurrent faller ≥ 2 falls. p<0.05 signifies statistical significance

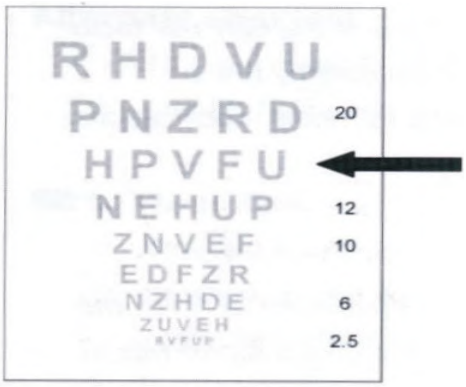

Figure 1. Balance systems low contrast (10%) acuity chart© (sample only). Reprinted from QuickScreen© by the Prince of Wales Medical Research Institute (POWMRI) 2007, p 10. Copyright 2007 by NeuRA. Reprinted with permission.

MAR (relative risk 1.64, 95% CI 1.21-2.21) (Table 2). Although statistically significant, the association was not as strong as reported by Lord and Dayhew[9] in their study.

Depth perception

Like contrast sensitivity, depth perception is another important element of vision which assists a person to safely mobilise as it allows a person to judge distances, and safely negotiate stairs and uneven walking surfaces.[6] Depth perception as a risk factor for falls was included in studies by Freeman et al,[15] Lord and Dayhew[9] and Nevitt et al.[18] Freeman et al[15] reported that reduced depth perception was not associated with falls in their study, which is inconsistent with the findings reported by Lord and Dayhew[9] and Nevitt et al[18] (Table 2). As the sampled populations were quite similar, this inconsistency may be due to the use of the Randot Circles test by Freeman et al.[15] This test has been reported to yield a high number of false negatives and may have misrepresented the association between depth perception and falls.[15] Despite the variation in method of assessment, older people who have reduced contrast sensitivity and depth perception have almost twice the risk of falling than those with less or no visual deficits (Table 2). These two elements of vision, when reduced, appear to be more useful indicators of falls risk than visual acuity for this population.

Visual fields

Visual field loss, as detected by either a full visual field assessment or a screening is not often considered as a potential risk factor for falls in older people. Nevitt et al[18] reported no association between visual field loss and falls in their sample, with the type of visual field loss not being detailed. Lord and Dayhew[9] also reported no association between visual field loss and falls in their sample, when measuring lower visual field. The method used by Nevitt et al[18] was detailed elsewhere and the method used by Lord and Dayhew[9] was a non-standard method of visual field assessment; that is, not translatable to usual measurement systems. Ivers et al[33] did use a standard method of visual field assessment (Table 3) and reported that the people in their study with central visual field loss were one-and-a-half times more likely to fall in a 12-month period than those with a normal central visual field. Also, in this particular study, central visual field loss was a stronger indicator of falls risk than reduced contrast sensitivity (Table 2).

Freeman et al[15] also used a standard method of visual field assessment (Table 3) and reported that visual field loss increases the risk of falls (odds ratio 1.08, 95% CI 1.03-1.13). Unlike the study by Ivers et al,[33] the falls data in the study by Freeman et al[15] was collected prospectively and the authors included measures of central, peripheral and total visual field. When Freeman et al[15] included central and peripheral visual field in a multiple regression model along with visual acuity, contrast sensitivity and depth perception, only peripheral visual field remained statistically significant, suggesting that peripheral visual field loss may be a more important risk factor for falls. These variations reinforce the need

Table 3. Visual field and falls

Element of visual function	Method of assessment	Level of visual impairment	Risk or Ratio (95% CI)	Faller type	Author
Visual field	Humphrey 81-point 60-degree screening each eye	At 10 points missing	Age-adjusted OR 1.08 (1.03-1.13) Significant association	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Humphrey 76 point 30-degree screening each eye	At 5 points missing	Age/sex-adjusted PR 1.5 (1.2-2.6) Significant association	Recurrent fallers	Ivers et al 1998[33] Retrospective (previous 12 months)
	Not described	Not described	No details Not associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)
	Binocular visual field angle from eye height to a target on the floor	≤ 60 degrees	Age-adjusted RR 1.25 (0.63-2.48) Not associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)

HR hazard risk, RR relative risk, PR prevalence ratio, OR odds ratio, MAR minimum angle resolution. Recurrent faller ≥ 2 falls. $p<0.05$ signifies statistical significance

for vision risk factors for falling to be investigated using detailed assessments with standard methods.

DISCUSSION

There is general agreement, that in comparison to other elements of vision, visual acuity is not a useful indicator of falls risk for community-dwelling older people.[9,14,15,32] Although Nevitt et al[18] reported that reduced visual acuity was associated with an increased falls risk in their study. Interestingly, it was at a more reduced level of visual acuity than usually seen in the literature.[9,14] Therefore, this finding is worthy of further investigation as visual acuity testing is often available in clinical settings.

Contrast sensitivity and low contrast visual acuity which are functionally similar elements of vision, are on the other hand consistently reported to be associated with an increased risk of falls in older people.[3,9,32,34] The ability to perceive depth, as with contrast sensitivity, assists with safe mobility. Therefore, the reported association between reduced depth perception and an increased risk of falls is understandable. In studies where findings have differed, the methods of measuring these elements of vision have also differed and perhaps explain the lack of association reported. Visual field is not commonly investigated as a risk factor in falls research.

When this element of vision has been included and tested using standard measures, the association between a reduced visual field and an increased risk of falls for community-dwelling older people is statistically significant[15,33] and a more useful indicator of falls risk than reduced contrast sensitivity and depth perception.[15,33]

CONCLUSION

The relationship between reduced vision and falls for community-dwelling older people is an important and complex one. Despite vision being an important risk factor for falls in older people it is not routinely or properly assessed. The elements of vision included in falls research include the well-known elements of visual acuity, contrast sensitivity, depth perception and visual field and more recently a less known element of low contrast visual acuity which combines visual acuity and contrast sensitivity.

The literature does suggest that although the elements of visual function such as depth perception and visual field are significant indicators of falls risk, contrast sensitivity including low contrast visual acuity is more informative regarding falls risk in this population. Despite this, the lack of standard methods of assessing vision in falls research offers the ongoing opportunity to further explore vision as a risk factor for falls for community-dwelling older people.

REFERENCES

1. Lord S, Sherrington C, Menz H, Close J. Epidemiology of falls and fall-related injuries. In: Falls in Older People 2nd Ed. New York: Cambridge University Press; 2007. p. 15.
2. Weir E, Culmer L. Fall Prevention in the elderly population. CMAJ 2004;171(7):724.
3. Delbaere K, Close JC, Heim J, et al. A multifactorial approach to understanding fall risk in older people. J Am Geriatr Soc 2010;58(9):1679-1685.
4. Tinetti ME, Speechley M, Ginter SG. Risk factors for falls among elderly persons living in the community. N Engl J Med 1988;319(26):1701-1707.
5. Australian Commission on Safety and Quality in Healthcare. Falls and falls injuries in Australia: Best practice guidelines for Australian hospitals 2009; 2009 [cited 2017 15th Mar] Available from: https://www.safetyandquality.gov.au/wp-content/uploads/2009/01/Guidelines-HOSP.pdf.
6. Lord SR. Visual risk factors for falls in older people. Age Ageing 2006;35-S2,ii42-ii45.
7. Callisaya ML, Buzzard L, Schmidt MD, et al. Gait, gait variability and the risk of multiple incident falls in older people: a population-based study. Age Ageing 2011;40(4):481-487.
8. Lamb SE, Jorstad-Stein EC, Hauer K, et al. Development of a common outcome data set for fall injury prevention trials: the prevention of falls network Europe consensus. J Am Geriatr Soc 2005;53(9):1618-1622.
9. Lord SR, Dayhew J. Visual risk factors for falls in older people. J Am Geriatr Soc 2001;49(5):508-515.
10. Cumming RG, Sherrington C, Lord SR, et al. Cluster randomised trial of a targeted multifactorial intervention to prevent falls among older people in hospital. BMJ 2008;336(7647):756-760.
11. Webster J, Courtney M, O'Rourke P, et al. Should elderly patients be screened for their 'falls risk'? Validity of the STRATIFY falls screening tool and predictors of falls in a large acute hospital. Age Ageing 2008;37(6):702-706.
12. Chen JS, March LM, Schwartz J, et al. A multivariate regression model predicts falls in residents living in intermediate hostel care. J Clin Epidemiol 2005;58(5):503-508.
13. Kerse N, Butler M, Robinson E, Todd M. Fall prevention in residential care: a cluster, randomized, controlled trial. J Am Geriatr Soc 2004;52(4):524-531.
14. Campbell AJ, Borrie MJ, Spears GF. Risk factors for falls in a community-based prospective study of people 70 years and older. J Gerontol 1989;44(4):M112-M117.
15. Freeman E, Muñoz B, Rubin G, West SK. Visual field loss increases the risk of falls in older adults: the Salisbury Eye Evaluation. Invest Ophthalmol Vis Sc 2007;48(10):4445-4450.
16. Letts L, Moreland J, Richardson J, et al. The physical environment as a fall risk factor in older adults: systematic review and meta-analysis of cross-sectional and cohort studies. Aust Occup Ther J 2010;57(1):51-64.
17. Lord SR, Clark D, Webster I. Physiological factors associated with falls in an elderly population. J Am Geriatr Soc 1991;39(12):1194-1200.
18. Nevitt MM, Cummings SR, Kidd S, Black D. Risk factors for recurrent nonsyncopal falls. JAMA 1989;261(18):2663-2668.
19. O'Loughlin JL, Robitaile Y, Boivin JF, Suissa S. Incidence of and the risk factors for falls and injurious falls among the community-dwelling elderly. Am J Epidemiol 1993;137(3):342-154.
20. Tromp AM, Pluijm SM, Smit JH, et al. Fall-risk screening test: a prospective study on predictors for falls for community-dwelling elderly. J Clin Epidemiol 2001;54(8):837-844.
21. Tromp AM, Smit JH, Deeg DJ, et al. Predictors for falls and fractures in the Longitudinal Aging Study Amsterdam. J Bone Miner Res 1998;13(12):1932-1939.

22. Harwood RH. Visual problems and falls. Age Ageing 2001;30(S4):13-18.
23. Berg WP, Alessio HM, Mills EM, Tong C. Circumstances and consequences of falls in independent community-dwelling older adults. Age Ageing 1997;26(4):261-268.
24. Boyd R, Stevens JA. Falls and fear of falling: burden, beliefs and behaviours. Age Ageing 2009;38(4):423-428.
25. Campbell AJ, Borrie MJ, Spears GF, et al. Circumstances and consequences of falls experienced by a community population 70 years and over during a prospective study. Age Ageing 1990;19(2):136-141.
26. Stevens JA, Sogolow ED. Gender differences for non-fatal unintentional falls related injuries among older adults. Inj Prev 2005;11(2):115-119.
27. Tinetti ME, Williams CS. The effects of falls and fall injuries on functioning for community-dwelling older persons. J Gerontol 1998;53A(2):M112-M119.
28. Dunn JE, Rudberg MA, Furner SE, Cassel CK. Mortality, disability and falls in older persons: the role of underlying disease and disability. Am J Public Health 1992;82(3):395-400.
29. Sattin RW, Lambert Huber DA, DeVito CA, et al. The incidence of fall injury events among the elderly in a defined population. Am J Epidemiol 1990;131(6):1028-1037.
30. Freidman SM, Muñoz B, West SK, et al. Falls and fear of falling: which comes first? A longitudinal prediction model suggests strategies for primary and secondary prevention, J Am Geriatr Soc 2002; 50(8):1329-1335.
31. Deandrea S, Lucenteforte E, Bravi F, et al. Risk factors for falls for community-dwelling older people a systematic review and meta-analysis. Epidemiology 2010;21(5):658-668.
32. de Boer MR, Pluijm SM, Lips P, et al. Different aspects of visual impairment as risk factors for falls and fractures in older men and women. J Bone Miner Res 2004;19 (9):1539-1547.
33. Ivers RQ, Cumming RG, Mitchell P, Attebo K. Visual impairment and falls in older adults: the Blue Mountains Eye Study. J Am Geriatr Soc 1998;46(1):58-64.
34. Tiedemann A, Lord S, Sherrington C. The development and validation of a brief performance-based fall risk assessment tool for use in primary care. J Gerontol 2010;65(8):896-903.

