HEARING AID FITTING AND HABILITATION FOLLOWING NEWBORN HEARING SCREENING: A FOLLOW-UP STUDY ON WELL-BABY NURSERY INFANTS

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ABSTRACT

Objective:Newborn Hearing Screening (NHS) at Kitasato University Hospital began in July 2002. Infants who failed NHS were referred to the Department of Otolaryngology, where they underwent further evaluations for hearing, diagnosis, hearing aid fitting, and habilitation. These evaluations were performed by otolaryngologists and speech-language-hearing therapists. This study reports the long-term follow-up findings of well-babynursery infants who failed NHS between 2003 and 2012.

Methods:Participants included 66 well-babynursery infants who failed NHS. We recorded their ages at the time of post-NHS evaluations.

Results: The mean age of the infants at the time of hearing evaluation was 2.8 ± 3.7 months. Ten had normal hearing; others had hearing loss characterized as unilateral (7), mild (13), moderate (18), severe (4), or profound (14). Average age at first hearing aid fitting by diagnosis was 17 ± 7.3 months (mild), 14 ± 5.3 months (moderate), 5.8 ± 1.0 month (severe), and 6.2 ± 2.4 months (profound). Among infants with bilateral hearing loss, 42.4% had mental retardation(MR). Sixty-six percent of those with mild-to-moderate hearing lossare now attending general schools, 24% are receiving special education for MR,and 10% are attending schools for the deaf. On the other hand, 88% of those with severe-to-profound hearing loss are registered at schools for the deaf.

Conclusion:Among well-baby nursery infants,hearing level had significant influence on early intervention and habilitation. In selecting an appropriate habilitation facility, not only the severity of hearing loss but also the level of intellectual development should be paid due attention.

INTRODUCTION

Numerous reports have been published regarding theNewborn Hearing Screening(NHS) system, including participation rates, pass/referral rates, and the prevalence of congenital hearing loss(Mehl,et al.1998,5,Lim,et al.2012,59-60). The introduction of the NHS system has provided the opportunity to diagnose and treat hearing-impaired infants earlier than previously possible.A combination of NHS and appropriate therapy is beneficial in speech promotion and language development of hearing-impaired infants (Vohr,et al.2008,543)

From 1998 to 2001, the Japan Ministry of Health, Labor, and Welfare investigated effective methods for NHS and habilitation, and several prefectures have since received public funding to perform NHS. At Kitasato University Hospital, NHS began in July 2002. Kitasato University Hospital is located in Sagamihara, a city of 700,000 people located at the southern edge of Tokyo. The facility is used by people residing in northern Kanagawa Prefecture and southern Tokyo. Infants who failed NHS at Kitasato University Hospital or at neighboring maternity clinics were referred to the Department of Otolaryngology, where they underwent further evaluations for hearing, diagnosis, hearing aid fitting, and habilitation performed by otolaryngologists and speech-language-hearing therapists. If necessary, they were referred to other facilities for specialized habilitation.

This study reports the long-term follow up of well-baby nursery (WBN) infants who failed NHS. Prevalence of hearing loss, prevalence of mental retardation (MR), hearing aid use, and types of habilitation facilities were investigated retrospectively.

METHODS

Participants

The study was conducted between 2003 and 2012. During the study period, 178 infants were referred to the Department of Otolaryngology of Kitasato University Hospital for hearing evaluation. Of these, 59 infants were excluded for the following reasons: eight infants from the neonatal intensive care unit (NICU)diagnosed with genetic or cardiac disease died; eight infants were transferred to another hospital; three infants stopped visiting the hospital; eight infants were diagnosed with a malformed external ear (i.e., microtia and aural atresia); 28 infants were referred from maternity clinics with little information on their NHS results; and four infants relocated to the local area and were examined at our hospital after being diagnosed elsewhere. Among the 119 participants, there were 66 WBN infants and 53 NICU infants.

