Hearing Review™

Making Education Easy

Issue 23 – 2010

In this issue:

Welcome to the twenty-third issue of Hearing Review.

This edition of Hearing Review covers a wide variety of topics, several of which involve the paediatric population: the effects of digital noise reduction on speech perception in the classroom for schoolchildren with hearing loss, clinical practices related to recommendations and uptake of amplification in children identified with permanent mild bilateral or unilateral hearing loss, preferences and use of classroom assistive learning devices among hearing-impaired students, auditory and cognitive abilities among children suspected of having auditory processing disorder, a new modified hearing screening method for school-age children, and an investigation into the risk factors for elevation of the auditory brainstem response threshold in neonatal intensive care unit-treated infants.

I hope you find the papers in this issue useful in your practice and I welcome your comments and feedback.

Kind regards,

Valerie Looi
Senior Lecturer in Audiology, University of Canterbury
valerielooi@researchreview.co.nz

Bone-anchored hearing aid subjective benefit for unilateral deafness

Authors: House JW et al

Summary: This study used the Abbreviated Profile of Hearing Aid Benefit (APHAB) and the Speech, Spatial, and Qualities of Hearing Questionnaire (SSQ) to evaluate the effectiveness of the bone-anchored hearing aid (BAHA) in 68 patients with unilateral deafness of various aetiologies. They were compared with 61 patients not implanted with a BAHA after a translabyrinthine craniotomy, who received only the SSQ questionnaire. The overall SSQ scores did not differ between the BAHA and the control group. Of the 50 patients in the BAHA group who completed the APHAB questionnaire, average aided (BAHA on) scores were significantly lower than unaided (BAHA off), indicating benefit from the BAHA ($p<0.0001$). Most improvement with the BAHA was seen in the Background Noise subscale, with a 17.4% improvement. Ease of Communication and Reverberation subscales also demonstrated an 11.6% and 13.2% benefit, respectively.

Comment: Although CROS aids may benefit some patients with a significant unilateral hearing loss, users often report problems such as the amplification of background noise, poor aesthetics, and sound distortion. More recently, the BAHA has been used as an alternative, with studies reporting better speech intelligibility and patient acceptance than the CROS aid. Additionally, for patients undergoing acoustic neuroma surgery where there is potential of a resulting unilateral hearing loss, the BAHA can be implanted at the time of tumour removal to save a second surgery. This study showed that the BAHA was both objectively and subjectively better than the CROS aid for speech perception in noise, probably as it partially preserves the head-shadow effect, as opposed to the CROS aid that will transmit greater levels of noise. However, sound localisation remained problematic; a monaural hearing loss diminishes the ability to use interaural timing and loudness cues, and the BAHA did not significantly assist with this. On the subjective questionnaires, the BAHA was preferred for certain situations (e.g. noisy backgrounds, communicating in the car, locating a speaker on the horizontal plane); however, scores on the sound qualities subscale were higher for non-BAHA users, suggesting that the BAHA did not improve sound quality.

Reference: Laryngoscope. 2010;120(3):601-7.
http://onlinelibrary.wiley.com/doi/10.1002/lary.20802/abstract

Effects of digital noise reduction on speech perception for children with hearing loss

Authors: Stelmachowicz P et al

Summary: This US-based study examined the effects of a commonly used digital noise-reduction scheme (spectral subtraction) in 16 children (eight 5- to 7-yr-olds and eight 8- to 10-yr-olds) with mild to moderately severe hearing losses. All participants wore binaural behind the ear hearing aids where noise-reduction processing was performed independently in 16 bands with centre frequencies spaced 500 Hz apart up to 7500 Hz. Test stimuli were nonsense syllables, words, and sentences presented in noise. For all stimuli, data were obtained with noise reduction (NR) on and off conditions. Performance improved as a function of the speech-to-noise ratio for all three speech materials. The main effect for stimulus type was significant. Post hoc comparisons of stimulus type indicated that speech recognition was higher for sentences than that for both nonsense syllables and words, but no significant differences were observed between nonsense syllables and words. The main effect for noise reduction (NR) and the two-way interaction between NR and stimulus type were not significant. The main effect for age group was significant; however, the two-way interaction between NR and age group was not significant.

