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Children with Hearing Impairment: Experience at Child Assessment Service (CAS), Department of Health in Hong Kong

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Early Identification of Significant Hearing Loss

Permanent significant congenital hearing loss is a condition with serious potential consequences on the language, speech, learning and emotional development of affected children. In 2009 the Centres for Disease Control and Prevention Hearing Screening and Follow-up Survey reported that 1.4 per 1,000 babies screened were identified with hearing loss,[1] while population-based studies in Europe and North America have identified a consistent prevalence of approximately 0.1% of children having a hearing loss of more than 40 decibels (dB) through review of health or education records, or both.[2]

Modern screening tests for newborn hearing impairment were reviewed, and were shown to improve identification of newborns with moderate to profound bilateral permanent hearing loss.[3] In 2007, a position statement on principles and guidelines for early hearing detection and intervention was issued by The Joint Committee of Infant Hearing (JCIH) of the American Academy of Pediatrics, recommending that screening for all infants should be completed by 1 month of age, with confirmatory audiological evaluation for those who do not pass screening done by 3 months of age, and that infants with confirmed hearing loss should receive intervention services from health and educational professional with expertise in hearing loss no later than 6 months of age.[4]

In Hong Kong a pilot for an infant hearing screening programme was made in 2000 by the Hong Kong Department of Health Family Health Service Maternal & Child Health Centres (MCHC) using automated otoacoustic emission (AOAE),[5] followed by the rolling out of universal screening at all MCHCs. Over 2003-2007, the programme yielded 0.49 per 1,000 screened babies for bilateral sensorineural hearing loss of moderate grade or worse.[6] This programme was subsequently followed by the launching of a two-stage screening model using automated auditory brainstem response (AABR) protocol at Hong Kong Hospital Authority (HA) birthing hospitals from 2007. It is recommended that screening for infants with risk factors for auditory neuropathy, estimated to account for 2.44% of sensorineural hearing loss, should include both DPOAE and AABR even if they pass the initial DPOAE testing.[7,8] Today, screening by AABR at hospitals and by AOAE at MCHCs are in place.

Experience at the Child Assessment Service (CAS), Department of Health

Child Assessment Service (CAS) of the Hong Kong Department of Health receives referrals for cases screened positive for further diagnostic assessment, and referrals for children with diagnosed hearing loss. In the years 2011 and 2012, CAS registered 45 and 55 referrals respectively with final diagnosis of permanent congenital hearing loss (PCHL) of moderate grade or worse. Current referral paths for infants and children diagnosed with PCHL are circuitous and tenuous, with HA hospitals directing cases of PCHL to the

Hong Kong Education Bureau (EDB) if hearing aid prescription is indicated, which in turn refers the children to CAS for comprehensive developmental follow up (Table 1). Territory wide data management and tracking systems to monitor the quality of longitudinal and coordinated services are not in place.

Table 1. Referrals to CAS in 2011 and 2012: age at referral, age at screening and age at diagnosis

	Year								
	2011			2012			Total		
Age	Min	Max	Median	Min	Max	Median	Min	Max	Median
Age of Referral (months)	2.0	65.0	10.5	2.0	57.0	9.0	2.0	65.0	9.0
At screening (days)	1.0	547.5	3.5	1.0	150.0	1.0	1.0	547.5	1.0
At diagnosis (months)	0.3	63.0	5.0	0.6	51.0	3.0	0.3	63.0	4.0

Compiling all cases newly diagnosed in 2012 within CAS with significant hearing impairment (HI), 85 records were retrieved. Referral reasons include diagnosed newborn hearing impairment and suspected hearing problems (64%), and others with various developmental concerns. At diagnosis, 44% were under 1 year of age, 36% between 1-2;11 years, 18% between 3-5,11 years and 2 % were 6 years or above. Co-morbidities were common, including 20% with borderline developmental delay and 14% with intellectual disability.

At CAS, infants and children with significant HI are seen by multidisciplinary assessment teams according to standardized protocols for medical, speech, language and nonverbal cognitive evaluation. The approach is family-centred and longitudinal. Parents are provided with evidence based information to make informed choices on technological interventions such as hearing aids, cochlear implants, and other assistive devices, on modes of hearing and language habilitation, and on choices of community programmes. Referrals are made for specialized language support for children with HI, and to parent groups for ongoing peer support. Joint conferences are held regularly between CAS, ENT and educational teams. At critical developmental points, children are reviewed for evaluation of language and literacy, hearing function, as well as intellectual, learning and psychosocial development. Consultations for genetics evaluation are made for children with suspected underlying etiology and syndromal diagnoses.

CAS is active in hearing impairment related parent work and research. The Hong Kong Parents' Association for Hearing Impaired Children (HKPAHIC) was founded in 2006 to provide support and education to families from the time of diagnosis. Recent HI related studies at CAS include cross sectional review of multidimensional functioning of primary school students with HI in Hong Kong, territory wide cohort study with the Chinese University of Hong Kong on language outcomes of students with HI, and systematic review on balance performance and vestibular function of children with significant HI.