Procedures

Ages of infants at times of hearing examination, diagnosis, hearing aid fitting, and rehabilitation were determined from a review of pediatric and otorhinolaryngology department records. Participants were diagnosed based on auditory brainstem response(ABR) thresholds and infant audiometry findings. Hearing was evaluated through behavioral observation audiometry, visual reinforcement audiometry, conditioned orientation response audiometry, peepshow test, and play audiometry, as appropriate for the level of developmental maturity. If right and left hearing thresholds could not be determined by infant audiometry due to severe MR, then the patient was diagnosed using ABR thresholds. Hearing loss was classified as mild (26–39 dBHL), moderate (40–69 dBHL), severe (70–89 dBHL), or profound (>90 dBHL). If hearing loss on the right and left sides differed in severity, then hearing was diagnosed according to the findings on the better side.

To diagnose MR, the intellectual development of each infant was evaluated using the Japanese equivalent of the Stanford-Binet Intelligence Scale, Wechsler Preschool and Primary Scale of Intelligence, or Wechsler Intelligence Scale for Children (third edition). If an infant was unable to complete intelligence tests, then intellectual development was assessed using medical records from the infant's pediatrician.

RESULTS

Results of NHS

Otoacoustic emission (OAE) testing was performed in 20 WBN infants. Out of 20 infants tested, 13 failed testing in both ears, and seven failed testing in one ear. One infant failed testing in one ear; the opposite ear could not be tested. This infant was grouped with infants who failed tests in both ears. Automated ABR (AABR) assessment was performed in 28 WBN infants; 19 failed testing in both ears, and nine failed testing in one ear. Eighteen WBN infants were tested by OAE followed by AABR; 15 failed testing in both ears, and three failed testing in one ear.

Age at further evaluation for hearing

The mean age of WBN infants at hearing examination was 2.8 months (range 0-20 months). Of 66 WBN infants tested, 51 (77%) underwent a hearing examination within 3 months of birth, seven (10%) within 6 months of birth, six (9%) within 12 months of birth, and two (3%) had a hearing examination over 12 months after birth.

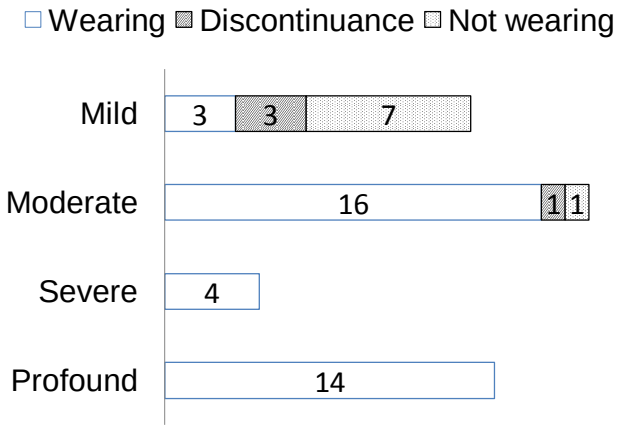
Diagnosis of hearing loss

Forty-four of 66 (67%) WBN infants underwent audiometry that measured right and left ear hearing thresholds. A total of 22 out of 66 (33%) WBN infants were diagnosed by ABR thresholds. Ten out of 66 (15%) WBN infants had normal hearing, seven (11%) had unilateral hearing loss, 13 (20%) had mild hearing loss, 18 (27%) had moderate hearing loss, four (6%) had severe hearing loss, and 14 (21%) had profound hearing loss.

Age at hearing aid fitting

Figure 1 demonstrates the use of hearing aids. Six out of 13 WBN infants with mild hearing loss were fitted with hearing aids, but three stopped wearing them. A total of 17 out of 18 WBN infants with moderate hearing loss were fitted with hearing aids;usage was discontinued in one infant. All four WBN infants with severe hearing loss and 14 WBN infants with profound hearing loss were fitted with hearing aids.

