Newborn hearing screening: experience in a Malaysian hospital

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ABSTRACT

Introduction: This study aims to determine the prevalence of hearing loss among newborns delivered at Hospital Universiti Kebangsaan Malaysia and to evaluate the usefulness of our hearing screening protocol.

Methods: All infants born in the hospital over a nine-month period, between April to December 2003, were screened for hearing loss with a portable otoacoustic emission (OAE) before discharge. At the age of two months, a second OAE test was repeated on newborns who failed the initial test. Those who failed the second test were re-tested at three months of age. When these infants failed the third OAE test, a brainstem evoked response (BSER) test was performed.

Results: During the study period, 4,219 infants were born in the hospital, and 3,762 (89.2 percent) underwent OAE screening. 620 (19.7 percent) of them failed the first screening test, and 506 (81.6 percent) of them came for a second stage-screening test. In the third stage screening at three months of age, only 39 (65 percent) patients turned up. Of these, ten infants passed the OAE test and 29 failed. However, when these infants underwent BSER, 13 had normal BSER and 16 have abnormal BSER. The prevalence of hearing loss in this study was 0.42 percent (16/3,762).

Conclusion: The large number of defaulters and false-positive results in this study suggest that this pilot hearing-screen programme requires fine-tuning to minimise these problems.

Keywords: brainstem evoked response, hearing loss, newborn screening, otoacoustic emission

Singapore Med J 2006; 47(1):60-64

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INTRODUCTION

The prevalence of mild to profound hearing loss is reported to be between 1.1 and 6 per 1,000 life-births[1-5]. The prevalence of hearing loss is estimated to be between 2.5% and 10% among high-risk infants[6-8]. In most countries, newborn hearing screening programmes that screen only high-risk infants have been in existence for more than 20 years. However, this group of infants with hearing loss comprises only 50% of newborn population with hearing loss[9-11]. Therefore, hearing screening programs that screened only high-risk neonates missed out 50% of hearing-impaired newborns, who are from among infants without any risks factors.

Hearing impairment in infants should be identified as early as possible to enable intervention to take full advantage of the plasticity of the developing sensory system. In a longitudinal study of young children with hearing loss, Yoshinaga-Itano (1995) found that pre-school children identified by six months of age had significantly higher developmental functioning in general development, expressive and receptive language, and personal-social areas[12]. These higher development outcomes were seen, regardless of the degree of hearing loss and cognitive status of the child. Markides (1986) reported that hearing impaired children who received amplification by six months of age showed far greater language development than children receiving amplification later[13].

The average age of identification of congenital hearing loss in United States of America (USA) in 1993, according to National Institutes of Health, was about three years old[14]. Erenberg et al (1999)[15] reported that average age of detection of significant hearing loss is 14 months. In New Zealand in 1996, the mean age detection of hearing impairment was at 26 months[16]. Gilbert (1997)[17] reported that the prevalence of hearing impairment among high-risk infants was 26.4% at three months and 18.8% at six months.

Various tools have been used for newborn hearing screening. Currently, the most promising technique

Table I. Result of otoacoustic screening test during the first, second and third stages.

Results	Stage 1 N=4,219 (5)	Stage 2 N=620 (%)	Stage 3 N=60 (%)
Pass	3,142 (74.5)	446 (71.9)	10 (16.7)
Fail	620 (14.7)	60 (9.7)	29 (48.3)
Not tested or defaulted	457 (10.8)	114 (18.4)	21 (35.)

Table II. The degree of bilateral hearing loss.

Degree of hearing loss	No.
Mild	10
Moderate	4
Severe to profound	2

for newborn hearing screening is the measurement of otoacoustic emission (OAE), first described by Kemp in 1978[18]. OAE screening test is a fast and easy test. It does not require highly-trained personnel to operate, and the test can be conducted without any sedation given to the newborn.

With the availability of OAE as a screening tool, screening of newborns has become more efficient, reliable and effective. The goal of universal hearing screening programme is for early detection of hearing loss. Therefore, active intervention and rehabilitation can be carried out to facilitate optimal speech and language programmes. A pilot study to screen all newborns at the Hospital Universiti Kebangsaan Malaysia (HUKM) was carried out from April 2003 to December 2003. The aim of this study was to determine the hearing loss among newborns delivered at HUKM and to evaluate our hearing screening protocol.