Early Language Access and Learning

Measures to promote language development and educate children with HI have long been the focus of heated academic and cultural debate. At the International Congress on Education of the Deaf, the first international conference of deaf educators held in Milan, Italy in 1880, it was declared that oral education was superior to signed education, and a resolution was passed banning the use of sign language in school.[9] This was followed by schools switching to speech therapy without sign language as a method of education for the deaf. Similarly in Hong Kong, preschool training and special educational support for students with HI subscribe to speech therapy and an aural-oral mode in education, supplemented by hearing assistive devices, gestures, environmental facilitation and remedial support.

In 2007 at the World Federation of the Deaf Congress in Madrid, a Congress Resolution was made whereby sign language was emphasized as a human right for all persons with HI, including those who use assistive devices and implants. This was followed in 2010 by the Vancouver Congress on Education for the Deaf where all resolutions passed at the Milan Congress were rejected, with acknowledgment of their detrimental effects and the calling upon nations to treat sign languages of their citizens as equal languages as those of the hearing majority.[10]

Over recent decades, neuroscientific understanding of language acquisition, related brain connectivity and critical periods, gave rise to new insights on intervention measures. Despite technological advances for hearing intervention including cochlear implantation, infants with congenital HI face substantial initial periods of no or suboptimal hearing. For those who do not or cannot entirely benefit from assistive devices or implants, hearing deafness/ HI remains. Questions are raised about potential permanent detrimental effects when limited language exposure is available during infancy and early childhood. Infants and children with significant HI, as all children, need adequate exposure to natural language models for satisfactory language development. It is argued that regular exposure to good language models in both visual and auditory modalities from the time of diagnosis is necessary to ensure proper language, cognitive and psychological development.[11]

Today, bilingualism in education with both speech and signed language is considered from linguistic, cognitive, practical and ethical perspectives.[12] In Hong Kong, the Jockey Club Sign Bilingualism and Co-enrolment in Deaf Education Programme project led by the Centre for Sign Linguistics and Deaf Studies of the Chinese University of Hong Kong studies co-enrolment of hearing and hearing impaired students in mainstream schools, applying bilingual speech and sign education. Currently the project supports over 80 deaf and hearing impaired children from baby signing to primary six. Positive outcomes are reported by the team on psychosocial development and academic learning of these students, with growth in Hong Kong sign language, spoken Cantonese and written Chinese. Comparable growth rate with typically developing students was reported, while higher percentages of passes in major subjects Chinese, English and Mathematics than students enrolled in current settings for hearing impaired students were observed (G Tang, unpublished data, 2013). In the 2013/14 school year, the study cohort will extend into secondary education.

Conclusion

Management of hearing impairment in children is informed by evidence from public health medicine, clinical science, special education and rehabilitation. It needs to be grounded on robust epidemiological data, medical technology and neuroscientific understanding of brain development. It takes into consideration cultural beliefs, human rights issues and public policies. Despite its long history, the field of hearing impairment in children is expected to witness much development in the coming years.

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Speech Recognition Ability of Children with High Frequency Sensori-neural Hearing Loss (HFSHL) Using Cantonese Hearing in Noise Test (CHINT)

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Background and Purpose of Study

High frequency sensori-neural hearing loss (HFSHL) is not a significant hearing impairment in terms of level of hearing deficit. According to Bess,[1] HFSHL refers to elevated hearing thresholds (at or above 25dB HL) at the higher frequency region (above 2 kHz) in one or both ears with no conductive involvement. The listener with HFSHL compliants primarily of having problems with understanding speech in noisy background. Numerous research findings[2-4] indicated that hearing deficit in high frequency region impacts on speech understanding, especially in less optimal listening environments or noise backgrounds.

To better understand the difficulties children with HFSHL experience in comprehending speech sounds, this study was designed to examine speech reception thresholds (SRTs) of children with HFSHL as compared to normal hearing listeners. The relationship between speech recognition performance and HFSHL and the effect of different degrees of HFSHL on SRTs were investigated. Speech intelligibility of children with hearing impairment mainly in the high frequency region in both ears was evaluated in quiet and noise conditions using Cantonese speech material, the Cantonese Hearing in Noise Test (CHINT), which is the first standardized instrument for local Cantonese speaking children.

