Review Article

Universal Newborn Hearing Screening in Singapore: The Need, Implementation and Challenges

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Abstract

With about 1 in 1000 born with severe to profound hearing loss and about 5 in 1000 with lesser degrees of loss, congenital deafness is the commonest major birth defect. It is the recommended standard that hearing loss in newborns be detected by 3 months of age and intervention implemented by 6 months of age. Delayed detection and intervention may affect speech, language and psychosocial development, resulting in poor academic achievements. Universal newborn hearing screening (UNHS) is the only effective way of detecting all babies with hearing loss, within the recommended time frame. A survey in Singapore revealed that traditional childhood hearing screening programmes resulted in late detection (mean age, 20.8 months; range, 0 to 86 months) and late intervention (mean age, 42.4 months; range, 1 to 120 months). Increasingly, UNHS is becoming standard medical care in developed countries. In Singapore, UNHS has been implemented in all hospitals with obstetric services. Although a screening rate of more than 99% has been achieved in public hospitals, private hospitals have a screening rate of only about 77%. Parents' awareness and acceptance of early detection is still lacking, and this needs to be addressed by appropriate public education. Support from obstetricians and paediatricians will significantly contribute towards this objective. Effective programme management is essential; this includes the use of data management systems, the maintenance of a team of experienced screeners, and efficient coordination between screening and diagnostic services. Early detection of childhood deafness, together with early and effective intervention, maximises the chances of successful integration into mainstream education and society.

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Introduction

About 1 in 1000 newborns have severe to profound hearing loss and about 5 in 1000 have lesser degrees of loss,[1] which suggests that it is the most frequently occurring major birth defect. Unfortunately, for many babies, this disability remains undetected until it is too late to prevent undesirable and often irreversible damage.

Early detection and the treatment of childhood hearing loss have remained very important health and social issues. It has been well established that early detection and treatment are essential for the acquisition of communication competence, important social skills, emotional well-being and positive self-esteem. Most language development occurs during the first few years of life and inadequate auditory input during this critical period irreversibly delays the development of language skills for communication and reading. It also has a profound effect on receptive and expressive speech and language development, which is

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likely to adversely affect academic and vocational achievements. This ultimately affects successful integration into society and the prospects of leading a productive life.

It has also been established that the traditional methods of behavioural childhood hearing screening are subjective and deficient.[2] Using these behavioural methods of screening, the average age of identification of children with hearing loss has been shown to be between 18 and 30 months. This falls far short of the recommended standard, that hearing loss in newborns be detected by 3 months of age and intervention implemented by 6 months of age.[3]

Many developed countries have adopted universal newborn hearing screening (UNHS) programmes using objective methods. UNHS has, in fact, become standard practice in medical care. In Singapore, UNHS programmes have been established in all hospitals with delivery facilities and in polyclinics for the past few years.

This paper discusses the need for UNHS in Singapore, its implementation and the challenges ahead.

The Need for UNHS in Singapore

Deficiencies of Traditional Hearing Screening Programmes

The Health Surveillance Programme, which is conducted free at polyclinics, was introduced more than 2 decades ago. Hearing screening is done at 3, 6, 9, 15, 18, 36 and 48 months of age by asking caregivers simple questions related to hearing and using subjective free field audiometry with crude testing materials such as rattles. Not uncommonly, even children with severe to profound hearing are not detected early enough, let alone children with mild to moderate hearing loss. Hearing screening in the private sector is, in general, even more subjective and inconsistent. It appears that there are some who do not even attempt to screen for hearing loss. Of those who do, there is little uniformity in the schedule or methods of testing among different doctors. In both public and private sectors, hearing screening is performed only on infants who turn up for immunisation. According to the Ministry of Health's annual report in 1999, 4% of children in Singapore are not immunised and hence, are not screened for hearing loss.

A visiting team of nurses from the School Health Services (SHS) screens the hearing of all Primary 1 students. Mass screening is performed in groups of 20 students at a time, using a screening audiometer over the speech frequencies at a test intensity of 30 dB. Students who fail the screening test are referred to the SHS for full audiometry testing. A major limitation of this method is the difficulty in getting Primary 1 students to understand instructions given for reliable testing.