Figure 1 Hearing aid use in WBN infants.
WBN, well-baby nursery



The mean age at which infants with bilateral hearing loss were first fitted with hearing aids is shown in Table 1. Among WBN infants with mild or moderate hearing loss, the mean age at which hearing aids were fitted was 15 ± 5.8 months (range, 5-26 months). Among WBN infants with severe or profound hearing loss, the mean age was 6.1 ± 2.1 months (range, 3-10 months).

Table 1 Mean age of first hearing aid fitting in WBN infants with bilateral hearing loss

All infants	Mild to moderate hearing loss	Severe to profound hearing loss	P value*
11 ± 6.3 (3–26)	15 ± 5.8 (5-26)	6.1 ± 2.1 (3-10)	< 0.001

All data presented as the mean ± standard deviation (range) and measured in months.
WBN, well-baby nursery
* Comparison between infants with mild to moderate vs severe to profound hearing loss in WBN using the Wilcoxon rank sum test.

Among WBN infants, the mean age at which hearing aids were fitted for those with severe or profound hearing loss was significantly lower than that for infants with mild or moderate hearing loss (Wilcoxon rank-sum test, $p < 0.001$).

Habilitation and developmental delay

Table 2 lists the distribution of habilitation facilities among patient groups. The mean follow-up period for WBN infants was 50 ± 30 months (range, 1-118 months).

Table 2 Rehabilitation facilities for WBC infants (N=45) according to severity of hearing loss

Hearing loss Severity	School for hearing Impaired children	Special education for MR	General preschool or elementary school
Mild to Moderate	3 (10%)	7 (24%)	19 (66%)
Severe to profound	14 (88%)	0 (0%)	2 (13%)
p-value*		< 0.001	

Data presented as the number (percentage) of infants.
WBN, well-baby nursery
*Comparison within WBN infants who were enrolled at three kinds of facilities according to hearing loss severity using the chi-square test.

Among 33 WBN infants with bilateral hearing loss, MR was diagnosed in 14 (43%). Nineteen out of 29 (66%) WBN infants with mild or moderate hearing loss were enrolled in general preschools and elementary schools, 7 out of 29 (24%) received special education for MR, and 3 out of 29 (10%) were enrolled in schools for hearing-impaired children. Fourteen out of 16 (88%) WBN infants with severe or profound hearing loss were enrolled in schools for hearing-impaired children, and 2 out of 16 (13%) were enrolled in general preschools or elementary schools. The occurrence of MR was identified as congenital in all cases. Among WBN infants with bilateral hearing loss, enrollment in a school for hearing-impaired children was associated with severity ofhearing loss (chi-square test, $p < 0.001$).

DISCUSSION

Guidelines recommend performing NHS within 1 month of birth and a hearing examination within 3 months of age. If required, hearing aid fitting and habilitation should begin within 6 months of age(Joint Committee on Infant Hearing2000,799). In this study, the standard was met only for infants with severe or profound hearing loss. Among infants with mild or moderate hearing loss, the mean age at the time of hearing aid fitting was significantly higher (15 ± 5.8 months; Table1).At the same time, our long-term data revealed that all participants with severe or profound hearing loss, and most of those with moderate hearing loss, ultimately wore hearing aids (Fig.1). These data suggest that among WBN infants who failed NHS, severity of hearing loss is a significant factor in the timing of rehabilitative intervention. Infants with mild or moderate hearing loss may need a longer intervention for hearing aid use.

Our data suggest that even among WBN infants, a habilitation facility was selected not only according to the severity of hearing loss, but also according to the level of intellectual development. All infants require habilitation appropriate to their individual needs. Otolaryngologists and speech-language-hearing therapists can advise families on the most appropriate habilitation facility based on the results of several different assessments.

CONCLUSION

Among WBN infants who failed NHS, hearing level was a significant factor in prompting early intervention and habilitation. Regardless of the good physical condition of WBN infants, the co-existence of multiple disabilities requires special attention. Based on the results of several assessments, otolaryngologists and speech-language-hearing therapists can select an appropriate habilitation facility to

address the hearing needs and developmental challenges of each individual patient.

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