Methods

Participants

Thirty children ages 7-11 years with HFSHL and 48 adults at age above 16 years with normal hearing were recruited in this study. Subjects in the hearing impaired group were clients of Child Assessment Service (CAS) who were diagnosed to have varying degrees of sloping HFSHL, with ten children in each of the mild, moderate and severe grade impairment categoris. These subjects were selected from CAS's clinical database and recruited on the basis of availability. Another group of subjects were 48 adult volunteers with normal hearing who served as a reference group for comparison, with 16 subjects in each of 3 test sites as recommended by the HINT Pro test manual.[5]

Speech Material

The present study adopted the CHINT as speech material for evaluating Speech Reception Threshold (SRT). The CHINT was developed by Wong and Soli[6] in 2005. The test contains several speech sets for use in testing adults or children or for running practice tests which were incorporated into the HINT Pro 7.0 software. Children sentence lists contain words that are familiar to young children and suitable for testing children ages 6-15 years. The test system randomized the presentation order of the lists automatically.[5]

Subject's Tasks

Testing was conducted in a sound treated audiometric test room. Two speakers were positioned at a 90° angle and 1 metre from the centre of the subject's head. The subject was required to recognize and repeat as much of the sentence as he/she can understand. The subject was given a practice test to become familiar with the test procedure. Minor variation with no change to the meaning of the whole sentence is considered to be acceptable response. For example, the word "阿媽" for "媽咪."[5]

Analysis

Individual speech recognition test results were compared to normative data of the respective test site. The HINT Pro software automatically adds the age-dependant correction factors to the norms for calculating percentile and maximum intelligibility change, and makes comparisons between CHINT scores and norms. Scoring is automatically calculated by the system. Speech reception thresholds (SRTs) were measured in quiet and noise conditions, with noise fixed at 65 dB. SRTs in quiet was measured in dB(A) and the SRTs in noise was measured in dB signal-to-noise.[5]

Results

Results of present study showed that normal hearing group performed significantly better than the hearing impaired groups. One-way Analysis of Variance (ANOVA) test revealed SRT for all HFSHL groups was significantly different from normal hearing group in both test conditions (p<0.001) (Table 1). Multiple comparison tests using Bonferroni correction were conducted to evaluate performance in each test group (Table 1).

Table 1. One-way analysis of variances (ANOVA) and multiple comparison tests comparing SRT of subjects with mild, moderate, severe HFSHL and normal hearing in quiet and noise

	Mild (1) (n=10)		Moderate (2) (n=10)		Severe (3) (n=10)		Normal (0) (n=48)		ANOVA	
SRT measure	M	SD	M	SD	M	SD	M	SD	F (3,74)	Post hoc
Quiet (in dBSPL)	21.120	4.469	27.190	5.471	30.640	12.625	17.015	3.602	20.400 ***	0<2,3;1<3;0=1;2=1,3
Noise (in dBSNR)	–2.370	1.448	-0.090	2.145	0.450	1.803	-4.944	1.108	64.017 ***	0<1,2,3;1<2,3;2=3

*** p < .001.

Note. The numbers (0-3) used for indicating the significant group difference in the post hoc column refers to the hearing status of each test groups: from normal, mild, moderate and severe grade to severe grade HFSHL respectively.

In quiet condition, there was a significant group difference between normal and hearing impaired group comparison ($p<0.001$). In comparing the group performance within test groups, significant group differences ($p<0.001$) were found in three pairs of test groups, where each comparison has greater difference in hearing levels i.e. (0 vs. 2, 0 vs. 3, and 1 vs. 3). On the contrary, no significant group difference was found in each of these pairs (0 vs. 1, 1 vs. 2, and 2 vs. 3) when the difference of hearing level in each pair was smaller (one grade difference).

In noisy condition, normal hearing group performed significantly better than all hearing impaired groups ($p<0.001$). Within hearing impaired group comparisons showed significant differences ($p<0.001$) in most test pairs (0 vs. 1, 0 vs. 2, 0 vs. 3, 1 vs. 2, and 1 vs. 3), except the comparison between (2 vs. 3).

A Spearman's rank order correlation (r_s) was run to determine the relationship between SRTs and hearing threshold levels (HTLs). A positive correlation between SRTs and HTLs, ($r_s(78)=.738$, $p<.01$) in quiet and ($r_s(78)=.760$, $p<.01$) in noise was illustrated. The results showed that the severity of HFSHL is associated with the level of deficit in speech reception performance. It means the increase severity of HFSHL will result in elevation of SRTs.

Discussion

Plomp[7,8] pointed out that hearing difficulties in noise background for hearing impaired listeners are related to the loss of audibility and distortion, especially at high frequencies where speech sounds are lower in intensity and spectral and temporal processing discrimination abilities are impaired. These lead to poor speech intelligibility in noisy listening environment even when speech level is audible.[9]

In this study, when the SRT performance in hearing impaired groups was compared with normal hearing groups, a significant group effect was found ($p<0.001$) in both quiet and noise conditions. Children with HFSHL have poorer SRT in CHINT as compared to normal hearers, and experience greater difficulties in noisy environment.

Within group comparison illustrated the fact that in noisy condition, the effect of noise in SRT performance was significant in most group comparisons, where in quiet condition, there was significant difference in SRT performance when the difference of hearing level was greater between test groups.

Furthermore, it is interesting to note that the group effect in comparison of (0 vs. 1) HFSHL was not significant in quiet condition. One may postulate that a person suffering from mild grade HFSHL may be able to demonstrate normal or close to normal speech perception in quiet situation, while listeners with higher degrees of HFSHL impairment will demonstrate difficulty in understanding speech in noisy condition.