Orthoptics and Orthoptists: The War Years 1939 - 1945

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ABSTRACT

Accurate depth perception was necessary for Royal Australian Air Force (RAAF) pilots during World War II (WWII) to land aircraft safely without the aid of instruments. In the inter-war period aviation ophthalmologists had identified a relationship between heterophorias and inaccurate stereopsis. As a result, the ocular motility standards for trainee aircrew in WWII were strict and failure to meet the standards could result in rejection for flying duties. Orthoptists were called on to test trainees' ocular motility status and, in borderline cases, provide treatment.

By 1939 there were fewer than 20 qualified orthoptists in Australia. This small number was unable to meet the needs of the RAAF while also serving the civilian population. Consequently in 1940 the RAAF Air Board decreed that a small number of RAAF Nursing Service (RAAFNS) and Women's Auxiliary Australian Air Force (WAAAF) personnel would receive basic orthoptic training to fill the gap. An unknown number of these Service women delivered orthoptic treatment to trainee aircrew, under the supervision of ophthalmologists and orthoptists.

Little is known about the orthoptists' role with the RAAF. Even less is known about the role of the RAAFNSs and WAAAFs. This paper discusses the qualified civilian orthoptists, and their military counterparts, who have come to light so far in my research. I also discuss their work. I argue that the orthoptists' contribution and the place of orthoptics in aviation medicine, in particular the management of heterophorias, was the springboard for the growth of orthoptics in the post-war period.

Keywords: orthoptics, aviation medicine, RAAF, heterophoria, stereopsis

INTRODUCTION

On 13 January 1939 Victoria suffered the worst bushfires in living memory. Seventy-one lives were lost, townships were destroyed and millions of acres of farmland torched in what has come to be known as the Black Friday fires. Perhaps this catastrophic event was a sign of what was to come. Rumblings about a possible European conflict had been going on for months – war seemed inevitable. When Germany invaded Poland in September 1939 England declared war on Germany. Australia followed suit. Australia's decision to go to war was 'automatic', automatic to a large extent because of our British cultural heritage.

In many fields of endeavour Australia followed England as was the case with orthoptics which had its genesis in England in the mid-1920s. By the outbreak of war orthoptic practice in both countries was similar. Australian orthoptists were skilled in the same testing procedures and treatment techniques as the British orthoptists and several Australians had travelled to England for their orthoptic training. The Australian training course, albeit in its infancy in 1939, was based on the English model. When war broke out British orthoptists became immediately involved in aviation medicine. They were called on in numbers to assess and treat heterophorias, which had been associated with inaccurate aircraft landings – a particular problem for young trainee aircrew. Australian orthoptists were also involved in aviation medicine, but their roles differed from their British counterparts as did the manner in which orthoptics was delivered.

This is an account of Australian orthoptics during World War II (WWII) and its place in aviation and military medicine. Problems associated with ocular muscle imbalance were not considered as important in the army so will not be dealt with in detail in this paper. However, it is interesting to note that later in the war some army service men began complaining of general ocular symptoms. As a result, ophthalmologist Major Bruce Hamilton conducted a study of 3,285 enlisted men and found that 18.2 percent showed some degree of ocular muscle problems. Because orthoptic services were not available in the army these men were referred to orthoptists in the capital cities, or were treated

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in the RAAF orthoptic clinics. Hamilton reported that in the majority of cases referred for ocular muscle imbalance, orthoptic treatment was successful.[1]

There is a dearth of literature and material pertaining to Australian orthoptic involvement in Australian aviation medical history. Consequently, this largely untold story has been pieced together from a variety of primary sources: scientific ophthalmic and orthoptic papers; newspaper articles; Royal Australian Air Force (RAAF) records. It is acknowledged that what these sources reveal is limited. It is also acknowledged that neither the voices of the qualified orthoptists who worked for the RAAF nor those who continued to work with the civilian population are not heard. The other unheard voices are those in the Royal Australian Air Force Nursing Service (RAAFNS) and the Women's Auxiliary Australian Air Force (WAAAF) who performed the bulk of orthoptic work in the RAAF. This paper concludes with evaluating the role of orthoptics during the war period and contributes to our understanding of the development of the fledgling practice of Australian orthoptics and the influence this period had for the following two to three decades.

What orthoptic historiography reveals

In the mid-1960s orthoptists' role in aviation medicine was mentioned in passing in the orthoptic scientific literature. The very name of the RAF Gauge, hints at its origins. The effect of ocular muscle imbalance on the accuracy of depth perception was known but it was not realised this association had its roots in aviation medicine. It was known that Australian orthoptists had played a role as employed civilians as opposed to service personnel during WWII so when searching for an historical account of their contribution it was surprising that the literature, including the orthoptic literature, is largely silent about this period of Australian orthoptic history.

The original intent of my research was to present a history of the role Australian orthoptists played in WWII. During the research, however, it became clear it was impossible to understand this period without also exploring the role of ophthalmologists and of a small group of RAAF nurses and WAAAF who had received basic orthoptic training specifically to provide orthoptics to the RAAF trainees. Ophthalmologists drove the inclusion of orthoptics as an integral part of selection criteria for RAAF personnel. To me it was a surprise that it was WAAAFs and RAAF nurses, who received some basic orthoptic skills training, not qualified orthoptists, who carried out the bulk of the orthoptic work. After an exhaustive search of Australian and international orthoptic and ophthalmic literature, and general historical databases only four historical accounts of Australian orthoptics during WWII were found. Using the word 'account' may suggest a detailed exposé – not so. Each was a simple narrative stating the most minimal details of orthoptic service and praising its valuable contribution to aviation medicine.

Immediately post-war Air Vice Marshall Philip Livingston, a Canadian born British ophthalmologist, addressed the annual scientific meeting of the Ophthalmological Society of Australia held in Melbourne.[2] He outlined a history of the role of ocular muscle imbalance and its influence on trainee pilots' ability to learn to fly in both WWI and WWII. While conceding that rigorous statistical analysis to determine the acceptable limits of ocular muscle imbalance was still required, he strongly held that there was little doubt 'as to the value of orthoptic treatment in the service'.[3] The next historical note is a sentence in orthoptist, Patricia Lance's presidential address of 1954, which states 'During the war years, Miss Russell, Mrs D'Ombrain and others worked as civilians with the Royal Australian Air Force at Bradfield Park Air Force Station [NSW] under Dr Hazelton'.[4] This quote provides no historical information except to confirm the names of the two orthoptists in New South Wales (NSW) who performed orthoptic duties. There is no reference to orthoptists in Victoria or in South Australia who had been actively involved, nor of the type of work these women performed. The third historical record is Air Vice Marshall Edward Daley's obituary tribute to Joseph Ringland Anderson. Daley acknowledged Ringland Anderson's efforts to incorporate orthoptic investigation and training to assist 'border-line subjects and those with post-traumatic ocular muscle malfunctioning … to learn to fly more easily'.[5] Almost a decade later Daley returned to the same subject when invited to address the 1970 orthoptic graduation in Melbourne. The details in both articles are scant but, apart from information in the RAAF papers, these are the only records of how orthoptics was administered in Australia during the war. While Daley's presentation did not explore the contribution of orthoptists in detail, he affirmed the importance of orthoptics to aviation medicine. He also summarised the contribution of WAAAF personnel, a little known aspect of war time orthoptics.

Empire Air Training Scheme and RAAF Initial Training Schools

Before the outbreak of war, Great Britain realised it could not fill the demand for aircrew and so sought assistance from Australia, Canada, New Zealand and South Africa. The result was the formation of the Empire Air Training Scheme (EATS). The formal agreement to establish the Scheme was signed in Ottawa, Canada in December 1939. By April and May 1940, the first Dominion training schools had opened. In Australia this amounted to 26 training facilities across the country.[6] Of those training schools, six were Initial Training Schools (ITS) one school each at Somers in Victoria; Sandgate in Queensland; Victor Harbour in South Australia; Clontarf in Western Australia; and two at Bradfield Park in NSW. It was at the Initial Training Schools (ITS) where trainees had their visual

assessment. The number of Australians trained under the EATS was 37,538 and of them 10,882 were pilots.[6] The body responsible for the oversight of trainee selection was the RAAF's Flying Personnel Research Committee (FPRC).

Why assessment of ocular motor balance was essential for trainee aircrew

Orthoptic examination and treatment of ocular muscle imbalance played an important role in the recruitment and treatment of Royal Air Force (RAF) and RAAF aircrew. From the information available the recruitment tests and orthoptic therapy techniques in Australia and Great Britain were identical. There is also evidence that the testing techniques for ocular muscle imbalance and depth perception were similar in USA.[7]

Before exploring what transpired during the war years, it is important to first examine the scientific knowledge of ocular muscle imbalance and its association with depth perception as it related to aviation. During WWI, Wing Commander and ophthalmologist, Edward Clements investigated a group of pilots who were slow learning to fly. His research was based on work done a decade earlier when he made an association between poor eyesight and motor vehicle accidents.[8] He found between 75 and 80 percent of accidents by trainee pilots, which resulted in a hospitalisation, were due to poor landings.[9] The results of his examination showed that 'first-class landers' had better eye muscle balance and more accurate depth perception compared to the 'border line', 'average', 'doubtful' and 'bad landers'.[9] He opined that borderline cases could benefit from 'eye training'.[9]

In the inter-war period Livingston, who had gained his Wings in the late 1920s, like Clements, became interested in ocular problems associated with flying. In one of Livingston's earliest publications, he directly attributed ocular muscle imbalance with inaccurate depth perception.[10] He found that pilots with esophoria, when attempting to land an aircraft, perceived the ground as being closer than it was, so tended to 'come down heavily on [their] wheels'. While those with an exophoria perceived the ground as further away and would stall the plane. He noted that small errors on approach 'of plus or minus five feet can end in a nasty accident, usually by the propeller catching the ground and turning the aircraft over'.[10] Livingston acknowledged that landing a plane safely was a multi-factorial exercise involving a large range of physiological and psychological attributes and was not solely reliant on a person's depth perception. However, he argued that good ocular muscle balance and accurate stereoscopic vision were essential elements.[11] The importance of accurate stereoacuity was also acknowledged by the Germans whose attitude in the late 1930s was 'The value of stereoscopic vision and the ability to judge distances will be confirmed by the pilot and above all by the ground'.[12]

Australia's involvement in aviation ophthalmology benefited from a close relationship between Livingston and Daley who, like Livingston, was both a medical doctor and pilot.[13] Daly had been sent to England on exchange in 1936 where Livingston and he collaborated. Daley stated 'it was my privilege to be allotted for certain work with him. At the time he was endeavouring to rationalise the range of visual standards required for people learning to fly, and for pilot and aircrew duties generally'.[14] Additionally the FPRC of the RAF had kept Australia abreast of their activities.[15] Consequently with the introduction of the EATS in 1940, the RAF standards were adopted for all Commonwealth aircrew including Australia. Nevertheless, the acceptance of all standards pertaining to ocular muscle treatment was not accepted without debate in Australia.

