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'Asymptomatic' South Auckland preschool children have significant hearing loss and middle ear disease

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ABSTRACT

Background: Seven hundred children were recalled for hearing screening at age 2–3 years due to a problem with their newborn hearing screen. They had all been well babies with no identified risk factors for hearing loss and hence were not scheduled for targeted follow-up to retest hearing.

Methods: There were 485 children (69%) that attended the recall. The average age was 36 months (SD 3.7). Family ethnicity was Pacific Island (36%), Asian (26%), NZ European (13%), and Māori (11%), and there was a high level of deprivation in the study population. Children were screened using distortion product otoacoustic emission (DPOAE) and a parent or caregiver completed a 14-item questionnaire about ear health. The children that did not pass screening were given appointments for audiology testing. Children with hearing loss and/or middle ear problems were referred for otolaryngology review and further hearing assessments.

Results: About one third (36%; n = 176) of children did not pass DPOAE screening; 82 (17%) had abnormal type B tympanograms and hearing loss; 29 underwent insertion of ventilation tubes, and one had a perforated tympanic membrane. There was a significant association between failed tympanometry and hearing loss (Chi-squared = 16.67, $p < .001$).

Five children had permanent sensorineural hearing loss (SNHL), two of whom required cochlear implants for idiopathic hearing loss, with no specific risk factors. Overall 380 of 485 children screened were deemed to have normal hearing (i.e. 22% failed hearing). From the questionnaire, 15% of the caregivers with no suspicion of hearing problems did have children with significant hearing loss. Regression analysis showed that Pacific/Māori ethnicity was significantly associated with risk of hearing loss, together with questionnaire items identifying hearing problems and breathing problems.

Conclusions: There is a high proportion of children in South Auckland with unsuspected hearing loss; a different approach to hearing screening is warranted for this population with high rates of middle ear disease at age 3.

1. Introduction

The incidence of permanent sensorineural hearing in neonates is about 1 in 1000 per live births [1,2]. In the United States of America (USA), overall estimates of HL are between 1 and 6 per 1000 newborns [3]. In Australia, the prevalence is estimated to be 1.2 per 1000 newborns [4]. In New Zealand a universal screening for hearing loss in newborn children has been in place since 2007. A universal screening program for identifying hearing loss in newborn children was commenced in CMDHB (Counties Manukau District Health Board) in 2010. In the period 1 March 2010 to 22 April 2011, problems with the implementation of the newborn hearing screening process were identified [5] and warranted a rescreen of 12% of infants screened during this period.

We took this opportunity to capture hearing outcomes and middle ear status in this asymptomatic group of preschool children who had had flawed newborn hearing screening. They were all well babies with no identified risk factors for hearing loss and hence were not scheduled for targeted follow-up to retest hearing. It was hypothesized that some children in the cohort would be found to have unidentified permanent hearing loss and middle ear disease. Specifically, we anticipated that 1–2 children in 1000 would have permanent HL and that a substantial proportion would have asymptomatic, acquired middle ear disease.

The primary aim was to determine the incidence of hearing loss and

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middle ear disease in 3-year old children recalled after the flawed newborn hearing screen. Secondary aims were to determine whether demographic factors (deprivation, gender, ethnicity) and responses to a caregiver-completed questionnaire about ear health and respiratory difficulties were associated with hearing and middle ear outcomes, and to document prevalence of hearing and ear pathology in the cohort. We hypothesized that hearing loss and middle ear disease would be correlated with ethnicity, deprivation index and caregiver questionnaire responses related to hearing and ear health.

2. Method

2.1. Design

A cross-sectional design was used to establish hearing and middle ear status, with longitudinal follow-up to determine outcomes for children with hearing and ear problems. Children with hearing loss and/or middle ear problems identified by the initial screen were referred to audiology and then referred for otolaryngology review, as required.

2.2. Setting

All data were collected in the CMDHB hospital outpatient clinic facility which provides secondary services. The initial screen was performed by trained newborn hearing screeners. Audiological and otolaryngological investigations were conducted by hospital audiologists, otolaryngology consultants, and ear nurse specialists.

2.3. Participants

1018 children were identified as having a potentially flawed initial screen that warranted a rescreen [5]. They were all well babies with no identified risk factors for hearing loss. Of these, 700 still resided in the area, and were not already current to the service. These children were contacted and booked for a hearing screen; 485 children (69% of those invited) attended (mean age 36 months, SD 3.7). Most children (81%) were tested in Spring or Summer. About half of the sample (n = 260, 53%) were boys.