Hearing in adverse listening environment is a common and difficult problem for hearing impaired individuals. Research findings show that the effect of hearing loss at 2kHz and above is significant for sentence reception in noise.[10] The results of present study have confirmed with previous study that children with hearing impairment performed worse than normal children in noisy environment. Furthermore, among those with hearing impairment, children with mild impairment performed better than children with moderate or severe impairment while there was no difference in performance between children with moderate impairment and severe impairment.

Lastly, the findings of the present study illustrate that children with higher levels of high frequency impairment have poorer performance than those without or with lower levels of high frequency hearing impairment. SRTs were well correlated with HTLs ($r_s=0.738$) in quiet and ($r_s=0.760$) in noise. This pattern of correlation suggested that listeners with no or less high frequency hearing impairment always performed better than those with greater high frequency impairment in quiet condition. This association was even stronger when noise is taken into account. These results follow the same trend of the recent findings reported by Wong et al.[11]

Several limitations should also be addressed. First, this study is limited by the number of participants in the hearing impaired group. The small sample size of respective hearing impaired groups may affect the within hearing impaired group comparison results. For instance, group mean comparison in (1 vs. 2), (2 vs. 3) were not significant. A second limitation involves the age related correction factor (ARCF) for use in converting adult norm to children, where norms were adapted from a western population with head circumferences of children that are less representative to that of local children. Increasing the number of hearing impaired subjects in the study and the use of local ARCF as a reference are recommended in future studies.

A number of investigators[12] found that subjects with dysfunction inner hair cells (dead regions) in the high frequency region were less able to make use of amplified high frequency signals than subjects without dead regions HFSHL. If amplification is not always a solution for HFSHL listeners, other rehabilitative options should be considered to minimize the effect of high frequency hearing impairment. For instances, acoustic treatment in the listening environment for improving the S/N ratio should be promoted. Communication tactics and strategies should be introduced to enhance speech understanding. Fitting of assistive listening devices (FM system), implementation of sound field amplification systems and preferential seating arrangements in the classroom can help to improve the quality of speech input.

Conclusions

Hearing in unfavourable listening environments is challenging for hearing-impaired listeners. This is supported by findings of the present study on children with HFSHL, who showed discrepant performance in SRT when compared with their normal hearing counterparts, as well as impaired speech perception ability in noise. Children with more severe HFSHL have greater difficulty in speech recognition task than children with mild HFSHL. The findings of this study not only extend our understanding on the effects of children's high frequency hearing impairment on speech understanding in noise, more importantly it provides evidence to parents, teachers and professionals that it is necessary to identify and address the communicative needs of children with HFSHL. Several rehabilitation options are recommended to facilitate communication whenever possible. Lastly, to better evaluate a person's ability to perceive speech, speech perception test using everyday sentences, such as in the CHINT test, should be included in clinical practice.

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Estimation of Hearing Thresholds Using Click and Tone Burst Auditory Brainstem Evoked Response and its Effects on Clinical Monitoring of Audiological Status and Speech Development

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Background

Auditory brainstem response (ABR) has long been used and proven to be a useful tool to estimate auditory sensitivity in difficult-to-test clients. As universal hearing screening becomes part of the health care protocol for newborn infants, effective measures for early diagnosis of hearing impairment is needed. No national standards exist for a uniform performance standards in ABR.[1] Click is the most commonly used stimulus, if not the only one, in most ABR testing. However, frequency specificity is often compromised. In previous research, click ABR may over or under estimate clients' hearing level when compared to pure tone audiograms.[2] There is an urgent need for a reliable and accurate protocol to diagnose not only the presence of hearing loss, but to also identify minimal degrees of impairment that may cause speech or language difficulties, and to provide better estimation of frequency specific hearing thresholds to facilitate hearing aid fitting and remedial services.

In this review, local data of click ABR was examined on how well it estimated hearing thresholds and compared to frequency specific tone burst ABR (TBABR) for its competence in detecting minimal hearing loss. For clients' with abnormal frequency specific TBABR results, both hearing review and speech and language assessment should be seriously considered for timely intervention.

Methodology

The clinical data gathered for this study were from September 2003 to May 2010 at Pamela Youde Child Assessment Centre (Shatin) (STCAC) of Child Assessment Service, Department of Health, Hong Kong. Assessment results of these clients were reviewed, including 27 male and 23 female, with 97 ears tested in total. The mean age at the time of testing was 5.94 months for ABR, and 50.46 months for behavioural audiometric assessment. Clients were included only when data from click ABR ± TBABR and behavioural audiometric assessments were available for analyses. Cases with conductive problems and abnormal otoscopic examination or tympanometric results at the time of ABR or behavioural testing were excluded.

Results

Table 1 summarized the data by dividing them into two groups according to their ABR click results, one group with click thresholds at or under 25dBnHL, and the second group with click thresholds greater than 25dBnHL.