Comment: This study looks at how noise and reverberation in combination affect speech recognition performance, as a function of age. The Australian/New Zealand Standards have specified guidelines for classroom design, to provide guidelines regarding the maximum allowable background noise level (35dBA averaged for 1hr), and the maximum reverberation time (0.6–07.sec depending on room size) for primary schools. A preview of the Standard is available at: http://shop.standards.co.nz/scope/ASNZS2107-2000.scope.scope.pdf; these are similar to the ANSI standards from the USA. A survey of 32 USA classrooms found that 88% exceeded the background noise recommendation, and 59% exceeded the reverberation time recommendation. Further, the standards relate to unoccupied classrooms; estimates of noise levels in occupied classrooms range from 50–65dBA. With research suggesting that occupied classrooms have a signal-to-noise ratio <10dB, and for young children between 0–5dB, the findings of the current study suggest that the younger children's average speech recognition abilities would be <50% in class. A SNR ratio of 15dB would be required for 95% speech recognition for children aged 6 and older in classrooms where the reverberation times were as per the Standards.

Reference: Ear Hear. 2010;31(3):345-55.

http://journals.lww.com/ear-hearing/Abstract/2010/06000/Effects_of_Digital_Noise_Reduction_on_Speech.5.aspx

Clinical practice for children with mild bilateral and unilateral hearing loss

Authors: Fitzpatrick EM et al

Summary: These researchers sought to determine the prevalence of mild bilateral or unilateral hearing loss identified in a clinical population from 1990 to 2006, and to document clinical practices related to recommendations and the uptake of amplification. Their retrospective analysis of data from medical charts at a single paediatric centre demonstrates a delay to amplification in the children identified with permanent mild bilateral or unilateral hearing loss, regardless of the age of identification, indicating considerable uncertainty regarding best practices for this population of children.

Comment: Research generally suggests that the prevalence of permanent hearing loss (HL) is 2–3/1000 births, and that mild or unilateral HL (M/UHL) accounts for 30–40% of these cases. However, there is much indecision and variation with regards to the management of these children. The 16-year retrospective chart review from a Canadian hospital encompassed 5 years of universal newborn hearing screening (UNHS) and 11 years of a high-risk screening protocol. In this time period, 670 children had a permanent congenital hearing loss, with 291 having a M/UHL. 255 of these were included in the review; of these, 178 had a mild bilateral HL, 31 had a mild high-frequency HL, and 46 had a unilateral HL. The median diagnosis age was 54.2 months; 60.4mo for the unilateral HL, 56.9mo for the mild high-frequency HL and 51.1mo for the mild bilateral HL. The median age for confirmation of the HL was 59.4mo. For children identified through UNHS, the median age of confirmation dropped to 10.6mo, with a 5mo gap between initial diagnosis and confirmation. Initial recommendations for amplification were made for 54.1% of the 255 children, with a further 37.3% receiving a recommendation later (median time: 16.4mo) (i.e. 91.4% in total). Of these 'amplified' children, 36.7% did not use their amplification consistently or at all. The delay in the recommendation for amplification in part reflects the uncertainty regarding best practice. The delay between initial identification of HL and confirmation may reflect the difficulty in confirming the presence of a mild HL with current electrophysiological/behavioural tests, and/or the prevalence of middle ear effusion.

Reference: Ear Hear. 2010;31(3):392-400.

http://journals.lww.com/ear-hearing/Abstract/2010/06000/Clinical_Practice_for_Children_with_Mild_Bilateral.11.aspx

Incidence, persistence, and progression of tinnitus symptoms in older adults: the Blue Mountains Hearing Study

Authors: Gopinath B et al

Summary: These researchers report a longitudinal description of the experience of tinnitus in a representative older population-based cohort – participants of the Blue Mountains Hearing Study (1997–1999) with complete tinnitus data who were followed up at 5-yr examinations in 2002–2004. Presence of prolonged tinnitus was assessed by a positive response to a single question administered by an audiologist. Incident tinnitus was defined in participants who were free of tinnitus symptoms at baseline but who reported tinnitus symptoms at the 5-yr follow-up. Progression of tinnitus was defined as the increase in annoyance of tinnitus symptoms from baseline to the 5-yr follow-up study. Persistence of tinnitus symptoms was defined as the presence of tinnitus symptoms at both the baseline and follow-up examinations. Hearing impairment was measured as the pure-tone average (PTA) of audiometric hearing thresholds at 500, 1000, 2000, and 4000 Hz (PTA0.5–4 kHz), defining bilateral hearing loss as PTA0.5–4 kHz >25 dB HL.