Required fitness of aircrew

Potential airmen had to be generally fit. Because of the unknown stresses placed on the body by long flying hours and the effects of high altitude and extreme cold, aircrew also had to be 'of sound stock, good personal history, reasonable physique with a stable nervous and vascular system, and physically and mentally alert' which included a high standard of ocular health.[16] The candidates for flying duties were not just pilots but included air observers and gunners, and while their responsibilities differed, the same visual standards, apart from the ocular motility requirements, applied. The necessity for high standards of visual health was especially true in WWII airplanes where there was less reliance on sophisticated instruments compared with the aircraft of today. Hence, it was imperative that aircrew had no significant ocular defects.

Required visual standards for aircrew

Each trainee had to have: good distance and near visual acuity; good night vision; normal colour vision; a full field of vision; normal ocular muscle balance and accurate depth perception.[16] Good distance visual acuity was considered essential to enable accurate take-offs and landings in any conditions and to spot enemy aircraft. The set standard for pilots was visual acuity better than 6/12 in either eye improving to 6/6 with glasses. Observers and gunners were required to have 6/6 in both eyes.[16] While a pilot could wear glasses the permissible degree of optical defect was minimal. The amount of allowable hypermetropia could not exceed 2.25 dioptres and the amount of astigmatism could not exceed 2.5 dioptres.[16] Airmen with even a suggestion of the smallest amount of myopia were rejected, or to use the RAAF term, 'scrubbed'. Near vision had to be good (N5) for reading instrument panels and maps. Good night vision was essential for night-flying missions, so trainees' dark adaption was tested. Colour vision had to be normal to recognise signals and flares. A pilot's field of vision needed to be full for two reasons – to ensure obstacles could be detected in the periphery of their vision and for successful take-offs and landings. Because landings and take-offs

were often performed without reference to instruments, accurate depth perception was essential. The amount of ocular motor imbalance was measured using the Maddox Rod and fusion was assessed on the synoptophore. For trainee pilots horizontal heterophorias could be no greater than 2-2.5 prism dioptres and vertical heterophorias no greater than 0.75-1.0 prism dioptre. The ocular motility requirements for gunners was not as stringent. A heterophoria was permitted but not a strabismus.[16] The strength of binocular vision was assessed by measuring the fusion range on the synoptophore. The considered normal range was convergence of 40 degrees and five degrees of divergence. Specially designed synoptophore slides (parachutes and fighter planes) were used to assess the degree of stereoscopic vision.

Flying Personnel Research Committee and the Vision Sub-committee of the RAAF

The Australian FPRC was set up late in 1940 on the recommendation of Air Commodore (later Air Vice Marshall) Victor Hurley, Director of the RAAF Medical Services. Its functions were similar to the RAF's FPRC, 'to advise the Air Board on the medical aspects of all matters which might conduce the safety and efficiency in flying and also on research into the scientific selection of personnel and maintenance of their physiological efficiency'.[17] The majority of the research was conducted at the University of Sydney and the University of Melbourne. Subsidiary work was undertaken in Queensland and South Australia.

The FPRC set up a number of advisory sub-committees, one being the Vision Sub-committee. The ophthalmologists on this sub-committee were Flight Lieutenant Walter Counsell, Squadron Leader Joseph Ringland Anderson and Flight Lieutenant Hugh Ryan. They were supported by other ophthalmologists in the RAAF – Squadron Leader Colin Blakemore in NSW; Squadron Leader JLR Carter in Tasmania; Squadron Leader DN Gawler in Western Australia; Squadron Leader EO Marks in Queensland; Squadron Leader Thomas a'Beckett Travers in Victoria; Squadron Leader Alfred Tostevin in South Australia, and the only full-time ophthalmologist, Flight Lieutenant RW Hazelton in NSW.

The Vision Sub-committee was responsible for research into flying goggles (with corrective lenses and anti-glare); cockpit lighting; night vision; visual fatigue and its effect on colour vision, and importantly for this discussion, ocular motility imbalance and binocular vision including the level of depth perception.[18] It was also responsible for the safety and efficiency of aircrew and therefore selection of trainees came under its purview. For the ophthalmology members the accuracy of a person's depth perception was an essential element of the selection process. Even so, from the outset, Hurley was sceptical of the 'supposed' relationship between ocular muscle imbalance and depth perception and the necessary skill to land aircraft. His submission to the Air Board singled out depth perception as one of the matters which required 'further investigation'.[19] The basis for his scepticism is not known. The fact that he had reservations on the subject is verified by Daley who later recalled the difference of opinion between Ringland Anderson and Hurley regarding the importance of accurate depth perception for landing.[5]

Australian ophthalmology and orthoptic research

Between the first meeting of the FPRC in December 1940 and June 1941 Ringland Anderson, Counsell and orthoptist, Diana Mann, presented information concerning standards set for RAAF personnel at the ophthalmology scientific meeting in 1940. The presentations included the rationale for including orthoptics for ocular muscle imbalance both as a selection test and for treatment for appropriate cases.[16,20,21] In June 1941 Ringland Anderson and his ophthalmology compatriots on the Vision Sub-committee must have persuaded Hurley to change his stance because his recommendation to the Air Board resulted in the establishment of orthoptic clinics at the ITSs. Whether these clinics were functional by the end of 1941 is unclear, but the FPRC minutes show that a meeting of the Vision Sub-committee was still discussing elements of vision and ocular standards which would suggest that they were not fully operational at all ITSs.

Prior to the meeting on 18 October 1941, Counsell, Ringland Anderson, Tostevin and orthoptist Lucy Willoughby gave papers at the ophthalmology scientific meeting in Melbourne. Counsell's paper presented an in-depth examination of British and Americans research into the diagnosis of ocular muscle imbalance and the effectiveness of orthoptic treatment.[16] Ringland Anderson's findings with Australian aircrew mirrored the overseas experience concluding that ocular muscle imbalance 'can be remedied by orthoptic training and that great improvement in flying ability follows'.[12] Tostevin and Willoughby reported on research they had conducted on RAAF trainees in South Australia.[22,23] They showed that ocular defects, as the principal cause of pilot failure, were negligible, and that landing faults were due to a myriad of causes. While their findings seemed to be at odds with those of Ringland Anderson and Counsell, they conceded that their sample was small and advocated continuing research. In sum, the debate centred on what tests should be administered as a screening tool, and what cases would benefit from orthoptic exercises, rather than any clinical objection to the assessment of ocular muscle balance per se.

Who assessed RAAF trainees' ocular motility?

I had always thought that qualified orthoptists examined all the RAAF personnel but this was not always the case. The Australian model of orthoptic service delivery was based on the English experience, but there were significant differences. Interestingly, Livingston reported the original

intention in England was for the orthoptic work, within the RAF, to be carried out by ophthalmic surgeons, but when the work load became too great 'a number of orthoptists were brought into service'.[24] Unlike Australia, orthoptics in England was immediately impacted by the outbreak of war. Hospitals were made ready for casualties and orthoptic clinics closed leaving many London-based orthoptists without work. When Livingston required orthoptists to work with RAF personnel, a number of them were employed as civilian staff. However, as their numbers rose to around 30, the authorities decreed they should be incorporated into the Service. Most entered the Women's Auxiliary Air Force (WAAF) as Non-Commissioned Officers (NCOs).[25]

Australia's experience was different. Before the bombing of Darwin on 19 February 1942, the Australian mainland had not been threatened by enemy attack so no hospitals and no orthoptic clinics had been closed. To a certain extent civilian life went on as usual and it is most likely that orthoptists continued their clinical work as before the outbreak of war. However, the major difference was that Australia had a much smaller orthoptic workforce compared to Britain. In Britain most orthoptists were employed in the public hospitals with many occupying full-time positions. In Australia the profession was less than a decade old. There were no full-time positions. Orthoptists worked part-time in eye clinics in public hospitals and part-time in private orthoptic practices to make up a full-time week of work. When war broke out there were fewer than 20 qualified Australian orthoptists. Several were working in Melbourne, several in Sydney, one in Adelaide, and one in Hobart. In the FPRC minutes there is mention of an orthoptist working in Brisbane but there are no orthoptic records to identify her. The FPRC minutes omit to say that there was an orthoptist in Adelaide, so it is possible that the minutes are incorrect and should have recorded that there was one orthoptist in Adelaide, rather than one orthoptist in Brisbane.

Australian orthoptists and their roles

During the war period an unknown number of civilian qualified orthoptists worked with ophthalmologists for the RAAF. Those known were: Janet (Bowman) Arnold; Ethel D'Ombrain and Emmie Russell in Sydney; Bev Balfour and Diana Mann (later Craig) in Victoria and Lucy Willoughby (later Retalic) in Adelaide. Other orthoptists may have been involved but no records exist to indicate who they were. There is no evidence that Lena Gilchrist in Hobart worked with the RAAF but she assisted Counsell in gathering data from a series of her private patients. Russell, Mann and Willoughby were also involved in research. Willoughby had been invited and presented a paper at the 1940 ophthalmological scientific meeting. As mentioned earlier she collaborated with Tostevin when the criteria for selection of orthoptic tests as a screening tool were being debated.[23]

The FPCM Minutes of 18 October 1941 document that there was no orthoptist available in Victoria. That may have been true at the time, but later Mann played a significant role in RAAF training and in research. Towards the end of the war she and Russell were invited to comment on the criteria for the research project set up to measure the effectiveness of orthoptic treatment.[26] This situation changed following the special conference of the Vision Sub-committee held on 18 October 1941 to discuss and formalise the role of orthoptics in the RAAF and how orthoptic services would be delivered, including the role of civilian orthoptists. The attendees at that conference were service ophthalmologists and all available ITS medical officers. Daley, who was the Acting Director of Medical Services, presided over the meeting. He stated at the outset that 'In forming our medical standards for the Royal Australian Air Force we must always be guided by those as adopted by the Royal Air Force. This is now all the more necessary since under the EAT Scheme Australia and the Royal Air Force serve side by side and any Commander of a mixed squadron must know that his personnel are physically capable of performing the same tasks'.[27]

Despite Daley's directive that RAF standards must be adopted there was concern that the RAF had lowered the criterion for visual acuity from 6/12 to 6/18 and had increased the size of allowable heterophorias by a couple of degrees. However, as Australia had 7,000 men on the wait-list to be tested they considered there were enough applicants with good visual acuity not to have to reduce the standard to 6/18. The sub-committee was also 'not prepared to take on those with muscle balance measurements outside the standards as they had sufficient recruits whose eye muscle balance was within the required limits. Time could be wasted training these young men when they could be gunners or observers'.[28] Ringland Anderson thought it more important to give orthoptic treatment to those who would fly solo, or to those whose visual judgement could be improved, rather than accept applicants with heterophorias outside the set limits. Lengthy debate ensured as to who should receive orthoptic training and how the effectiveness should be assessed. Against Ringland Anderson's wishes, there was a majority agreement to assess the outcomes of orthoptic therapy. He was not against measuring the appropriateness per se, but he was so convinced that orthoptic therapy aided pilots' ability to land their aircraft safely that he thought a research project would take up valuable time and would put trainees at risk of accidents. As events transpired efforts were made to carry out the assessment in 1944 but the war ended before sufficient data had been accumulated.