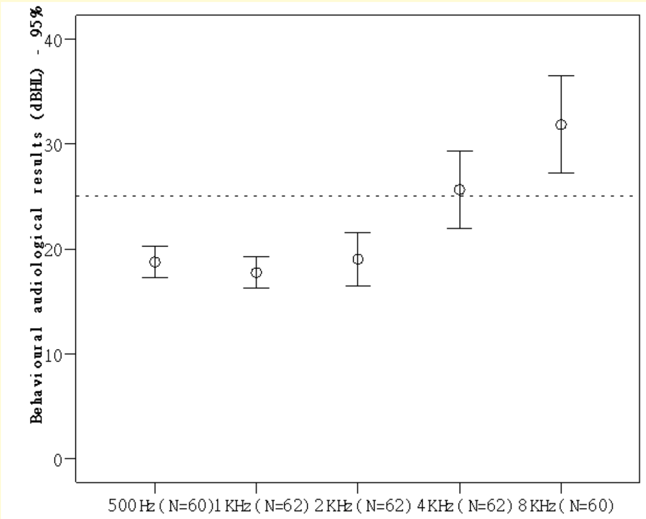
I Comparing actual hearing status with different passing criteria of ABR

The passing criteria for click ABR is widely accepted as 25 dBnHL. In this section, we focused on participants (No. of ears=62) who passed click ABR with hearing levels at or under 25dBnHL. The mean hearing thresholds from behavioural testing were plotted across frequencies from 500Hz to 8KHz in Figure 1. Hearing thresholds at 4KHz and 8KHz fell into the range of mild grade hearing loss, at 26dBHL and 32dBHL respectively. Hearing loss at these frequencies was therefore not detected and passed for click ABR at 25dBnHL.

Table 1. Grouping of subjects with click thresholds better or worse than 25dBnHL

Group		Age at ABR test (months)	Age at behavioural test (months)
Click ≤ 25dBnHL	N	32	32
(Male = 16; Female = 16)	Mean	5.84	54.63
	Min	2	14
	Max	13	77
	SD	2.2	14.48
	% of total	64%	64%
Click > 25dBnHL	N	18	18
(Male = 11; Female = 7)	Mean	6.11	43.06
	Min	2	12
	Max	14	79
	SD	3.01	13.7
	% of total	36%	36%
Total	N	50	50
	Mean	5.94	50.46

Figure 1. Behavioural testing hearing thresholds at 500Hz to 8KHz of participants who passed click ABR at 25dBnHL



To explore whether TBABR could yield a better detection rate of hearing loss, especially for minimal level, hearing status obtained from behavioural audiological assessment of participants was compiled in Table 2 under three different passing criteria. In condition I, ABR was considered as passed if Wave V was observed with click ABR at 25dBnHL. In condition II, ABR was considered as passed if Wave V was both observed using click at 25dBnHL and 500HzTB at 40dBnHL. In condition III, ABR was considered as passed if Wave V was both observed using click at 25dBnHL and 4KHzTB at 40dBnHL.

Under condition I, 40% of ears that passed ABR click at 25dBnHLwere normal at behavioural testing, while 60% of the ears that showed a mean normal hearing at frequencies between 250Hz and 2KHz *but* mild to moderate grade hearing loss at 4KHz (mean=34dBHL) to 8KHz (mean=44dBHL). In other words, these higher frequency losses were not identified by ABR clicks alone. The detection rate was slightly improved under condition II.

Under condition III a significantly higher portion of ears (62%) could be correctly identified by ABR as normal hearing, while less ears with a mean normal hearing at frequencies between 250Hz and 2KHz had high frequency hearing loss that were undetected (38%). Among the 13 ears with hearing loss undetected by ABR with Click≤ 25dB & 4KHzTB≤ 40dB, only five ears (of three clients) had mild to moderate grade high frequency hearing loss at and beyond 2KHz. Eight ears had normal hearing at 500Hz to 4KHz and mild to moderate grade loss at 8KHz.

Table 2. Comparison of hearing status by behavioural testing with three different ABR passing criteria

	Passing Criteria (dBnHL)		
No. of ears	I) Passed ABR with Click ≤ 25dB	II) Passed ABR with Click ≤ 25dB & 500HzTB ≤ 40dB	III) Passed ABR with Click ≤ 25dB & 4KHzTB ≤ 40dB
Hearing status in behavioural testing			
Normal hearing	24 (40.00%)	24 (45.28%)	21 (61.76%)
Hearing loss	36 (60.00%)	29 (54.72%)	13 (38.23%)
Total (in %)	60 (100%)	53 (100%)	34 (100%)