Comment: Data from the Blue Mountains Hearing Study have been reported in previous editions of HRR. In this study, the incidence and progression of tinnitus from baseline to a 5yr follow-up (5yFU) was investigated for 2006 adults aged ≥49yr. At baseline, 37.2% reported tinnitus, with the 5yFU incidence being 18%. At the 5yFU, there was a significant age trend with incidence rates decreasing with increasing age, particularly in men. It may be that older adults find the relative contribution of tinnitus to their overall health less significant as they get older, or that they have learnt better coping and management skills, and/or that younger adults are at greater risk due to workplace and recreational noise exposure. The presence of a hearing loss doubled the 5yrFU incidence (odds ratio 2.13), and annoyance was not associated with severity of hearing loss. Of those who reported tinnitus at baseline, 81.6% reported tinnitus persisting at the 5yFU, and usually the tinnitus symptoms were worse and more annoying than for the new cases of tinnitus. However, 78 adults who reported tinnitus at baseline did not report it at the 5yFU, with more than half of those experiencing tinnitus at baseline reporting diminished annoyance of symptoms at the 5yFU. Other interesting findings were that the majority of cases reported their symptoms to be only mildly annoying, and that it did not affect their sleep. Less than 10% had sought treatment or help for their tinnitus.

It should be noted that the presence of tinnitus was assessed using one question: "Have you experienced any prolonged ringing, buzzing, or other sounds in your ears or head within the past year…that is lasting for 5 minutes or longer?"

Reference: Ear Hear. 2010;31(3):407-12.

http://tinyurl.com/2eks5g4

Factors influencing rehabilitation decisions of adults with acquired hearing impairment

Authors: Laplante-Lévesque A et al

Summary: This Australian study explored the factors influencing the rehabilitation decisions of adults with acquired hearing impairment. Four options (hearing aids, group communication program, individual communication program, and no intervention) were discussed using shared decision making with 153 adults with acquired hearing impairment who had not previously received hearing rehabilitation.

Comment: The Health Belief Model describes how people conceive health behaviour change, and suggests that 'perceived susceptibility and seriousness of the condition' and 'perceived benefits and barriers to intervention' are the two main factors that influence health decisions. Four rehabilitation options were available, and the study identified 7 categories of factors that influenced the adults' choices: Convenience (e.g. location, time commitment, travel time, ease of access); Expected adherence and outcomes; Financial costs; Hearing disability (e.g. some reporting that their disability was too mild to warrant intervention); Nature of intervention (e.g. concerns over business practices for hearing aid clinics, ease with technology, comfort in a group setting, independent learning abilities, stigma etc); Other people's experiences/recommendations/ support; and, Preventive and interim solutions (i.e. that their decision is ongoing and reversible, as hearing loss is a chronic condition). As has been shown in previous studies, the degree of hearing impairment had minimal impact on decisions; rather, it was how the individual perceived their hearing disability. This is in line with previous studies implying that emotion, rather than cognition, underpins many health behaviours and decisions.

This article also provides examples of the written material provided to patients on the various rehabilitation options available, which may be of interest to clinicians. Research has indicated that such material needs to be in language understandable for people with no more than 8 years of education.

Reference: Int J Audiol. 2010;49(7):497-507.

http://tinyurl.com/2ayyl2k

Self-assessment of classroom assistive listening devices

Authors: Odelius J, Johansson Ö

Summary: This study investigated the preference of classroom assistive listening devices (ALDs) based on induction loop systems in Swedish classes for hearing-impaired students. The study cohort consisted of 25 students (bilateral hearing aid users, 10–20 years old).

Comment: ALDs improve the signal-to-noise ratio, and for a HA user, they can either listen to the signal from the HA microphone (M), the signal from the ALD via telecoil (T), or in many HAs, a mixed mode (M/T). This study asked Swedish hearing-impaired students about their preferences and use of classroom ALDs, and to compare the T- to the M-mode using a questionnaire that assessed speech perception in different listening situations, spatial perception (e.g. localising sounds), and general sound perception (e.g. pleasantness & naturalness of the sound, effort required, emotion identification, etc). The 18 questions are provided in the article. Overall, T-mode was preferred for speech; M-mode for spatial hearing and sound segregation; T-mode was associated with less listening effort, and there were no significant differences between the two for sound quality. However, there were a lot of individual differences in preferences. The dilemma is that T-mode enables the student to better ignore competing sounds (described as a 'teaching communication channel' by some), but M-mode enables them to better monitor what is happening, and to have multiple conversations. MT mode was preferred by some, but others reported that this mode was confusing and unnatural. Interestingly, the study also found that mode preference was associated with hearing levels; those with better hearing preferred M-mode, those with a severe loss preferred T-mode. The authors' suggestion that T-mode enabled audibility and M-mode enabled awareness may be a succinct way of summarising the main practical difference between modes to new HA users.