WAAAF and RAAFNS roles

Qualified orthoptists were not the only group to deliver orthoptic services to the RAAF. As discussed at the Vision Sub-committee it was recognised that the orthoptic

manpower could not meet the demand for orthoptic services for the RAAF. Additionally, the Air Board did not want civilians and preferred that the positions be full and not part-time.[29] The solution was to train others. Daley announced that the Air Board had made the decision that orthoptic clinics at the ITS be staffed by a medical officer who had received eye training, and answering to him would be one or two RAAF nursing sisters and WAAAF personnel who would carry out orthoptic work. Clerks would be supplied for record keeping to save the orthoptists' time.

Daley stressed the importance of a having a uniform scheme across all the ITSs.[30] He noted that Ringland Anderson had already commenced orthoptic training for six WAAAF personnel. Ringland Anderson had set up the first orthoptic training school in Australia in the early 1930s and so was eminently qualified to conduct the proposed training. Whether the qualified orthoptists were concerned that some people would gain partial orthoptics skills is not known. However, it was recognised that a lay workforce could not replace the adequately trained and professional orthoptists. As a consequence, one qualified orthoptist in each state was employed by the RAAF. It was further agreed that the services of the professional orthoptists who were 'currently engaged should be retained indefinitely irrespective of the capacity in which they were serving'.[30] These comments suggest that the level of training Ringland Anderson provided was below that required for a fully qualified orthoptist. Therefore, it is possible that the WAAAF lay workers were skilled in a limited number of orthoptic procedures but not skilled enough to be considered a qualified orthoptist. Daley provides some evidence for this when he said 'we established of necessity a special Visual Centre, with [a] Medical Officer, [a] Sister and [a] WAAAF medical orderly, each empirically trained to some degree in eye examination, in the use of orthoptic methods (my emphasis)'.[5] From available sources at least six WAAAFs trained under Ringland Anderson's scheme. Records suggest that only one WAAAF went on to complete formal training. She was Sergeant Beatrice Lilian Barnes who had joined the WAAAF in 1942 as a sick-quarter attendant, having previously studied pharmacy.[31] When Barnes gained her qualifications in 1945 she was the first servicewoman in Australia to obtain the Diploma of Orthoptics.[32] She continued orthoptic practice for some years after the war.

Apart from Barnes no records can be found of any WAAAFs or members of the RAAFNS personnel, who carried out orthoptic tasks during the war, who then continued to practise, or attempted to practise orthoptics in peace time. There is evidence that Sister Eve Ahlston, a member of the RAAFNS who trained as a nursing sister at the Prince Alfred Hospital pre-war, undertook some orthoptic duties at a number of ITSs. Her specific tasks are not recorded but in July 1945 she was involved in a proposed research project 'to test the test-retest reliability of some of the Orthoptic Tests' which would suggest a degree of proficiency.[33] After the war she worked at the Medical Eye Service (MES) in Melbourne. It is possible that she worked there in an administrative capacity rather than performing orthoptic duties as evidenced by a letter she sent to the editor of the Age newspaper and signed by her as the Secretary of MES. What became of the WAAAFs who trained with Ringland Anderson in 1941 or any member of the RAAFNS, other than Eve Ahlston, is a mystery. It is possible that they fulfilled their duty working at ITSs during the war, but did not pursue a career in orthoptics in peace time.

The role of other personnel

There is also evidence that other non-qualified personnel were involved in orthoptics within the RAAF. In 1942, Mrs John Baker (nee Mary McGlip) delivered a talk on orthoptic work in the RAAF to an alumna gathering of the Presbyterian Girls' College in Adelaide (now Seymour College). The newspaper article states that she was amongst 'women and girls in uniform [who] will talk about their war work'.[34] Her exact role with the RAAF is uncertain. Could she have been one of those trained by orthoptist Lucy Willoughby at the ITS at Parafield in South Australia? Barker's name does not appear on the orthoptic register so it would appear that she did not have formal orthoptic training. Additionally, she was married and it was most unlikely that a newly married women at that time would have embarked on a new career. It is more likely that Barker's and Willoughby's paths may have crossed socially. Both had been kindergarten teachers, although Barker would have completed her training by the time Willoughby changed careers and was a qualified orthoptist. They both worked on the same charity functions and Barker was a member of the Red Cross. Her daughters have been able to provide some, although sketchy, information and confirmed that their mother 'tested pilot's vision'.[35] Whether she did more ocular examinations than test vision is unknown. They also commented that their mother had not been allowed to work once she was married and so did volunteer work with the Red Cross.[35]

CONCLUSION

On reflection the war period was an important time in the history of Australian orthoptics. Women gained a voice in the profession and drove its development both scientifically and through the establishment of the professional association. The Orthoptic Association of Australia, now Orthoptics Australia, was formed in 1944 following preliminary discussions in 1942. Those orthoptists who worked for the RAAF in wartime - Janet Arnold, Bev Balfour, Ethel D'Ombrain, Diana Mann, Emmie Russell and Lucy Willoughby, were founding members of the association. All

played active roles in setting up and running the association in its formation period and for the ensuing decades. Annual scientific meetings were held and transactions from the meetings were published in the precursor to the Australian Orthoptic Journal. Over the following years the training courses in NSW and Victoria were formalised and the registration boards, the Orthoptic Association of Australia and the Orthoptic Councils of NSW and Victoria, became more firmly established.

Management of heterophorias was an ongoing topic of orthoptic research. As late as the 1980s many orthoptists would state that heterophorias made up the bulk of their clinical practices, particularly in private practice. It was probably not appreciated in the post-war period, but in hindsight the work of the wartime orthoptists with the RAAF personnel profoundly influenced the practice of orthoptics for years to come.

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REFERENCES

1. Walker AS. Australia in the war of 1939-1945. Series Five Medical. Vol. 1. Clinical Problems of War. Canberra: Australian War Memorial; 1952.
2. Excellence in combat: Doctor praises Australians. The Age (Melbourne, Vic:1854-1954), Wednesday 23 October 1946:2. [cited 2016 17th Sep] Available from: http://trove.nla.gov.au/newspaper/article/204949849.
3. Livingston PC. Heterophoria in aircrew: its clinical and psychological significance. Trans Ophthalmol Soc (Br Med Assoc) 1946;6:60-75.
4. Lance P. Presidential address: a history of the treatment of strabismus. Minutes of the Eleventh Annual Scientific Meeting of the Orthoptic Association of Australia; Melbourne: Orthoptics Australia; 1954:1-19.
5. Daley E. Joseph Ringland Anderson. Aust J Ophthalmol 1961;21:7-8.
6. Ilbery P. Empire Airmen Strike Back: the Empire Air Training Scheme and 5SFTS, Uranquinty. Maryborough: Banner Books; 1999.
7. Armstrong HG, Principles and Practice of Aviation Medicine. Baltimore: The Williams and Wilkins Company; 1943.
8. Clements EC. Errors of vision as a factor in motor car accidents. Br Med J 1906;2(2397):1636.
9. Clements EC. Visual Problems in regard to flying and industrial fatigue from a service standpoint. Proc R Soc Med 1925;19:15-23.
10. Livingston PC. The role of heterophoria in binocular disharmony with special reference to air pilotage. Br Med J 1937; 2(3999):409-411.
11. Livingston PC. Approach to the phorias. Br Orthopt J 1939;171-104.
12. Ringland Anderson J. Aviation and orthoptics. Trans Ophthalmol Soc Aust (Br Med Assoc) 1941;3:151-159.
13. Thomson DS. Daley Edward Alfred (Ted) (1901-1985). Australian Dictionary of Biography, Australian National University 2007;17:1-2.
14. Daley E. Orthoptists and the Royal Australian Air Force. Aust Orthopt J 1970-1971;11:8-10.
15. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/1/956,1941:268.
16. Counsell WD. Air Force eye standards and examination procedure. Trans Ophthalmol Soc (Br Med Assoc) 1940;2:7-18.
17. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/1/573 Part 1,1940:40.
18. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 43/1/527 Part 1, 1941-1943:379.
19. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/1/573 Part 1, 1943-194:41.
20. Ringland Anderson J. Some aspects of visual fusion in peace and war. Trans Ophthalmol Soc (Br Med Assoc) 1940;2:20-25.
21. Mann D. Treatment of fusion (convergence) deficiency. Trans Ophthalmol Soc (Br Med Assoc) 1940;2:26-27.
22. Tostevin AL. Orthoptics and aviation. Trans Ophthalmol Soc (Br Med Assoc) 1941;3:145-146.
23. Willoughby L. Research into the effects of ocular conditions in pilot training. Trans Ophthalmol Soc (Br Med Assoc) 1941;3:147-150.
24. Livingston PC. The present position of orthoptics in aviation ophthalmology. National Archives of Australia Appendix A. Flying Personnel Research Committee Minutes, National Archives of Australia A705, Control 132/1/956 18 Oct 1941:280-283.
25. MacLellan AV. Orthoptics, The Early Years: Recollections and a Personal Account. Keighley, Yorkshire: Ann Macvie; 2006.
26. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/1/956, 1941:225 and 168.
27. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/1/956, 1941:268.
28. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/132/1/956, 1941:259.
29. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/1/956, 1941:267.
30. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, Series A705, Control 132/1/956, 1941:259.
31. How Sydney celebrated. The Dubbo Liberal and Macquarie Advocate (NSW: 1894-1954) Thursday 23 August 1945:4. [cited 2016 7th Nov] Available from: http://trove.nla.gov.au/newspaper/article/133035030.
32. Interesting people. The Australian Women's Weekly. Saturday 1 September 1945:10. [cited 2016 10th Oct] Available from: http://trove.nla.gov.au/newspaper/article/47246836.
33. [Medical – General] – Flying Personnel Research Committee, Canberra: National Archives of Australia, FPRC Minutes A705, Control 132/1/956 1941; 18 October:280-283.
34. Women talk on war work tonight. News (Adelaide, SA: 1923-1954) 1 June 1942:5. [cited 2016 7th Sep] Available from: http://trove.nla.gov.au/newspaper/article/128551100.
35. Email communication from Louise (Barker) Lipman with Shayne Brown 16th December 2016.

The First Sydney Orthoptist - Emmie Russell or Audrey (Roberts) Wormald?

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INTRODUCTION

To New South Wales (NSW) orthoptists Emmie Russell is considered the doyen of orthoptics, the first in the state, one of the first in Australia and a foundation member of the Orthoptic Association of Australia (now Orthoptics Australia). In the few historical accounts of Australian orthoptics that is how she is described. But was she really the first? Certainly, she was the first qualified orthoptist but she was not the first undertake some basic orthoptic tasks. That honour goes to Audrey (Roberts) Wormald who worked under the supervision of Sydney paediatric ophthalmologist, Dr Ernest Temple Smith.

In the early 1930s Drs Norman (later Sir Norman) Gregg, Frederick Gregory Roberts and Edwin Temple Smith were Honorary Surgeons in the Department of Ophthalmology at Royal Alexandra Hospital for Children (RAHC). Temple Smith was the most senior having been appointed to the Department in 1914. Gregg followed in 1925 and, slightly later still, Gregory Roberts. According to author and doctor, DG Hamilton, Temple Smith 'prided himself on keeping up to date and was keen to establish an orthoptic clinic at RAHC before he retired.'[1] Around 1930 Gregory Roberts returned to Sydney, having spent three years working in London, and was tasked with establishing the new Orthoptic Clinic. Emmie Russell commenced her orthoptic training in Melbourne in 1932 and while waiting for her to complete it, and for the Orthoptic Clinic to be formally established, it would appear that Audrey (Roberts) Wormald, Temple Smith's secretary, accompanied him to RAHC where she assisted in some clinical tasks.