METHODS

During the study period, OAE tests were carried out on all inborn infants within 24 hours of life at their mother's bedside or inside the nursery room in the postnatal ward. In the neonatal intensive care unit (NICU), the test was conducted in an isolation room before newborns were discharged. After ear inspection and removal of any vernix or fluid in the external ear canal (EAC), the probe was inserted into the EAC and adjusted. The OAE was then performed and the result of "pass" or "fail" recorded. In newborns with a "fail" result, a second test was immediately performed after appropriate adjustment of the positions of the probe. When a "fail" was obtained on the second attempt, the newborn was considered as having failed the screening test. Parents were notified of the screening result immediately.

Newborns who failed the screening test were given an appointment at the age of two months. A repeat OAE was performed. Those who failed at this stage were again tested at three months of age with OAE and if they failed the OAE test, then the brainstem evoked response (BSER) test would be performed.

RESULTS

There were 4,219 deliveries during the study period. A total of 3,762 (89.2%) newborns were screened. 620 (19.7%) newborns failed the first screening test. Among the 620, only 506 (81.6%) came for second stage screening test. 446 of them passed the repeat OAE and 60 infants failed at this stage. 114 (18.4%) newborns/infants defaulted follow-up (Table I).

During the third stage follow-up at three months of age, only 39 (65%) infants turned up and 21 (35%) defaulted appointment. Among these 39 infants, ten passed and 29 failed the OAE test. However, when these infants underwent BSER, 13 had normal and 16 had abnormal results (Table II). Two of the infants were subsequently fitted with hearing aids. Another 14 infants were still under follow-up with plans to have hearing aids fitted after behavioural testing. Overall, the prevalence of hearing loss in this study was 0.42% (16/3,762).

DISCUSSION

Otoacoustic emission (OAE) is a cost effective screening tool and more convenient than BSER[19]. OAE is sensitive to cochlear function[19]. Lesions located in the cochlear will affect the OAE response, whereas retrocochlear of central auditory lesion will not affect the OAE result. The incidence of acoustic nerve or brainstem involvement is rare in the general newborn population[19]. The OAE test requires normal middle ear function[20]. Conductive hearing loss is commonly caused by low eardrum motility following tube dysfunction and middle ear effusion. This can depress acoustic signals in both directions, either stimulus as well as emission conduction. Even a mild conductive loss can make emission signals undetectable as was shown in this study where only 16 of the 29 infants with abnormal OAE test at the third stage failed BSER.

A screening test is efficient if the number of false-positive is small or the specificity approaches 100%[21]. The result of the OAE screening performed by White et al (1993) on 1,850 neonates showed a sensitivity of around 100% and a specificity

of 73%[11]. According to that study, OAE was moderately specific but very sensitive.

Our local study showed similar findings[22]. Ng and Yun reported the sensitivity and specificity of OAE with respect to BSER was 95% and 93%, respectively[23]. Bantock and Croxson (1998) conducted OAE screening on 700 neonates with risk factors for hearing loss and on 1,492 neonates without any risk factors[20]. They found that the sensitivity was l00% in both groups. The specificity in both groups was 94% and 91%, respectively. On the second stage-screening test done about six months after, the sensitivity remained 100% and specificity improved to 99.3% in a group with no risk factors for hearing loss[20].

In this study, the prevalence of hearing loss was 0.42% which, in view of the unacceptably high default rates, might not be accurate. Although we try to cover 100% newborns in this study, we only achieved 89.2% (3,762/4,219). We were not able to achieve the guideline of the Joint Committee on Infant Hearing 2000 to get >95% coverage. There were 457 (10.8%) newborns not screened and this occurred mainly during the early phase of this study for the following reasons: discharged during weekends before the screening test could be done, the staff responsible for screening was on leave, or some newborns were unintentionally overlooked for the screening test.

We took note that of the 620 newborns who failed the first stage, only 506 (81.6%) turned up for the second stage at two months of age to repeat OAE. At this second stage, 88.2% (446/506) who "fail" OAE during the first stage, "pass" the second stage. This gave the impression that there were a lot of false positives during the first stage. We postulate that we have a high failure rate (false-positive) during the first stage due to the test being conducted too early (less than 24 hours). In newborns less than 24 hours old, they are more likely to have debris in the EAC that interferes with OAE testing. In our hospital, full-term healthy newborns were routinely discharged between 12 to 24 hours of age in the absence of maternal complications.

OAE has been reported to have a high false-positive rate (about 15% at the first screen on day one and then reduces by about 50% with each retest). Screening using automated auditory brain responses (AABR) technique is associated with a much lower false-positive rate (about 5% on day one and reduces to about one percent by the second retest[24]. Gabbard et al[25] showed that a significant difference in the age-related effect was identified during the OAE screen test. They conducted two newborn screening procedures, AABR and transient otoacoustic emissions (TOAE) on 110 neonates with a mean age of 15 hours. 107 (97%) passed the AABR whereas 69 neonates (63%) passed the TOAE. A significant difference (at the level 0.05) was found between neonates younger than ten hours of age, neonates 10 to 24 hours of age and those more than 24 hours of age. Young neonates were less likely to pass the TOAE screen test than older neonates[25]. Joseph reported that since 2002, when TOAE screen tests were complemented with an early AABR in Singapore, their reference rate for diagnostic evaluation of hearing loss was reduced to less than one percent[24].