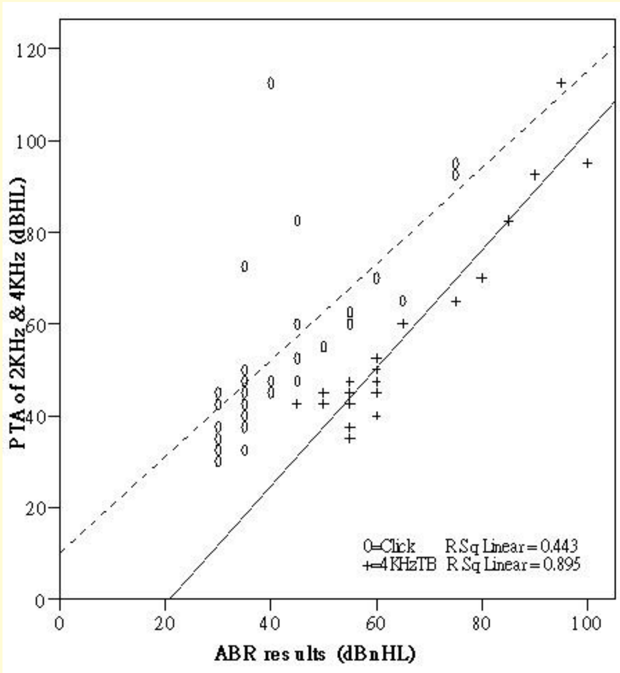
Note. Not all normal hearing clients completed 500Hz or 4KHz tone burst ABR, so total number of ears were different under three criteria.

II Estimation of hearing loss

To measure and compare how closely ABR thresholds with click and tone bursts relate to behavioural thresholds, we included all participants in this section, regardless of their hearing level in click ABR. Nonparametric Spearman correlation (rs) showed that the correlation was found to be highest when 4KHzTB≤ 40dB were related to behavioural thresholds for 500Hz, 1KHz and 2KHz (PTA512) rs=0.80 and 2KHz and 4KHz (PTA2&4K) rs =0.90, P<0.001, respectively. Lower correlation coefficients were noted when click stimuli alone was used, at rs =0.76 (with PTA512) and rs =0.79 (with PTA2&4K), P<0.001. The lowest correlation coefficients were computed when 500HzTBABR was used, at rs =0.49 (with PTA512) and rs =0.52 (with PTA2&4K), P<0.001.

Spread of individual data points showing the relationships between behavioural audiological results of PTA2&4KHz with click ABR and 4KHzTB ABR respectively are illustrated by a scatter plot in Figure 2. More widely scattered pattern was observed for click ABR results while a more linear expression spread was observed for 4KHzTB. A higher value of linear R^2 of 0.895 for 4KHzTB shows that it provides a better estimation of hearing thresholds at frequency region at 2KHz and 4KHz.

Figure 2. Comparison of pure tone average of 2KHz and 4KHz with ABR click and 4KHz TB ABR



III Outcome of speech development with click ABR passed at 25dBnHL

Participants who had passed click ABR at 25dBnHL were selected for investigation of their speech development. Two participants were excluded for they had borderline developmental delay. Among the remaining 30 participants, eleven had normal hearing and normal speech development. Fourteen participants were found to have mild grade high frequency loss (HFHL) but had normal speech pattern. Four participants were found to have HFHL and speech problems. One participant with normal hearing developed speech problems.

Discussion

I Inclusion of frequency specific tone bursts stimuli is highly recommended in ABR testing for identifying minimal hearing loss

Although click is the most commonly used stimulus in ABR, its detection of frequency specific hearing loss is often unsatisfactory. In our study, over half of the subjects with various degrees of hearing loss at specific frequencies were unidentified when broadband frequency click stimulus was used as the only test stimulus in ABR. However, when 4KHz toneburst stimulus was added to the testing protocol, the miss-rate decreased to about one third. If cases with hearing loss at 8KHz alone were not counted (as clients were not tested with 8KHzTB in this study), the detection rate increased to 85%. It is suggested that the discrepant observations are due to the spread of energy in the click ABR stimulus, which elicits responses at lower levels in contrast to pure tone thresholds.[3]

The current practice for hearing screening for newborn infants in public hospitals under the Hong Kong Hospital Authority sets the passing criterion at 35dBnHL for click stimuli. The use of this screening protocol is primarily designed to identify bilateral and unilateral hearing losses of a moderate degree or greater (35dBnHL). As such, a significant number of infants with minimal hearing loss, such as mild to moderate grade hearing loss and high frequency hearing loss, are highly likely to be undetected with no follow up.

II 4KHzTB ABR correlates with pure tone average and high frequency thresholds

An overall 0.8 to 0.9 correlation coefficient of 4KHzTB with PTA512 and PTA2&4KHz showed that 4KHzTB is equally or more effective than click ABR in estimating hearing level at high frequencies. This study provides local evidence to support the incorporation of TB stimuli in ABR testing protocol whenever feasible.