Audrey (Roberts) Wormald.

Emmie Russell.

Audrey Roberts was born circa 1908. She spent her early childhood in Hobart. Sometime after her father's untimely death, her mother moved to Sydney. Audrey attended Ascham School in the eastern suburbs of Sydney for her high schooling from 1920 to 1923 where she gained her Intermediate Certificate.[2] After school she completed a business college course. She then worked as a medical secretary for a family friend, ophthalmologist Dr Edwin Temple Smith in Macquarie Street in Sydney. By February 1926 Audrey was engaged to William Dalton Wormald an Englishman with relatives in Sydney.[3] She continued working with Temple Smith after she was married. This was unusual for women at that time. Most gave up work mainly because society pressure which saw a woman's place as in the home to support and care for her working husband. She did not have children and worked in Temple Smith's rooms for some years. As a young patient of Temple Smith's, orthoptist, Lyn (Lipman) Brent recalls Mrs Wormald being his secretary in the late 1940s.[4]

Hamilton records that Mrs Wormald 'was appointed the first orthoptist to the [RAHC Orthoptic] clinic. She had previously received a short training at the Royal Westminster Hospital' but this has proved to be incorrect.[2] In 1997 Dr Reuben Hertzberg, who had been head of the Ophthalmology Department at the RAHC, wrote an unpublished article in response to Dr Bill Gillies who had asked for more details about the history of orthoptics in Sydney. In the paper, Hertzberg contradicts Hamilton and states 'There was no orthoptic clinic at this time [that is in 1931]. Mrs Wormald attended the outpatient clinic and assisted the honoraries by taking visual acuities and instructing parents whose children had an eye occluded.'[5]

Hertzberg's comments provide some insight into Audrey's likely role as Temple Smith's secretary. The science of orthoptics developed in England in the 1920s in response to ophthalmologists' need for assistance with the time-consuming assessment of children's ocular motility status. Like the British ophthalmologists before him, it is probable that Temple Smith taught Audrey how to assess

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a child's visual acuity and give advice to parents whose children required occlusion therapy. Essentially, he was following the apprenticeship training model which had been in place before Mary Maddox established the formal orthoptic training course in England in 1928. Hamilton was referring to the period in the early 1930s. By that stage Audrey had worked with Temple Smith for several years, so she may well have been quite adept at vision testing young children.

As has been well documented the first orthoptist, Mary Maddox, was taught by her ophthalmologist father Dr Ernest Maddox, to examine and treat patients with ocular motility defects. In some ways Audrey's experience mirrored Mary Maddox's path to becoming the first orthoptist. Like Audrey, Mary first worked as a secretary, and then went on to take a great interest in the science of ocular motility function. The difference between them was the path each of them followed. Mary continued along a professional route while Audrey chose to remain a secretary and to leave the orthoptic work to the orthoptically qualified Emmie Russell. Whether Audrey ever contemplated orthoptic training is unknown but being newly married, and the only orthoptic training course in Australia was held in Melbourne, it is likely that she simply chose to remain in Sydney.

As a final note it is unclear why Audrey is referred to in Hamilton's book as Mrs 'M` Wormald. We know her husband was William Dalton Wormald and, as was the custom at the time, women adopted and were referred to by their husband's initials. She therefore should have been referred to as Mrs WD Wormald. We can only presume that Hamilton's entry is incorrect either due to a printing error or that he was given incorrect information. Hamilton wrote Hand in Hand in 1979 some 46 years after the Orthoptic Clinic was established. As no records can be traced that record details of how the Orthoptic Clinic was set up, it is likely that some of his information was gathered from hearsay and may have contained factual errors. Whatever the reason there is compelling evidence that Mrs M Wormald was indeed Audrey Roberts, a medical secretary, not an orthoptist. But nevertheless, under Temple Smith's tutelage she assisted him by assessing children's vision and gave advice to parents whose children required patching. She may have performed some clinical tasks, but it is Emmie Russell and not Audrey Wormald who was the first orthoptist in Sydney.

ACKNOWLEDGEMENTS

Almost as interesting as the history of Audrey (Roberts) Wormald and her role in the formative years of Australian orthoptics is how the story was unearthed and the pieces put together.

I am extremely grateful to the following people who helped 'find' Mrs Wormald – to retired Australian orthoptists Jill (Coddington) Gordon and Lyn (Lipman) Brent and British orthoptists, Ann (McIntyre) Edwards and Bronia Unwin. Without their input, the identity of Mrs Wormald would have remained a mystery. Ann and Bronia confirmed that 'our' Mrs Wormald did not train at Westminster Hospital as Hamilton suggested. Lyn attended Temple Smith's surgery as a child. She remembered Mrs Wormald and so could confirm that she was his secretary and not his orthoptist. But these discoveries still did not tell us Mrs Wormald was. Without Jill's forensic genealogical searching we would never have discovered Mrs Wormald's true identity. Jill searched the births, marriages, deaths and shipping records and pieced together the information which lead to the conclusion that Audrey Roberts was in fact Mrs William Dalton (nee Audrey Roberts) Wormald. I am extremely indebted to Jill for all her hard work and tireless efforts in solving the mystery.

REFERENCES

1. Hamilton, DG. Hand in Hand: The Story of the Royal Alexandra Hospital for Children. Sydney: John Ferguson; 1979.
2. Gillezeau, M. Personal communication with Shayne Brown, 8th Mar, 2017.
3. Recently Engaged, The Sun (Sydney, NSW: 1910 - 1954) Sunday 14th February 1926 p 22.
4. Brent, L (nee Lipman). Personal communication with Shayne Brown, 24th Feb, 2017.
5. Hertzberg, R. The Emmie Russell Department of Orthoptics, circa 1997 with accompanying letter to Dr WE Gillies. Unpublished. Sydney Eye Hospital Library.

Selected Abstracts from the Orthoptics Australia 74th Annual Scientific Conference held in Perth 30th October to 1st November 2017

PATRICIA LANCE LECTURE: DELAYED DIAGNOSIS OF CHILDHOOD STRABISMUS: WHEN DOES IT MATTER?

Sandra Staffieri

Strabismus, real or otherwise, is an enigma. Fleeting and transient in the first few months of life, strabismus is a feature of the developing visual system. If epicanthal folds are particularly broad or persisting, it could just be an optical illusion. Although true strabismus will most often be benign in origin, untreated it could lead to severe, irreversible amblyopia and loss of binocular function.

Sometimes however, strabismus will be a sign of a more serious pathology. Accompanying systemic or neurological symptoms may alert the parent or primary health care practitioner that prompt referral and investigation are required. Often, there are none. Whilst the child is well and appears to see, for the uninformed, strabismus may be easily dismissed to simply 'watch and wait'.

Waiting however, could result in poor outcomes as the 'red flag' continues to be ignored. Which begs the questions: When should a parent seek advice if strabismus is observed in their child? What are the consequences of delayed diagnosis? And what can we do as orthoptists to challenge the current thinking and champion earlier diagnosis to achieve better outcomes, irrespective of the cause?

VARIATIONS IN THE PREVALENCE OF STRABISMUS BY AGE

Felicia Adinanto, Kathryn Rose, Amanda French

Purpose: To determine the prevalence of strabismus and it's variations with age.

Methods: The Sydney Paediatric Eye Disease Study (SPEDS) examined children between 6 months and 6 years, while the Sydney Myopia Study (SMS) cluster sampled children at 6 and 12 years, with a 5 to 6-year follow-up. All children underwent an age-appropriate comprehensive ocular examination including cover test, visual acuity and cycloplegic autorefraction. Prevalence of strabismus, esotropia and exotropia were analysed in 6,531 children by age groups 6-36 and 37-72 months, 6 and 12 years.

Results: The prevalence of strabismus remained consistent at 2.6% - 2.9% ($p=0.2$) in all age groups; 6-36 months, 37-72 months, 6 years and at 12 years. Intermittent exotropia was the most prevalent type of strabismus overall. Children in the 6 to 12-month age group had the highest proportion of esotropia (46%). However, by 6 and 12 years of age, the proportions of those with esotropia and exotropia were similar (1 - 1.3%, $p=0.2$). Of 1,205 children re-examined at follow-up in the SMS study, 2% of those who did not have strabismus at baseline, developed a strabismus, usually intermittent exotropia. Of those who had strabismus at baseline in both cohorts, a large portion (47%) became heterophoric at follow-up.

Conclusions: The overall prevalence of strabismus remains relatively stable from infancy to adolescence with intermittent exotropia being the most prevalent type of strabismus. However, the type of strabismus present changed with age due to both an increase in intermittent exotropia and reduction in constant esotropia, potentially due to treatment.

SILENT SINUS SYNDROME

Jodie Attard

Although relatively uncommon, patients with silent sinus syndrome (SSS) may present to an orthoptic clinic with enophthalmos, hypoglobus, eyelid retraction and/or diplopia. This presentation used a case study to explore the presentation, investigation and treatment of a patient suspected of having SSS. The discussion highlighted the importance of good history taking, imaging and multi-disciplinary care.

THE FUNCTIONAL IMPACT OF PERIFOVEAL GEOGRAPHIC ATROPHY IN PATIENTS WITH EARLY TO INTERMEDIATE DRY AMD

Jess Boyle, Meri Vukicevic, Konstandina Koklanis, Catherine Itsiopoulos, Wilson Heriot

Conventional measures such as best-corrected visual acuity (BCVA) often grossly underestimate the profound visual dysfunction experienced by patients with perifoveal geographic atrophy (GA) secondary to dry age-related macular degeneration (AMD). Foveal preservation in these patients typically means that BCVA is often only moderately impaired, in the order of 6/9 to 6/12, and thus misleading. Despite this, BCVA is widely used as a gold standard measure in assessing patient eligibility for disability support, such as the Blind Pension, and legal driving status. Moreover, clinical studies of GA often include BCVA as a primary outcome measure when investigating the efficacy of new therapeutic agents and patient response to treatment.

A systematic review by Boyle et al (2017) revealed only two studies to date have investigated functional deficits specifically in patients with perifoveal GA, comparing conventional outcomes with microperimetry thresholds. Microperimetry was found to represent a valuable tool in quantifying visual deficits in these patients and was significantly more sensitive than conventional acuity measures, including BCVA and low-luminance visual acuity. However, neither study investigated the relationship between microperimetry thresholds and functional vision measures such as reading speed, or patient-reported outcome measures (PROMs) in this clinical population.

This study aimed to investigate the functional impact of ring scotomata in patients with perifoveal GA secondary to dry AMD. Specifically, it aimed to explore the relationship between microperimetry thresholds and performance on both functional vision and visual function tests in this clinical population.

Twenty-five patients with perifoveal GA secondary to dry AMD will be recruited from a private ophthalmology practice. Participants will perform a battery of visual function and functional vision tests; including distance and near BCVA, MN Reading Speed, Melbourne Edge contrast sensitivity, MAIA microperimetry and the Melbourne Low Vision Activities of Daily Living Test. A self-administered, validated questionnaire (Visual Functioning Questionnaire-25; VFQ-25) will also be used to assess the degree of self-reported difficulty with vision-demanding activities in daily life. Statistical analysis will be undertaken to assess for data correlation between the different clinical variables. At the time of writing, data collection for this project was still in process. The preliminary results of this study were presented.