Consequences of Delayed Diagnosis

It is widely accepted that children with untreated hearing loss generally do not do well academically. Hearing loss affects reading and writing skills, resulting in poor communication and academic performance. However, early diagnosis together with early and effective treatment, could reverse this trend.

In Singapore, a study was conducted on the students from 2 special schools for hearing-impaired children.[4] The results showed that hearing loss was generally detected late, at a mean age of 20.8 months (range, 0 to 86 months). The mean age of intervention was even later, at 42.4 months (range, 1 to 120 months). It is noted that students from these schools generally have more severe degrees of hearing loss. Those with milder degrees of hearing loss may be detected even later.

In the same study, students from each cohort (i.e., students from the same class) were ranked according to academic performance and the ranking was correlated with the age of intervention. The results revealed that the longer the delay in intervention, the poorer the academic outcome tended to be. These findings are consistent with the established fact that the later hearing impairment is detected and intervention implemented, the poorer the outcome will be.[5] The Primary Six Leaving Examination results from the 2 schools were compared with those of the national average. Not surprisingly, children with hearing impairment generally had poorer results than their peers with normal hearing, particularly in English.

The accepted international standard of practice dictates that congenital deafness should be identified by 3 months of age and intervention implemented by 6 months of age for optimal speech and language development.[5] In Yoshinaga-Itano's 10-year longitudinal study[6] on the effect of early identification on the development of deaf and hard-of-hearing infants and toddlers, the language abilities of 46 hearing-impaired children identified before 6 months of age were compared with 63 similar children identified after 6 months of age. The result revealed that the average total language quotient for infants identified and receiving intervention prior to 6 months of age was significantly better than that of children identified late, across all degrees of hearing loss.

The benefits of early identification do not apply solely to children with severe to profound hearing loss. There are also possible developmental and academic effects resulting from milder degrees of hearing loss.[7,8] Children with hearing loss in 1 ear are 10 times as likely to be retained at least 1 grade compared to their peers with normal hearing.[9] Unilateral deafness affects the child's learning and relationship with classmates and teachers.[10]

Unidentified and untreated hearing loss can also lead to emotional and psychosocial handicaps.[11,12] Moreover, delayed identification and management of severe to

profound hearing impairment may impede the child's ability to adapt to life in a hearing world or in the deaf community. There is general agreement that hearing impairment should be recognised as early in life as possible, so that the remedial process can take full advantage of the plasticity of the developing sensory systems and the child can enjoy normal social development. With proper rehabilitation, they will have better career opportunities.

Limitations of Targeted Newborn Hearing Screening

It can be argued that instead of screening all newborns, it may be more cost-effective to confine screening to the 6% to 8% of babies who are at high risk of developing hearing loss.[13] Risk factors include very low birth weight and APGAR score, severe jaundice, perinatal asphyxia, congenital malformations, family history of deafness, meningitis/intrauterine infections/septicaemia and the use of ototoxic drugs. However, this argument is not tenable because about 50% of infants with hearing loss do not fall within the high-risk category.[5,14] To identify these children, as well as those in the high-risk group, it is necessary to screen all newborns.

Economic Considerations

The cost of educating 1 child in a special school for 1 year is 4 times that required for a child in a mainstream school in Singapore.[5] On the average, a hard-of-hearing child takes 8 years to complete primary education. In FY2000, the cost of completing primary school education for each hearing-impaired child was $71,500 more than that for a normal hearing child. Assuming an annual birth rate of 42,000 and a 1 in 1000 incidence of significant congenital deafness, each cohort requires an additional $3 million ($71,500 x 42) to complete primary education.

Early detection and treatment of hearing loss in children will reduce communication disability and enhance the opportunity for children to receive formal education. Having acquired sufficient communication and reading skills, these children will be able to achieve vocational prospects equivalent to that of their hearing peers. Otherwise, a particularly high societal cost will be required to provide support for these individuals in the long term.[15]

Implementation

Pilot Studies

The National University Hospital (NUH) started mass screening for hearing impairment in 1995 with the distraction method and switched to using Otoacoustic Emission (OAE) testing in 1999.[16] The Singapore General Hospital (SGH) also started a pilot UNHS programme using OAE technology in late 1998. The programmes aimed to screen all neonates before they were discharged from the hospital. Newborns who failed the initial screening had a repeat screening within 4 to 6 weeks. Failure in both screening tests would necessitate referral for audiological diagnosis and medical evaluation before the age of 3 months. The pilot studies suggested that it was feasible to implement a UNHS programme in Singapore.[17,18]