Reference: Int J Audiol. 2010;49(7):508-17.

http://informahealthcare.com/doi/abs/10.3109/14992021003645886

Auditory and cognitive abilities of children suspected of auditory processing disorder (APD)

Authors: Rosen S et al

Summary: Children suspected of having auditory processing disorder (APD) show, on average, poorer performance on a number of auditory tasks. This study evaluated auditory and cognitive abilities in a group of children referred for an auditory evaluation on the grounds of a suspected auditory processing disorder (susAPD), and in age-matched children who were typically developing, in an attempt to determine the extent to which any auditory deficits impact on the development of cognitive abilities. The study cohort comprised 20 susAPD school-age children, all reported as having listening/hearing problems but performing within normal limits for standard audiometric assessments, who underwent a battery of auditory and cognitive tests. A group of 28 age-matched controls was also tested. The susAPD group was also assessed for symptoms of Attention Deficit Hyperactivity Disorder (ADHD).

Comment: Unlike most articles on APD discussed previously in HRR, this one looked at children *referred* for APD assessment – i.e. not confirmed to have APD. An earlier study by the authors found that two tests differentiated referred children (susAPD) from an age-matched control group. These were a verbal discrimination task where the rhyming word pairs which differed in their initial consonant cluster were presented in background noise (SNR –2.3dB), and a non-verbal discrimination task where complex period tone pairs were presented with varying amounts of time between them. In this study, 65% of the children performed in the bottom 5% of the population on one or both tasks, with the verbal discrimination task providing better differentiation between the two groups. The susAPD group also scored lower than the controls for the cognitive assessment and non-verbal IQ assessments. There were no correlations for the susAPD group between auditory scores and measures of ADHD, suggesting that the poor auditory test scores were not a reflection of inattention and/or hyperactivity.

This study focused on looking at correlations within (rather than between) groups on the premise that if auditory deficits were the primary cause of the cognitive deficits, strong correlations between the auditory processing and the cognitive tasks should be seen. However, the results showed no correlation between performance on a speech perception task to measures of language ability or reading, implying that impaired speech perception is not the main cause of impaired language. Having said this, there is also other research that suggests otherwise. The debate continues…!

Reference: Int J Pediatr Otorhinolaryngol. 2010;74(6):594-600.

http://www.ijporlonline.com/article/S0165-5876%2810%2900069-8/abstract

Independent commentary by Dr Valerie Looi, a Senior Lecturer in Audiology for the Department of Communication Disorders at the University of Canterbury. Her primary areas of research are in the field of cochlear implants, along with the music perception of those with a hearing impairment. She is particularly interested in developing a music training programme for cochlear implant users.

Research Review publications are intended for NZ Medical Professionals.

The Hearing Scale Test for hearing screening of school-age children

Authors: Liao WH et al

Summary: These researchers detail outcomes of a comparison between a new modified hearing screening method that can rapidly screen hearing and provide stratified test values for each screened ear of children – the Hearing Scale Test (HST) – and the conventional pure-tone screening (PTS), in a cohort of 384 school-age children.

Comment: The screening performed in this study was for school-age children. One commonly adopted approach is PTS, where 4 pure tones are presented to each ear at a predetermined level and the child 'passes' if they respond to all 4 tones in each ear. The disadvantage of this is that it provides no further information – e.g. it does not provide values that can be recorded for monitoring. The HST is applied with a computerised audiometer and uses a stratified 10-point scale for results, allowing a record to be kept of the levels which the child responded. A pass/fail classification is still applied, but the 'level' of pass or fail can be determined (i.e. S1–S5=normal hearing and a 'pass'; S6–S7 indicates possible hearing loss and a 'fail'; S8–S10 or NR indicates confirmed hearing loss and a 'fail'). In comparing the HST to PTS, there were no significant differences between results obtained, indicating that both tests provide similar hearing results. The authors estimated that the HST took 2–3 mins per child, which is approximately 1 min longer than the PTS, but possibly justifiable, given that the results give minimum audible hearing values that can used for monitoring and tracking. As the HST uses a computerised audiometer, the procedures are standardised, and hence results can be used to make comparisons between classes, schools or groups.