GAME ON! AN UPDATE ON DICHOPTIC THERAPY AT THE CHILDREN'S HOSPITAL AT WESTMEAD

Louise Brennan, Jane Lock, Lindley Leonard

The current mainstay of amblyopia treatment is correction of any underlying refractive error along with occlusion therapy, which involves patching or penalisation of the non-amblyopic eye.

More recently, experimental evidence has supported the role of binocular methods of treating amblyopia, referred to as dichoptic therapy. This treatment method forces both eyes to function together by presenting different images to each eye, either in a movie or as an interactive game. The amblyopic eye sees images of higher contrast, while the fellow eye sees images of lower contrast. In order for the game to be played successfully, both images must be seen.

Multiple small studies have already demonstrated the efficacy of dichoptic tablet games for visual improvement in amblyopes. The current study into dichoptic therapy being undertaken at The Children's Hospital at Westmead is aimed at better defining the game 'dosage'. The study outline along with the acceptance and resistance of this new treatment method for amblyopia was discussed.

COLOUR DISCRIMINATION: A COMPARISON OF CLINICAL FINDINGS OF INDIVIDUALS WITH AND WITHOUT CONGENITAL COLOUR VISION DEFICIENCY

Holly Brown, Julie Crewe, David Mackey

Introduction: The aim of this study was to assess vision and other ocular parameters of a group of individuals with congenital colour vision deficiency (CVD) and compare their results with a normal colour vision (nCV) group. It was hypothesised that people with a CVD may have a potential advantage in detecting camouflaged objects in outdoor environments, and this ability relates to measurable ocular functions.

Methods: Ocular examination involved best corrected visual acuity (BCVA), colour vision assessment with Ishihara plates (1-17) and Farnsworth D-15 test, autorefraction and ocular biometry. Dilated retinal imaging included SD-OCT imaging, fundus photography and cone cell imaging (rtx1 Adaptive Optics). The ocular parameters of the CVD cohort (n=17) were compared to a cohort of males (1:4, n=68) with confirmed nCV derived from the Western Australia Pregnancy Cohort (Raine) study. The Mann-Whitney U test was used to compare CVD and nCV groups with right and left eye averaged.

Results: The median BCVA of the CVD group was -0.1 (Snellen equivalent 6/4.8) compared to -0.06 (6/4.8-2) of the nCV group (p=0.18). There was no significant difference between the median axial length of the two groups (CVD=23.86, nCV=23.45, p=0.082). Spherical equivalent of the CVD group was 0.125 and -0.031 for the nCV group (p=0.57).

Conclusion: There was no measurable difference in the visual acuity, axial length or spherical equivalent of the CVD and nCV groups. Any enhanced vision skills of individuals with CVD may relate to their cone packing density or whether and if 'missing cones' are replaced in the photoreceptor mosaic.

THE TWILIGHT ZONE

Linden Chen, Ross Fitzsimons

These case presentations highlighted three adult strabismus patients who have very similar histories. The main presenting complaint is aesthenopia and eye strain. These symptoms are not debilitating. Examination reveals they had a manifest squint, intermittent diplopia, poor fusion and minimal suppression. They have all been managed by a behavioural optometrist at some point in their lives. 'The Twilight Zone' is a term we have used to describe these patients who all have somewhat intractable diplopia with very poor means of suppression or fusion. All synoptophore findings showed some form of abnormal binocular vision.

ORTHOPTIST-LED SECONDARY VISION SCREENING SERVICE

Jessica Collins

Amblyopia affects 1 to 5 % of children worldwide and can lead to permanent visual impairment despite being a treatable condition. Childhood vision screening is an effective way to identify amblyopia at an early age. Prompt detection allows more timely treatment aimed at reversing vision loss. Primary screening in South Australia is commonly done by general practitioners and community nurses. Many children initially fail this first vision screen and are often then referred for ophthalmic review, contributing to long waiting lists.

With the Orthoptist-led Secondary Vision Screening Service every child who fails their initial vision test is rescreened by an orthoptist in the community. This secondary screen provides more accurate results in amblyopia detection. It is a model of care that will reduce patient waiting times and lead to improved health outcomes for children. This model has been designed to service Adelaide's central and northern populations, enabling wider access to services.

The main aim of this service is to contribute relevant examination findings to improve the quality of triage of referrals. This enables a more direct, timely, and streamlined process for children requiring tertiary care. It will also aim to reduce the number of children on our waiting list. Consequently, this will improve the visual outcomes for children in our community. Vision screening is a vital service for early detection of amblyopia. A secondary orthoptist-led screening serves as an additional model of care to ensure redirection of resources to those who really need it.

PREDICTING PATIENT-REPORTED OUTCOMES TO CATARACT SURGERY

Vu Quang Do, Lisa Keay, Kris Rogers, Anna Palagyi, Andrew White, Nicole Carnt, Fiona Stapleton, Peter McCluskey

Background: Patient-reported outcome measures (PROMs) are recognised as a key component in assessing cataract surgical success. Accurate prediction of patients who are at higher-risk of poorer perceived outcomes will allow for more informed prioritisation of waiting lists and better management of postsurgical expectations. The aim of the study was to determine whether preoperative factors can accurately predict PROMs (satisfaction with surgery, satisfaction with vision, visual disability and health-related quality of life) following cataract surgery.

Methods: Bilateral cataract patients (aged ≥50 years) scheduled for their first-eye surgery were invited to take part in a prospective cohort study conducted at four urban public hospitals in NSW. Data collection occurred prior to cataract surgery and three months following first-eye surgery. Logistic and linear regression were used to model predictors of PROMs.

Results: 220 participants completed both baseline and follow-up assessments. Anisometropia (OR: 0.5, 95%CI: 0.3-0.98, p=0.04) and positive mood (OR: 0.92, 95%CI: 0.9-0.98, p=0.01) were protective against surgical dissatisfaction (c-statistic: 0.72). Females (OR: 2.4, 95%CI: 1.2-4.9, p=0.02) and preoperative visual disability (OR: 1.5, 95%CI: 1.1-2.1, p=0.01) were predictive of postoperative vision dissatisfaction (c-statistic: 0.66). Models examining predictors for visual disability and quality of life had poor predictive power (predicted r-squared: 0.11-0.30). The addition of intraoperative and postoperative factors only slightly increased (4-11%) the ability of all models to predict PROMs.

Conclusion: PROMs of cataract surgery are complex and multifactorial. Preoperative factors were able to predict satisfaction with surgery and vision with moderate confidence, but were unable to predict postoperative visual disability and QoL. These findings may assist clinicians to identify and manage patients at higher-risk of postsurgical dissatisfaction.

THE IMPORTANCE OF CONTINUING PROFESSIONAL DEVELOPMENT

Kerry Fitzmaurice

The concept of continuing education dates back to the middle ages and the guild system. The medical and health professions have been slower to embrace the need for regulated continuing professional education than many other professional groups such as chartered practicing accountants. A Continuing Professional Development Registration Standard is part of the Health Practitioner Regulation National Law 2010 and therefore mandated for all professions governed by this legislation.

Continuing professional education provides the basis for professional development (CPD). All professions have an expectation that their members will continually learn to improve practice and learn new skills. Not all are regulated by Statutory Authority however many professions self-regulate in relation to professional development. In this presentation the CPD requirements of health professions registered under the Health Practitioner Regulation National Law 2010 were reviewed. The CPD requirements of the Australian Orthoptic Board were discussed in relation to the Allied Health Practitioner Regulation Agency (AHPRA) managed registration boards to promote understanding of the need and purpose of CPD. The potential for the rapidly growing field of micro-credentialing in relation to continuing professional development was also explored.

ORTHOPTIC STUDENT LEARNING IN THE CLINICAL ENVIRONMENT

Amanda French, Felicia Adinanto

Aim: To investigate factors that shape positive and negative clinical learning environments and determine the influence on student approach to learning.

Methods: A questionnaire was administered to final semester orthoptic students from UTS. A set of 30 neutral-language statements were rated on a 5-point Likert scale from 'not important' to 'essential' for contributing to positive and negative environments. The 2-factor Study Processes Questionnaire was used to measure student learning approach at university and using this format, a set of statements reflecting deep and surface approach in the clinical environment were developed.

Results: Most students adopted a deep approach to learning at university (90%) and in the clinical environment (100%). All students adopted a deep approach in positive environments but, only 60% took this approach in environments considered negative. Most factors relating to the clinical supervisor were rated as equally important to positive and negative environments including; attitude towards teaching (4.89 and 4.81, $p=0.3$), interest in student learning (4.89 and 4.59, $p=0.12$) and attitude towards the orthoptic profession (4.61 and 4.46, $p=0.31$). Friendliness (4.89 and 4.63, $p=0.02$) and constructiveness of feedback (4.85 and 4.57, $p=0.02$) were also important for both environments, but significantly more so for shaping positive environments. Additionally, factors relating to students' belonging and opportunities to perform clinical tasks were more important for creating positive environments.

Conclusions: Quality student learning was better facilitated in positive clinical environments, with supervisors being the most important influence. Creating positive learning environments is essential for developing the clinical competencies of orthoptic students.

WHEN THE EARS MEET THE EYES. IS VISION SCREENING IMPORTANT IN CHILDREN WITH A HEARING IMPAIRMENT?

Katie Geering

Children who are diagnosed with a hearing impairment at The Children's Hospital Westmead are referred to the Eye Clinic for a baseline eye examination. A retrospective analysis of patient files was conducted for a 5-year period to determine the risk of eye disease in these children. A guideline for review will be developed to determine the best clinical care for these patients.

CONCUSSION: AN ORTHOPTIST'S ROLE

Premkumar Gunasekaran, Christopher Hodge, Clare Fraser, Kathryn Rose

Purpose: With at least 3,000 hospitalisations from sports-related concussion (SRC) annually in Australia, the optimal diagnosis and treatment of concussion and its sequelae is essential. Of consideration to orthoptists; ocular dysfunction, including version and vergence oculomotor defects, have been documented in up to 90% of concussed patients. This suggests that ocular testing may represent a crucial aspect of concussion assessment and surveillance. However, standard SRC assessment protocols do not typically include any analysis of the ocular systems. The aim of this research is to conduct a systematic literature review, identifying the prevalence of ocular defects associated with concussion and to examine the potential role an orthoptist may have in diagnosing and managing these patients.

Methods: A PubMed search using MeSH terms including 'brain concussion and concussion cerebral' and 'vision' resulted in 118 papers, or with the term 'eye movement' (86 papers) or 'visual dysfunction' (157 papers) were identified. These were searched individually and only included human-based studies published within the last 10 years (119 papers). A web-based review of existing Australian SRC assessment protocols was conducted concurrently.

Results: The literature indicates that commonly experienced oculomotor functions affected post-concussion are convergence (34-55%), accommodation (13-65%), smooth pursuits (33-60%) and saccades (29-42%). Minor deficits have been reported in visual fields, extraocular muscle motility and pupil function.

Conclusion: Ocular dysfunction is commonly found in cases of concussion. No Australian SRC diagnostic protocol includes visual assessments. Orthoptic testing may be a useful adjunct to the standard diagnostic tests for concussion in sports and the clinical setting.

AN AUDIT OF PAEDIATRIC REFERRALS OF PATIENTS WITH SUSPECTED PAPILLOEDEMA MADE TO THE CHILDREN'S HOSPITAL AT WESTMEAD

Sarah Harkins

Papilloedema is defined as optic disc swelling which is caused by raised intracranial pressure. Due to the serious implications of papilloedema in the paediatric population, patients are seen expediently in both the emergency department and outpatient ophthalmology clinic at The Children's Hospital at Westmead (CHW). The eye team at CHW noted an increase in referrals being made with children with suspected papilloedema. An audit was conducted of referrals for papilloedema and compared with the patient's clinical findings.