A National UNHS Programme

In April 2002, UNHS was implemented in KK Women's and Children's Hospital (KKWCH), which accounted for approximately one-third of deliveries (or 15,000 per year) in Singapore. Besides sponsoring a 1-year free screening in KKWCH, the Ministry of Health also provided screening equipment in 17 polyclinics to screen infants who had not had UNHS. The UNHS programmes in the restructured hospitals and polyclinics share a common database, using the Hi-Track Software.

Over the following 2 years, all 6 private hospitals with delivery facilities also introduced UNHS programmes.

Screening Tools

The 2 physiologic screening measures are OAE and the Automated Auditory Brainstem Response (AABR). Both are non-invasive, quick and easy to perform on newborns, although each assesses different hearing mechanisms.

OAE measures sound waves (emissions) generated by the motion of the outer hair cells in the cochlea. It detects peripheral hearing loss. Emissions are not detected in an infant who cannot hear. The OAE technology can have a sensitivity of 95% and a specificity of 90%.[19] The referral rate is 5% to 20% when screening is performed within the first 24 hours of life.[20]

AABR provides an electrophysiological measure of the hearing pathway along the auditory nerve. Three small sensors are placed on the infant's head to record the brain wave activity of the auditory brainstem in response to sound. AABR judges the response against a "normal" template in order to determine the presence/absence of waveforms. The false positive rates range from 0.3% to 2.5%.[21] The referral rate is less than 3% when screening is performed during the first 24 to 48 hours after birth.[20]

Effectiveness of UNHS Programmes in Hospitals

Newborn hearing screening has become standard medical care in restructured hospitals. Screening is carried out on babies before they are discharged from hospital, by trained personnel who work throughout the week. The screening personnel also document the screening results in the respective personal health booklets and educate parents on the importance of monitoring for late-onset hearing loss. For children who are at risk for hearing impairment, 6-monthly reviews are recommended until 2 to 3 years of age.

The data from SGH, NUH and KKWCH for the period 1 April 2002 to 31 March 2004 are presented. Of the 36,175

babies eligible for screening, 36,093 (99.8%) were successfully screened (Table 1). A total of 220 babies (0.6%) failed the screening test, and were referred for diagnostic audiological evaluation. Of these, 18 (8.2%) refused diagnostic audiological tests and a further 18 (8.2%) did not complete the necessary tests (Table 2). Of the remaining 184 babies (83.6%), 146 (79.3%) were confirmed to have hearing loss. This gave an overall prevalence of 4.0 per 1000 babies having hearing loss, with 64 being severe or profound (1.7 per 1000 babies) (Table 3). The median age of diagnosis was 2.7 months. Of the 115 infants with at least moderate hearing loss, only 55 (47.8%) were identified to be at risk for hearing impairment.

Among the hospitals, differences in the referral and prevalence rates were observed (Tables 1 and 3). These are likely to be attributed to the different screening tools used. KKWCH uses AABR whereas SGH uses OAE, to screen all newborns before discharge. For those who fail the initial screen, they are re-screened as outpatients using the same tools. The babies who fail the second screen are referred for Ear, Nose and Throat (ENT) assessment. Babies in NUH are initially screened with OAE, followed by AABR for babies at high risk or babies who have failed the initial OAE screen (both done as inpatients). Those who fail are screened again by AABR, as outpatients.

An average of 77% of newborns were screened in the private hospitals. Attempts are being made to improve the screening rates in private hospitals.