III The impact of minimal hearing loss to speech development

Even though our sample was a small and biased sample from CAC's clinical database, the results revealed an association between hearing loss and speech problems. This agrees with Tharpe and Sladen[4] that children with minimal hearing loss, such as permanent unilateral or mild bilateral hearing loss, are known to be at risk for psycho-educational difficulties. Although factors that influence developmental outcomes in this population are not well understood yet, further research is warranted to lend support to timely identification, assessment and remediation for this group of children, in order to minimize or prevent any possible adverse outcomes.[5]

Behavioural audiological assessment before three years of age is strongly recommended for clients for whom only click ABR results are available and without frequency specific information. Speech and language assessment should also be scheduled for children with minimal hearing loss. All infants, regardless of newborn hearing screening outcome, should receive ongoing monitoring on development of age-appropriate auditory behaviors and communication skills. Children who had passed newborn hearing screening but demonstrate delayed auditory and/or communication skills development should receive audiological evaluation to rule out hearing loss.[1]

Limitations

The results in our study should be interpreted with caution in view of the small sample size (N=97 ears in 50 clients) and the restricted data source of one CAC. This convenient sample may not represent the true occurrence in general population and biases could not be eliminated.

In comparing ABR and behavioural audiological assessment results, we assumed that there were no significant deteriorations in hearing status of our clients. With up to a few years between ABR and behavioural testing, changes in hearing levels, especially progressive hearing loss, could not be excluded.

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Universal Infant Hearing Screening Programme: First 4 Years' Experience (August 2003 to July 2007)

Family Health Service, Department of Health, HKSAR Government

Background

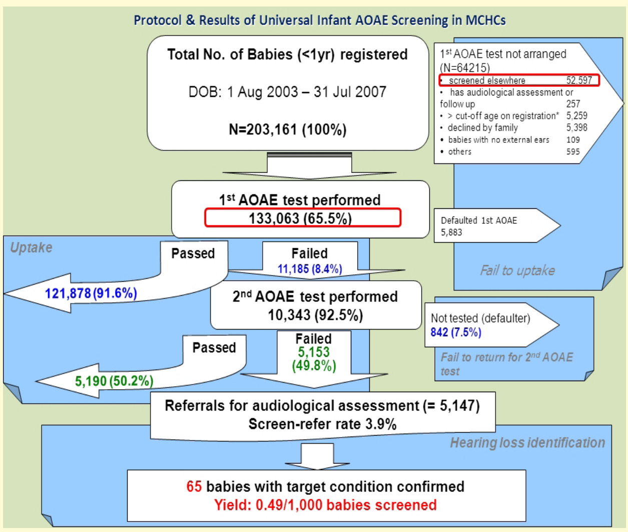
Bilateral permanent childhood hearing impairment (PCHI), commonly present at birth, is an important health problem because of its adverse effects on a child's language and communication skills, social and emotional development and education achievement.[1,2] Early identification and rehabilitation are crucial for improving language and communication development of the child.[3]

Universal Infant Hearing Screening Programme in Hong Kong

Since August 2003, the Maternal and Child Health Centres (MCHCs) of the Department of Health (DH) have implemented a universal infant hearing screening programme using Automated Otoacoustic Emission (AOAE), subsequent to the promising results of a one-year pilot project.[4] The target condition to be screened is PCHI of moderate to profound grade (defined as 40 decibel hearing level (dB HL) or greater).

From February 2007 onwards, birthing hospitals under the Hospital Authority (HA) also commenced a newborn hearing screening programme using Automated Auditory Brainstem Response (AABR) testing prior to hospital discharge. Since then, MCHCs only conducts AOAE screening for those infants who have not been screened by hospitals.

Figure 1. Protocol and results of universal infant AOAE screening in MCHCs



The Protocol

All registered infants (up to 4 months) were offered the 2-staged AOAE screening. Those who have already received hearing screening by other service providers, or who are receiving audiological services were excluded. Babies failing both AOAE tests were referred for diagnostic evaluation at ENT Departments of HA or Child Assessment Service of DH.

Programme Evaluation

Screen Coverage

A total of 203,161 infants registered in MCHCs during this period. The coverage of universal neonatal/infant hearing screening programme (by birthing hospitals and MCHCs) was 91.4% (Figure 1).

Screen Performance and Outcomes

Table 1. Key performance indicators of AOAE screening were compared with international benchmarks

	AOAE Screening	International Benchmarks	
	MCHC (2003-2007)	UK NHSP[5] (2010)	US JCIH[6] (2007)
Screen Coverage	91.4%	95%	≥95%
Screen Performance			
Screen-refer rate	3.9%	§	4%
Timing of the screening			
Median age at 1st AOAE	25 days	§	§
Median age at 2nd AOAE	44 days	§	§
% completed screening	92.8% by 60 days	≥95% by 5 wk	≥95% by 4 wk
Yield of target condition			
Bilateral sensori-neural hearing loss of ≥ moderate grade	0.49 per 1,000 screened babies (65 PCHI cases)	0.36-0.49 per 1,000[2] 1.2 per 1,000[1]	
Among those identified with PCHI			
Median age at audiological confirmation	6 m	80% by 6 m 98% by 12 m	>90% by 3 m
Median age at intervention			
Hearing aids (n=54)	12 m	Within 1 month of audiological confirmation	
Cochlear implant (n=16)	1 y 8 m	§	§
Auditory brainstem implant (n=2)	3 y 7 m	§	§