CASES OF PETERS ANOMALY IN YOUNG CHILDREN

Amy Huynh

Peters anomaly is a rare congenital disease which affects the eyes during the embryonic stages of development. The anterior structures fail to separate completely, hence resulting in the abnormality of cloudy eyes and generally poor visual outcome. Clinical findings of a few patients have been selected to provide an overview of their visual outcome and management of the condition.

REFRACTIVE ERROR IN PRESCHOOL CHILDREN: SYDNEY PAEDIATRIC EYE DISEASE STUDY (SPEDS)

Mythili Ilango, Kathryn Rose, Amanda French

Purpose: It has long been accepted that most young infants are relatively hypermetropic but some recent reports suggest that a more myopic refractive error is prevalent. The distribution of refractive error was examined in a population-based study of Australian pre-school children evaluating the role of ethnicity, iris colour and cycloplegia.

Method: 2,462 children aged 6 to 78 months had comprehensive eye examinations, including biometry measures (for ≥30 months) and cycloplegic (cyclopentolate 1%, 0.5% for ≤12 months) autorefraction (Canon RK-F1), Retinomax or retinoscopy. Ethnicity was ascertained by a questionnaire; iris colour was graded using reference photographs. Spherical equivalent refraction (SE) of the right eye was used for analysis using SPSS (v22, IBM, NY).

Results: Mean SE varied between the age groups (6-12, 13-30, 31-48 and >48 months, p=<0.0001), with infants 6-12 months (1.49D) being the most hypermetopic (all $p<0.05$). The least hypermetopic were the 13-30 months group (1.05D) where the Retinomax was predominantly used. With Retinomax measures excluded, the mean SE was 1.21D for this age group, while Retinomax alone was 0.92D. Children with darker irides were less hypermetopic than those with lighter irides (all ages $p<0.05$). This remained significant in European Caucasian children ($p=0.008$). Axial length/corneal radius ratio is a good predictor of refraction ($r=-0.639$, $p<0.0001$), but did not differ significantly between any of the iris colour groups ($p=0.238$).

Conclusion: The Retinomax and darker irides negatively shifted refractive measures in contrast to ocular biometry, posing the question of what is the reliable refraction protocol in young children?

WHAT? WHEN? WHY?: TELLING MY CHILD THEY WILL LOSE THEIR VISION

Lisa Kearns, Sandra Staffieri, Jonathan Ruddle, Alex Hewitt, David Mackey

Purpose: When their child is diagnosed with a blinding, inherited eye condition, parents experience feelings of shock, devastation, guilt, anger and isolation. Parents often face a dilemma on what and when to tell their child they will go blind.

Method: A series of case studies were used to describe and demonstrate the complexities of disclosure for both parent, child and the extended family.

Results: Two children (unrelated) 5 years and 10 years were diagnosed with Usher Syndrome and X-linked retinitis pigmentosa respectively. Both sets of parents limited the amount of information disclosed based on their child's age and potential exacerbation of anxiety in the child and/or sibling if they were aware of the diagnosis and future prognosis. By contrast, in another family, two brothers in their first decade, were aware they had inherited X-linked choroideremia. Despite the challenges, the brothers were able to make appropriate career choices based on their future visual potential. Families felt the context in which such a prognosis of vision impairment is delivered can be of major importance and influences the decision of when, whether or how much information is provided to their child.

Conclusions: Breaking bad news is complex and difficult. The moment of receiving the diagnosis may influence the emotional impact of such news on parents. Assisting them with appropriate information and supportive genetic counselling can facilitate their decision-making process and enable better adaptation for both parent and child.

PERSISTENT FOETAL VASCULATURE AND THE UNILATERAL CATARACT: ARE WE DOOMED FROM THE BEGINNING?

Lachlan Knight

Persistent foetal vasculature (PFV, previously known as PHPV) is an ocular development disorder in which the embryonic hyaloid vasculature has failed to regress. Unilateral posterior polar cataracts are a common presentation of anterior PFV. The cataracts invariably cause unilateral stimulus deprivation amblyopia in the affected eye, which is considered the most resistant to amblyopia therapy. Progressive anisometropia following cataract extraction also contributes to poor visual prognosis for such patients. However, there are case reports of significant vision improvement. This presentation demonstrated three varied cases.

These cases report the visual results following cataract extraction and primary posterior capsulotomy with anterior vitrectomy in PFV. Each case involves the use of aphakic contact lenses, instead of intraocular lenses, due to the added complexities of PFV-associated microphthalmia and management of high anisometropia.

The first case outlined the expected poor prognosis of vision, owing to difficulty with contact lens wear and compliance issues with amblyopia therapy. The second case, however, presented a successful and promising visual prognosis following compliance with treatment post-surgery. The final case challenges the school of thought that severe stimulus deprivation amblyopia only responds to treatment in early infant years.

In cases of unilateral cataract, a good visual prognosis is rarely expected or achieved. On the contrary, when treatment regimens are followed rigorously, an excellent prognosis is more likely. It is critical to decide when we cease treatment and when we push for further improvement, as our case illustrates that the potential for visual improvement could persist even years later.

THE EFFECTIVENESS OF AMBLYOPIA TREATMENT IN 4-YEAR OLD CHILDREN

Melanie Lai

An audit of the effectiveness of amblyopia therapy in the hospital setting will be discussed. Data from a retrospective analysis of patient demographics, treatment prescribed, the visits attended or not, and treatment outcomes were presented. The estimated hospital costs for the treatment of amblyopia were also be presented.

DEFINING HIGH RISK IN PREMATURE INFANTS

Lindley Leonard

The Ophthalmology department at The Children's Hospital at Westmead has historically accepted referrals for children born prematurely from a number of tertiary hospitals. The referral criteria, protocols and procedures have remained largely unchanged despite advancement in medical care and the treatment of premature babies. Internationally published literature was reviewed to determine the efficacy our current referral criteria and to ensure we align with best practice in ophthalmic assessment of premature babies.

THE PREVALENCE OF MYOPIA IN WESTERN AUSTRALIAN BABY BOOMERS

Gareth Lingham, Seyhan Yazar, Michael Hunter, Diane Wood, David Mackey

Introduction: Since the Blue Mountains Eye Study and Melbourne Visual Impairment Project conducted in the mid-1990s in NSW and Victoria, respectively, there has been little research into the prevalence of myopia amongst older Australians. Thus, the current and generational changes in myopia prevalence of older Australians are unknown. We present data from two contemporary 'Baby Boomer' Western Australian studies (aged 45 to 69 years), the rural Busselton Healthy Ageing Study (BHAS) and the metropolitan-based parents (Gen1) of the 25-year-old Western Australian Pregnancy Cohort (Raine) Study (G1RS) participants.

Methods: All participants underwent autorefraction. Only BHAS participants had cycloplegia. Those who self-reported a cataract or keratoconus diagnosis, or cataract or refractive surgery, were excluded. Myopia was defined as spherical equivalent <-0.50D. Independent samples t-test and test of equal proportions were used to compare continuous and binary outcomes, respectively. Myopia prevalence was standardised for age and sex according to 2016 Australian Census data.

Results: The mean age of participants was 56.4 ± 5.0 years and 57.6 ± 5.7 years ($p<0.001$) in the G1RS (n=891) and BHAS (n=4519), respectively. There was no difference in the mean spherical equivalent between the two cohorts (mean diff=0.07, 95%CI: -0.077 -0.21, $p=0.36$). However, the adjusted prevalence of myopia was higher in the BHAS (33.76% [n=1553] vs 27.08% [n=257], $p<0.001$).

Discussion: The prevalence of myopia was slightly higher in the rural BHAS population which may be a result of the differing autorefraction methods. The prevalence of myopia in both the G1RS and BHAS was higher than that reported in the previous studies of similar-aged Australians.

FUNDUS AUTOFLUORESCENCE IMAGING: AN INTRODUCTION

Myra McGuinness, Robyn Guymer

Fundus autofluorescence joins fundus photography, optical coherence tomography and fluorescein angiography as a powerful imaging tool in the modern ophthalmic clinic. The diagnosis and surveillance of several retinal conditions can be augmented via the use of autofluorescence. This presentation aimed to review autofluorescence techniques and illustrate the characteristic findings of age-related macular degeneration and other inherited retinal dystrophies as viewed via autofluorescence. Recent findings from research on the use of quantitative autofluorescence were also discussed.

HORIZONTAL GAZE PALSY WITH PROGRESSIVE SCOLIOSIS (HGPPS)

Michael Patti

Horizontal gaze palsy with progressive scoliosis (HGPPS) is a rare autosomal recessive disorder caused by homozygous or compound heterozygous mutations in the ROBO3 gene. This rare congenital disorder results in complete absence of horizontal eye movements. The majority of cases that have been documented are from Middle Eastern, African and European backgrounds. It seems that this case report of two brothers aged eight and six of Hokkien descent who have migrated from China, may be the first presented cases in Australia.

QUANTIFYING SPONTANEOUS RETINAL VENOUS PULSATIONS USING A NOVEL TABLET-BASED OPHTHALMOSCOPE

Sahar Shariflou, Ashish Agar, Mojtaba Golzan

Purpose: Spontaneous venous pulsations (SVPs) are fluctuations in vessel diameter observed at the optic nerve. Recent studies have pioneered SVP amplitude as a novel biomarker of glaucoma progression, however, absent SVPs have been reported in up to 50% of glaucoma patients. It was hypothesised that SVPs are detectable and quantifiable in all individuals using appropriate retinal imaging techniques and computer analysis. A novel tablet-based ophthalmoscope can be used to detect SVPs, providing crucial screening for ocular diseases such as glaucoma, leading to early intervention, preventing potential visual impairment.

Methods: Videoscopy of the retinal circulation at the optic nerve was performed on 13 glaucomatous eyes using an iOS-operating device with an attached add-on 20D indirect ophthalmoscopy lens. Data on SVPs were quantified by exporting individual video frames, manipulating image contrast and stabilising frames to eliminate eye movements. The central retinal vein diameter was measured in each frame and plotted against time.

Results: Thirteen eyes; 6 male (average age 60 years) and 7 female (average age 71 years) were imaged. SVPs were detected in all eyes and were quantified, with the average percentile pulse being 36.57% change (range 15.6-72.73). There was no significant difference in SVPs in males and females.

Conclusion: This study provides proof of principle that by applying correct computer algorithms, manipulating image quality with a high-powered lens, SVPs can be reliably extracted and quantified using this hand-held device. The next step in this research is to determine whether SVP assessment can aid early diagnosis of glaucoma in a larger cohort.

EXPLORING METHODOLOGY THAT REVEALS THE FUNCTIONAL IMPACT OF CHILDHOOD VISION IMPAIRMENT - THE OUTCOME OF AN E-DELPHI STUDY

Sue Silveira

To ensure that the National Disability Insurance Scheme (NDIS) provides reasonable and adequate support when a child has vision impairment, it is critical that reporting captures the functional impact of vision impairment on the child's day-to-day learning and experiences. However, the current NDIS access requirements for vision do not allow the child's vision to be represented functionally, but rather in terms of their clinical performance, ie their distance visual acuity and visual fields. This issue was investigated during 2017 in a study that used an e-Delphi technique to explore the functional impact of childhood vision impairment. The study participants consisted of orthoptists and specialist teachers in vision impairment. The study addressed ways in which the factors that impact on a child's daily visual function could be identified and rated. The participants provided feedback on the suitability of the inventories within the revised World Health Organization's International Classification of Diseases version 11. These inventories described other impairments of vision such as reduced contrast sensitivity and glare; subjective visual experiences such as visual fatigue, specific visual dysfunctions such as spatial neglect; and the effects of non-visual disabilities such as dual sensory impairment.