Socioeconomic status was determined using deprivation index scores. Deprivation was measured using the NZDep2013 index [6]. NZDep2013 combines data relating to income, home ownership, employment, qualifications, family structure, housing, access to transport and communications, leading to a decile score from 1 to 10, with 10 representing the 10% most deprived (see Fig. 1). It was hypothesized that deprivation (level 1–6 versus 7–10) may be a risk factor for middle ear disease. The median deprivation level was 9; 45% of the sample were at the highest deprivation level 10, and 72% were at levels 7 to 10. Ethnicity (Table 1) comprised Pacific Island (41%), Asian / Indian (29%), European (15%) and Māori (12%).

2.4. Otoacoustic emission screening

All children (N = 485) were initially screened by using Automated Distortion Product Oto-acoustic Emission (DPOAE) testing, using the Accuscreen instrument. Ethics approval was obtained from the institutional ethics committee; informed consent was obtained from the caregiver prior to the initial screen. Children passing the DPOAE screen were not assessed further. The pass criterion was DPOAEs present at 3 or 4 out of 4 frequencies (frequencies tested: 2000, 2500, 3200, and 4000 Hz). A DPOAE was considered present at any frequency if the signal to noise ratio (SNR) was at least +6 dB and the absolute response amplitude was −5 dB or better. Children who did not pass were given pure tone audiometry, tympanometry, and repeat DPOAEs. Children with hearing loss and/or middle ear problems were referred to Otolaryngology and/or had further hearing assessments.

2.5. Questionnaire

At the time of screening, a parent or caregiver completed a 14-item questionnaire (see Appendix) relating to potential risk factors for otitis media, such as ethnicity (Māori/Pacific versus other), attendance at daycare (< 20 h versus ≥20 h), breast feeding, smoking in the home, and presence of home insulation.

2.6. Audiological assessment

Children attending the audiology appointment were tested using pure tone audiometry (500–4000 Hz) with a minimum presentation level of 20 dB HL, DPOAEs (Biologic Scout) and tympanometry (GSI 61). Some children were uncooperative and did not complete their pure tone audiometry test and were tested at three frequencies per ear only or were retested using DPOAEs. An audiology 'pass' for pure tones was defined as a threshold of 20 dB HL at 500, 1000, 2000 and 4000 Hz bilaterally. A pass for DPOAEs was defined as present DPOAEs for three out of four frequencies.

Tympanometry was also performed at the audiology assessment. Tympanometry results were classified as Type A if all parameters were normal (identifiable peak, middle ear pressure greater than −100 daPa, admittance ≥ 0.3 ml). If the admittance was low (0.2–0.3 ml) then this was also classified as a Type A so long as ipsilateral acoustic reflexes were present and tympanometric width was within normal limits. Type C tympanograms had a measureable peak and middle ear pressure more negative than −100 daPa. Type B (flat) tympanograms were classified as low or high if the peak admittance was < 0.4 ml, or > 1.0 ml, respectively.

2.7. Data analysis

A hearing rating scale was created in order to combine data from children who passed DPOAEs at the screening appointment with the data from subsequent hearing tests for the children who did not pass initially. Those who passed OAEs both ears or passed all eight pure tone audiometry frequencies (left and right ears; 500, 1000, 2000, 4000 Hz) were given a hearing score of 8. A score of 8 indicated the best hearing outcome and 0 indicated the worst hearing outcome. Those who passed 7 frequencies for PTA were given a score of 7, those who passed 6 frequencies for PTA were given a score of 6, etc.

Analysis of data used non-parametric statistics (Mann-Whitney *U* test for ordinal data, and chi-squared for testing data in binary contingency tables). A forward binary logistic regression was undertaken to determine the association between demographic factors, questionnaire responses and hearing. For this analysis a dichotomised hearing outcome was computed, with a pass equivalent to a hearing scale score of 8 and a fail representing a hearing loss at any frequency on any ear (hearing scale score of 7 or less).

3. Results

3.1. Screening testing and audiology

About two thirds of children (309 /485; 63.7%) passed the DPOAE screen. These were not assessed further and were assigned a PTA score of 8. The 176 children who did not pass the DPOAE screen were given audiology appointments (normally on the same day). Two children who failed screening DPOAEs in one (n = 1) or both (n = 1) ears did not attend the audiology appointment, hence 174 children were tested by the audiologist. Of these, many had tympanometric evidence of middle ear dysfunction (46 Type C and 81 Type B tympanograms; 26% of total cohort). There was a significant statistical association between failed tympanometry and hearing loss (Chi-squared = 16.67, $p < .001$).

Forty (23%) of the 174 children that failed screening passed the subsequent hearing test tympanometry screen (thresholds ≤20 dB HL