§ Information not available

Table 2. Language development# of children identified with PCHI#

	Isolated Hearing Impairment No. (%)	Presence of co-morbidities* No. (%)
Children confirmed with PCHI at 5 years review (n=65)	32 (49%)	33 (51%)
With normal language	18 (56%)	1 (3%)
With language impairment#	14 (44%)	32 (97%)

* Co-morbidities include cognitive impairment / developmental delay, pervasive development disorder or congenital abnormities
# excluding isolated articulation problems
Source of information: Child Assessment Service, Department of Health

Conclusion

The infant hearing screening programme in MCHCs was effective in early identification and referral of infants suspected of having PCHI. Favourable language development outcomes were achieved in a significant proportion of the children with isolated hearing impairment. However, there is room for improvement in the timing of completion of screening, diagnosis and interventions (such as fitting of hearing-aid and cochlear implant) when compared with international benchmarks.

Challenges Ahead

The greatest challenge of the infant hearing screening programme is the coordination between providers of screening, diagnostic, treatment and rehabilitation services to ensure that timely attention and care are provided to children with hearing impairment.

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Recent Publications and Scientific Presentations

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Clinical approach to motor delay in infancy on 6 December 2012 at Developmental Paediatrics Educational Workshop, Department of Paediatrics, Prince of Wales Hospital by FONG Kin-han, Anita, LAU Pui-heung, Beverley.

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二零一二年十一月十日
張秀萍

新手上路 – 認識自閉症幼兒的特徵及需要
社會福利署 – 建設健康九龍城協會 – 循道衛理楊震社會服務處合辦「愛・使孩子不一樣」自閉症幼兒管教研討會
二零一二年十一月十日
陳淑儀醫生

Diagnostic issues/structured teaching for children with ASD and outcome research finding on 1 November and 22 November 2012 at Diploma in Special Education: Special Learning Needs Education Course in Autism/Asperger's Syndrome, HKU SPACE by LAM Ling.

儿童发展发展障碍及評估
南京医科大学附属南京市妇幼保健院儿童发展評估、監察与干預学習班
李敏尤医生
二零一二年十月二十七日至二十九日

Diagnostic issues/structured teaching for children with ASD and outcome research finding; Learning to read and write: strengthening children's hand-writing skills on 19 October 2012 at Department of Educational Psychology, The Chinese University of Hong Kong by CHUI Mun-yee.

Developmental coordination disorder and learning disabilities on 13 October 2012 at M.Ed. course, Department of Educational Psychology, The Chinese University of Hong Kong by CHUI Mun-yee.

Initial assessment for children with physical and sensory disabilities and multiple disabilities; Assessment of different cognitive functions in children on 9 October 2012 at M.Soc.Sc. (Clinical Psychology) program, Department of Psychology, The University of Hong Kong by CHEN Yuk-ki, Theresa.

Clinical approach to language delay on 16 August 2012 at Department of Paediatrics, Prince of Wales Hospital by NG Kwok-hang, Ashley.

Learning to read and write: strengthening children's hand-writing skills on 1 August and 22 August 2012 at Department of Educational Psychology, Faculty of Education, The Chinese University of Hong Kong by FONG Kin-han, Anita.

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Understanding the aim, scope, and procedures on screening and assessment of oral language functions in pre-school and school-age children. How can teachers identify children with oral language difficulties in schools? on 28 June and 29 June 2012 at Department of Special Education and Counselling (SEC), The Hong Kong Institute of Education by CHAN Wai-ki, Amy.

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Workshop on the Hong Kong Cantonese Oral Language Assessment Scale (HKCOLAS) at The University of Hong Kong on 20 April 2012:

- **Administering HKCOLAS & Test** of Hong Kong Cantonese Grammar by NG Kwok-hang, Ashley
- **Textual Comprehension Test** by CHAN Yvonne Binva
- **Word Definition Test** by MAN Yuk-han, Yonnie
- **Lexical-Semantic Relations Test & Expressive Nominal Vocabulary Test** by CHAN Wai-ki, Amy
- **Nonword Repetition Test & Hong Kong Cantonese Articulation Test** by CHEUNG Sau-ping, Pamela

Autism Diagnostic Observation Schedule (ADOS) on 27 March 2012 at Master of Educational and Child Psychology, The Hong Kong Polytechnic University by CHAN Mee-yin, Becky.

腦癱評估與策劃干預方案的原則
中国殘联社会服务指導中心腦癱儿童矯治手術項目业务管理学習会議
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Diagnostic issues/structured teaching for children with ASD and updates research evidence for its effectiveness on 22 March and 26 April 2012 at Diploma in Special Education: Special Learning Needs Education Course in Autism/Asperger's Syndrome, HKU SPACE by LAM Ling.

Cognitive rehabilitation on 14 March 2012 at Specialty Training Program for Occupational Therapists in Neurological Rehabilitation (Module II-Cognitive Rehabilitation for Neurological Patients), Institute of Advanced Allied Health Studies by CHAN Yau-kam.

認識及如何照顧專注力不足/過度活躍症兒童
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