The findings of the e-Delphi study were presented in this paper, including a proposed model that may be suitable to judge a child's eligibility for NDIS funding. This model combines traditional clinical measurements with those phenomena that impact on a child's visual function, thus potentially indicating the functional impact of childhood vision impairment.

THE DELIVERY OF EYE CARE IN A CAMBODIAN HOSPITAL

Suzy Toovey

This presentation provided a personal look at the delivery of eye care in a Cambodian Hospital run by Korean Christian Missionaries. Whilst volunteering in an Eye Clinic in Cambodia I was able to witness the delivery of optical and some basic eye care. This talk is a personal tale of what I observed whilst I was there. It also explored the delivery of eye services at one hospital in Phnom Penh and makes some observations of how delivery of services could be improved. It also compared the services available to an older population to what is available in one hospital in Phnom Penh.

BOTOX

Faren Willett

Strabismus was the initial use for Botox and remains one of the five management options for someone who presents with strabismus and diplopia. It can be a good option for some patients with diverse circumstances. This presentation described a few patients who presented with varying complaints and how they benefited from Botox treatment.

The first patient is a surgeon who presented with a vascular sixth nerve palsy and diplopia after poorly self-managing his own diabetes. Being a surgeon, he relied on his excellent vision and his diplopia was preventing him from being able to work and support himself, his family and his clinic. Botox alleviated the diplopia and he was able to return to surgery. It has been a year since his last Botox injection, his palsy has resolved and he no longer suffers from diplopia.

The second patient had convergence insufficiency which was preventing her from completing her PhD study and interfered with her daily routine. Botox improved her convergence near point and alleviated her symptoms so that she was able to read more comfortably.

Another had a large angle exotropia since childhood. He doesn't have any diplopia, but is self-conscious of his turn. The patient has been returning for Botox injections for cosmetic alignment when he has important social events.

A CASE OF A POOR HISTORIAN

Shandell Wishart

To develop a sustainable clinical model of care for the management of In a busy retinal clinic a patient attends with non-specific eye trouble; the usual method would be to perform a vision, IOP and dilate. This case turned out to be much more than that. This case study to highlighted the importance of a good history, observing patient behaviour and using our gut instincts as clinicians.

Named Lectures, Prizes and Awards of Orthoptics Australia

THE PATRICIA LANCE LECTURE

1988	Elaine Cornell	Home exercises in orthoptic treatment
1989	Alison Pitt	Accommodation deficits in a group of young offenders
1990	Anne Fitzgerald	Five years of tinted lenses for reading disability
1992	Carolyn Calcutt	Untreated early onset esotropia in the visual adult
1993	Judy Seaber	The next fifty years in orthoptics and ocular motility
1995	David Mackey	The Glaucoma Inheritance Study in Tasmania (GIST)
1997	Robin Wilkinson	Heredity and strabismus
1998	Pierre Elmurr	The visual system and sports perfomance
1999	Kerry Fitzmaurice	Research: A journey of innovation or rediscovery?
2005	Kathryn Rose	The Sydney Myopia Study: Implications for evidence based practice and public health
2006	Frank Martin	Reading difficulties in children - evidence base in relation to aetiology and management
2008	Stephen Vale	A vision for orthoptics: An outsider's perspective
2009	Michael Coote	An eye on the future
2010	John Crompton	The pupil: More than the aperture of the iris diaphragm
2011	Neryla Jolly	On being an orthoptist
2012	Shayne Brown	A snapshot of orthoptics from the 1960s to 2000
2013	Sue Silveira	Finding the leader within
2014	Patricia Dunlop	A life in orthoptics
2015	Fiona Rowe	The spectrum of post-stroke visual impairment
2016	Linda Santamaria	50 years: The development of research and publication in the Australian Orthoptic Journal
2017	Sandra Staffieri	Delayed diagnosis of childhood strabismus: When does it matter?

THE EMMIE RUSSELL PRIZE

1957	Margaret Kirkland	Aspects of vertical deviation
1959	Marion Carroll	Monocular stimulation in the treatment of amblyopia exanopsia
1960	Ann Macfarlane	A study of patients at the Children's Hospital
1961	Ann Macfarlane	A case history "V" Syndrome
	Margaret Kirkland	Surgical cases of intermittent divergent strabismus
1962	Adrienne Rona	A survey of patients at the Far West Children's Health Scheme, Manly
1963	Madeleine McNess	A survey of the use of miotics
1965	Margaret Doyle	Diagnostic pleoptic methods and problems encountered
1966	Gwen Wood	Miotics in practice
1967	Sandra Hudson Shaw	Orthoptics in Genoa
1968	Lesley Stock	Divergent squints with abnormal retinal correspondence
1969	Sandra Kelly	The prognosis of the treatment of eccentric fixation
1970	Barbara Dennison	A summary of pleoptic treatment and results
1971	Elaine Cornell	Paradoxical innervation
1972	Neryla Jolly	Reading difficulties
1973	Shayne Brown	Uses of fresnel prisms
1974	Francis Merrick	The use of concave lenses in the management of intermittent divergent squint
1975	Vicki Elliott	Orthoptics and cerebral palsy
1976	Shayne Brown	The challenge of the present
1977	Melinda Binovec	Orthoptic management of the cerebral palsied child
1978	Anne Pettigrew	
1979	Susan Cort	Nystagmus blocking syndrome
1980	Sandra Tait	Foveal abnormalities in ametropic amblyopia
1981	Anne Fitzgerald	Assessment of visual field anomalies using the visually evoked response
1982	Anne Fitzgerald	Evidence of abnormal optic nerve fibre projection in patients with dissociated vertical deviation: A preliminary report
1983	Cathie Searle	Acquired Brown's syndrome: A case report
	Susan Horne	Acquired Brown's syndrome: A case report
1984	Helen Goodacre	Minus overcorrection: Conservative treatment of intermittent exotropia in the young child
1985	Cathie Searle	The newborn follow up clinic: A preliminary report of ocular anomalies
1988	Katrina Bourne	Current concepts in restrictive eye movements: Duane's retraction syndrome and Brown's syndrome
1989	Lee Adams	An update in genetics for the orthoptist: A brief review of gene mapping

1990	Michelle Gallaher	Dynamic visual acuity versus static visual acuity: Compensatory effect of the VOR
1991	Robert Sparkes	Retinal photographic grading: The orthoptic picture
1992	Rosa Cingiloglu	Visual agnosia: An update on disorders of visual recognition
1993	Zoran Georgievski	The effects of central and peripheral binocular visual field masking on fusional disparity vergence
1994	Rebecca Duyshart	Visual acuity: Area of retinal stimulation
1995-97	Not awarded	
1998	Nathan Clunas	Quantitative analysis of the inner nuclear layer in the retina of the common marmoset callithrix jacchus
1999	Anthony Sullivan	The effects of age on saccades made to visual, auditory and tactile stimuli
2001	Monica Wright	The complicated diagnosis of cortical vision impairment in children with multiple disabilities
2005	Lisa Jones	Eye movement control during the visual scanning of objects
2006	Josie Leone	The prognostic value of the cyclo-swap test in the treatment of amblyopia using atropine
2007	Thong Le	What is the difference between the different types of divergence excess intermittent exotropia?
2008	Amanda French	Does the wearing of glasses affect the pattern of activities of children with hyperopic refractive errors?
2009	Amanda French	Wide variation in the prevalence of myopia in schools across Sydney: The Sydney Myopia Study
2010	Alannah Price	Vertical interline spacing and word recognition using the peripheral retina
2011	Amanda French	Comparison of the distribution of refraction and ocular biometry in European Caucasian children living in Northern Ireland and Sydney
2012	Melanie Cortes	Treatment outcomes of children with vision impairment detected through the StEPS program
2013	Jess Boyle	The accuracy of orthoptists in interpreting macular OCT images
2014	Allanah Crameri	Orthoptist-led clinics: investigating the effectiveness and efficiency of orthoptists in diabetic retinopathy screening and cataract assessment
2015	Jess Boyle	The psychological impact of repeated intravitreal injections on patients with neovascular age-related macular degeneration
2016	Gareth Lingham	Early life risk factors of amblyopia, strabismus and anisometropia in a young adult population
2017	Linden Chen	The twilight zone

PAEDIATRIC ORTHOPTIC AWARD

1999	Valerie Tosswill	Vision impairment in children
2000	Melinda Syminiuk	Microtropia - a challenge to conventional treatment strategies
2001	Monica Wright	The complicated diagnosis of cortical vision impairment in children with multiple disabilities
2005	Kate Brassington	Amblyopia and reading difficulties
2006	Lindley Leonard	Intermittent exotropia in children and the role of non-surgical therapies
2007	Jody Leone	Prevalence of heterophoria in Australian school children
2008	Jody Leone	Can visual acuity screen for clinically significant refractive errors in teenagers?
2009	Jody Leone	Visual acuity testability with the electronic visual acuity-tester compared with LogMAR in Australian pre-school children
2010	Fiona Gorski	Neurofibromatosis and associated ocular manifestations
2011	Suzy King	Understanding Sturge-Weber syndrome and the related ocular complications
2012	Jane Scheetz	Accuracy of orthoptists in the diagnosis and management of triaged paediatric patients
2013	Louise Brennan	Visual outcomes of children seen in the StEPS High Priority Clinic at The Children's Hospital at Westmead
2014	Nicole Carter	Understanding ocular motor apraxia
2015	Lindley Leonard	Long-term follow-up of a high priority referral clinic at The Children's Hospital at Westmead - beyond the clinic
2016	Cem Oztan	A novel method for measuring nystgamus
2017	Sarah Harkins	An audit of paediatric referrals of patients with suspected papilloedema made to The Children's Hospital at Westmead.

THE MARY WESSON AWARD

1983	Diana Craig (Inaugural)	1998	Not Awarded	2010	Elaine Cornell
1986	Neryla Jolly	2001	Heather Pettigrew	2011	Zoran Georgievski
1989	Not awarded	2004	Ann Macfarlane	2014	Mara Giribaldi
1992	Kerry Fitzmaurice	2008	Julie Barbour	2107	Keren Edwards
1995	Margaret Doyle				

ZORAN GEORGIEVSKI MEDAL

2012	Neryla Jolly (Inaugural)	2014	Linda Santamaria	2016	Julie Barbour
2013	Connie Koklanis	2015	Sue Silveira	2017	Meri Vukicevic

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1947-48 Lucy Willoughby
1948-49 Diana Mann
1949-50 E D'Ombrain
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1954-55 Diana Mann
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1956-57 Mary Carter
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1959-60 Patricia Lance
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1968-69 Diana Craig
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1976-77 Vivienne Gordon
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1982-83 Jill Stewart
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1987-89 Margaret Doyle
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1991-93 Anne Fitzgerald
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1995-97 Jan Wulff
1997-00 Kerry Fitzmaurice
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2002-04 Val Tosswill
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Vol 9 1969	Barbara Dennison & Neryla Heard
Vol 10 1970	Neryla Heard
Vol 11 1971	Neryla Heard & Helen Hawkeswood
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School of Allied Health
La Trobe University
Bundoora, VIC 3086
T: 03 9479 5285
www.latrobe.edu.au/courses/orthoptics

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Discipline of Orthoptics
Graduate School of Health
University of Technology
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