Reference: Int J Pediatr Otorhinolaryngol. 2010;74(7):760-4.

http://www.ijporlonline.com/article/S0165-5876%2810%2900128-X/abstract

Risk factors for elevation of ABR threshold in NICU-treated infants

Authors: Morimoto N et al

Summary: These researchers sought to elucidate the relationship between risk factors in neonatal intensive care unit (NICU)-treated infants and a deterioration of auditory brainstem response (ABR) threshold in their childhood. A cohort of 101 NICU-treated infants with ABR threshold of ≥50dBnHL underwent a second ABR test at 20 months after delivery.

Comment: Previous studies have suggested that infants in the NICU have a 10–20-fold increased risk of hearing impairment compared to healthy newborns. Possible causes include both congenital (e.g. genetic or anatomic issues) as well as acquired (e.g. ototoxicity, noise in NICU) considerations, but the relative contribution of each is unknown.

Of 1121 neonates treated in a NICU of a Japanese paediatric hospital who had an ABR (click stimuli) prior to discharge, 125 (11%) had thresholds ≥50dBnHL in one or both ears, which is significantly higher than the rates of permanent hearing impairment in children. Of these, only 10 were conductive losses. For the 101 neonates in this study, at the initial ABR test, 57 had bilateral losses, 44 unilateral losses, and 20 had thresholds ≥90dBnHL bilaterally. At the 2nd ABR test, 28 infants had bilateral thresholds ≥50dBnHL, 9 had unilateral losses ≥50dBnHL and 19 had thresholds ≥90dBnHL bilaterally. There were 7 infants whose ABR thresholds increased by ≥20dBnHL, and 70 whose thresholds decreased by ≥20dBnHL. Of these 70 whose thresholds decreased, 65 infants had thresholds within normal limits. For the 7 infants whose ABR thresholds increased, there was a significant correlation with congenital diaphragmatic hernias, severe respiratory diseases or high C-reactive protein levels. These can result in reduced oxygenation, which has been associated with delayed-onset hearing loss. For the infants whose ABR improved, reasons may include immaturity in the development of the auditory features and/or incomplete myelination.

Reference: Int J Pediatr Otorhinolaryngol. 2010;74(7):786-90.

http://www.ijporlonline.com/article/S0165-5876%2810%2900173-4/abstract

Otoacoustic emissions in a hearing conservation program: General applicability in longitudinal monitoring and the relation to changes in pure-tone thresholds

Authors: Helleman HW et al

Summary: This study had two aims: to clarify whether otoacoustic emissions (OAEs) can be used to monitor noise-induced hearing loss (NIHL) in a setting such as a newspaper printing office, and it sought to investigate the patterns in development of hearing loss in audiometry and OAEs.

Comment: General indications are that OAEs can help the early detection of NIHL at the preclinical damage stage, and also demonstrate smaller standard deviations than pure tone audiometry in test-retest measurements. Hence, this study looked at the feasibility of using it to monitor for NIHL in a workplace environment. In this study, where 233 employees of a printing factory were tested 17 months apart using OAEs and pure tone audiometry, deterioration in mid-high frequency hearing was noted on all assessments. However, the application of OAEs as a monitoring tool in this setting struck one crucial issue – determining an appropriate starting point. A high SNR inclusion criterion reduces the number of employees for whom OAEs can be used as a monitoring tool (as they do not have sufficient emissions). A lower SNR criterion would increase the number of employees 'dropping out' in the early years of monitoring if their hearing deteriorates. When using OAEs in a noise-exposed population, a pre-existing hearing loss will limit the range of measurable emissions that can be used for monitoring. Further, although the high frequency region is the most useful for monitoring individuals, it is also the region where nearly half of the targeted population does not have emissions present to enable monitoring. Hence, OAEs could only be used effectively for a subset of the targeted population, and pure tone audiometry would be necessary for those with a pre-existing hearing loss, and/or low OAE levels.

Reference: Int J Audiol. 2010;49(6):410-9.

http://www.ingentaconnect.com/content/apl/tija/2010/00000049/00000006/art00002