Vohr et al (1993) also reported that the age of the patients might affect the OAE result[26]. Waiting as long as possible prior to discharge before screening the baby provides more opportunity for debris in the EAC to clear naturally. This was confirmed by data from Rhode Island Hearing Assessment Project (RIHAP) in neonates tested before 24 hours of age[26]. When the examiners waited until the infants were at least 24 hours of age, the "pass" rate for a sample of over 4,000 infants at RIHAP increased from 70% to 82%. This might be due to the fact the vernix and amniotic fluid has a chance to clear from the ear canal during the first day of life[26].

Bantock and Croxson (1998) reported that testing at three to four weeks of life could lower the initial failure rate of OAE[20]. They reported a nine percent failure rate for both ears when the OAE screening test was carried out in the first few weeks of life. However, when they were retested one month later, only 0.8% failed and had to be referred for diagnostic BSER testing[20].

Another factor that can cause a high failure rate is the site of the screening test. Brass and Kemp (1994) suggested that the screening test be conducted in a quiet or soundproof room[21]. However, a soundproof room was not essential if a quiet room was available[20]. Inappropriate probe size, especially for small premature babies, will also cause false-positives. According to the RIHAP data, the probe must be stabilised before the test can be conducted[26].

In the present study, there were many defaulters during both the second stage (18.4%) and third stage (35%) of screening. A number of reasons were identified. Some parents were too busy to bring their infants for follow-up. Some were not fully briefed on the importance of this test and therefore did not see the need for follow-up. Some had misconceptions about their infants' hearing

status, as they had thought that as their child could respond to sound, they could hear and were able to develop normal speech.

In an attempt to minimise the number of defaulters, we assigned one assistant officer to call back the patient when they defaulted follow-up. On discharge from the ward or NICU, all newborns with "fail" result received a letter that documented the result. We also gave the OAE brochure to every newborn before discharge.

There are several study limitations. The test was not conducted in a quiet room before 24 hours of life in postnatal ward patients. There was also improper probe size for pre-term babies. An automated data information system was not available in the hospital. It was introduced about eight years ago and could provide immediate feedback to the screener. Indeed, Diefendort and Finitzo (1996) noted that in a survey of 90 infant hearing detection programmes in 43 states, as many as 50% of programmes had either no data information management and tracking system or paper records maintained[28].

We need to have long-term follow-up, as Vohr et al (1998) had provided data on the issue of follow-up with behavioural testing of newborns where five patients were identified to have hearing loss after having initially passed the TOAE screen test[29]. These five patients were confirmed to have high risk factors and were among the group referred for comprehensive audiological evaluation. They found that two patients had progressive hearing loss and therefore might have passed the screening initially. One patient was diagnosed to have hearing loss after the initial screen. In the other two cases, the diagnosis was auditory nerve pathology. This showed that the otoacoustic emission screening procedure only evaluates cochlear function[28]. Although the number of infants with auditory neuropathy is small (one in 25,000 population), OAE as a screening tool will still potentially miss infants with retrocochlear lesion[30].

We advocate the timing of the test to be after 24 hours following lower caesarian section and vagina delivery, or before discharge for neonates from NICU. The amniotic fluid and vernix are likely to be present in the neonatal ear and these need to be cleaned before the test can be performed. The screening test needs to include long-term follow-up, bigger sample size and a proper data management system. According to Finitzo (1998), screening in the nursery with low false-positive rates were achieved when there were audiologists involvement, hospital support and automatic data management[31]. The audiologists' role in the programmes involved were training and monitoring technician performance, documentation, diagnostic testing, and communication with hospital staff.

Adding a screening programme requires the cooperation of different people, including physicians, nursing staff, material management personnel, medical record staff and audiologists. It is absolutely essential to have systematic training and certification of screeners for the support staff. Maintaining good communication with hospital staff, including audiologists as well as paediatricians, is an essential part of the screening programme. In view of the fact that the multi-stage screening protocol used in this study had unacceptably high default rates, it could be improved by reducing it to a 2-stage screening process and/or by using automated acoustic brainstem response (AABR) combined with OAE technology.

ACKNOWLEDGEMENT

We are grateful to the all our staff at our ENT clinic, postnatal wards and NICU for their cooperation during this study.

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