Challenges

Parents' acceptance and awareness of the importance of early detection and early intervention is one of the greatest challenges. A survey was carried out at 9 local polyclinics in March 2003, on the families of babies 4 months of age and below, who brought their babies there for immunisation. The survey aimed to establish the number of babies seen at these polyclinics, who had not had UNHS at their respective hospitals of birth. A total of 2331 babies were studied, of which 23% had been referred from private hospitals. As UNHS programmes in some private hospitals were still not well established, only 65% of the babies born in private hospitals had had UNHS. Interestingly, the families of 59% of those who had missed UNHS refused the offer of hearing screening at the polyclinics. The reasons cited were: "my baby can hear" (49.5%), "no family history of hearing loss" (12.6%), "parents can monitor themselves" (13.5%), "too

Table 1. Screening and Referral Rates

	KKWCH		SGH		NUH		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Eligible for screening	28,333		2981		4861		36,175	
Screened	28,273	99.8	2973	99.7	4849	99.8	36,095	99.8
Referred to ENT	117	0.4	72	2.4	31	0.6	220	0.6

Table 2. Audiological Evaluation

	KKWCH		SGH		NUH		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Referred to ENT	117		72		31		220	
Refused	6	5.1	11	15.3	1	3.2	18	8.2
Incomplete	17	14.5	1	1.4	0	0.0	18	8.2
Confirmed	94	80.4	60	83.3	30	96.8	184	83.6
Hearing Loss	84	89.4	36	60.0	26	86.7	146	79.3
Normal	10	10.6	24	40.0	4	13.3	38	20.7

Table 3. Degrees and Prevalence of Hearing Loss

	KKWCH		SGH		NUH		Total	
	No.	Per 1000	No.	Per 1000	No.	Per 1000	No.	Per 1000
Mild	7	0.2	16	5.4	3	0.6	26	0.7
Moderate	33	1.2	11	3.7	12	2.5	56	1.6
Severe	15	0.5	4	1.3	2	0.4	21	0.6
Profound	29	1.0	5	1.7	9	1.9	43	1.2
Total	84	3.0	36	12.1	26	5.4	146	4.0

costly" (10.8%), "wait till baby is older" (7.2%) and "no time" (5.4%). There is, therefore, no doubt that more public education on the potential benefits of modern day intervention and the consequences of late detection is needed. Strong support from paediatricians and obstetricians will significantly contribute towards the acceptance of this exercise.

Parental anxiety in children who have failed hearing screening is natural and is to be expected. There are concerns that UNHS unnecessarily creates parental anxiety, particularly in false positive results.[22] Although such concerns are real, parental anxiety can be minimised if counselling is done effectively by skilled and empathetic professionals. Research has shown that parents generally support early identification of hearing loss,[23,24] and despite a past experience of anxiety associated with hearing screening, most would still prefer hearing screening for their subsequent children.[25]

Ensuring a consistently high capture rate and low referral rate is another challenge. A high turnover of staff can make it difficult to constantly maintain a team of trained and competent screeners. There may be logistical difficulties in trying to schedule hearing screening for the patients who are discharged early from hospital, particularly during weekends. With increasing healthcare costs, there is a growing trend towards discharging patients within 24 hours of delivery.

The selection of the most appropriate screening tool is controversial. Although OAE is simpler, cheaper and quicker to perform, it results in higher false positive rates than AABR. The logistics involved in the management of large numbers of patients with false results can be problematic. Furthermore, patients with hearing loss due to auditory neuropathy will be missed by OAE without AABR screening. Although AABR has lower false positive rates, it is more costly and tends to miss out on the milder degrees of hearing loss.

For babies who have failed screening, successful diagnostic evaluations in a timely fashion can also be a challenge. Delays can occur if there are inadequate audiological resources to meet service needs, or if these services are not well coordinated with the screening process. Difficulties may also arise from patient factors, such as parental concerns regarding sedation and affordability for costly diagnostic tests.

It can be seen that most of these challenges are attributable to ignorance and deficiencies related to the work processes and the resources required for a successful UNHS programme. To meet these challenges, the public and the professionals concerned must be appropriately educated. The necessary resources must be available to run and support an effective programme. Efficient programme management, including proper coordination of screening, diagnostic and intervention services, is also essential.

Conclusion

UNHS ensures that all babies born with hearing loss are detected early. Together with early and effective intervention, they can optimise speech and language development so that the chances of successful integration into mainstream society can be maximised. Increasingly, UNHS is becoming standard medical care in developed countries. In Singapore, UNHS programmes have been implemented in all hospitals with obstetric services. Although considerable success has been achieved, much more needs to be done in addressing the difficulties encountered and challenges ahead. Education of the public and professionals concerned, and having an effective and efficiently managed programme, are key priorities.

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