

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

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ABSTRACT

Objective: Newborn hearing screening (NHS) began in July 2002 at Kitasato University Hospital. Infants who failed NHS were referred to the Department of Otolaryngology, where otolaryngologists and speech-language-hearing therapists carried out further evaluations for hearing, diagnosis, hearing aid fitting, and habilitation. The aim of this study was to report on the long-term follow-up of neonatal intensive care unit (NICU) infants who failed NHS between 2003 and 2012.

Methods: Participants were 53 NICU infants who failed NHS, whose ages at further evaluations for hearing, diagnosis, hearing aid fitting, and habilitation were examined in this study.

Results: The mean age of infants at further evaluations for hearing was 5.2 ± 5.4 months. Eight were diagnosed with normal hearing; others, with unilateral (9), mild (15), moderate (12), severe (3) or profound (6) hearing loss. Mean age at first hearing aid fitting was 24 ± 25 months in mild, 23 ± 15 months in moderate, 18 ± 7.6 months in severe, and 15 ± 7.2 months in profound hearing loss. Approximately 86.2% of those with bilateral hearing loss had multiple disabilities; 54% with mild or moderate and 56% with severe or profound hearing loss needed special education for mental retardation (MR).

Conclusions: The majority of NICU infants had multiple disabilities. Their age at hearing aid fittings was later than that of well-baby nursery infants. More than half required not only special education for hearing impairment but also for MR. The results suggest the need for individualized habilitation programs.

INTRODUCTION

The newborn hearing screening (NHS) system includes facilities for screening (obstetrics and pediatrics clinics), advanced hearing evaluation (otorhinolaryngology departments at general hospitals), and intervention and habilitation. Hearing impaired children are typically educated at schools for the hearing impaired or institutional daycare facilities with supports for hearing loss

children. Depending on the severity of hearing loss, some hearing impaired children may be educated at general nurseries, kindergartens, and schools while receiving habilitation at hospitals. Children with both hearing loss and mental retardation (MR) may be educated at schools for MR or at institutional daycares with supports for MR.

The aims of this study were to examine the long-term outcomes in neonatal intensive care unit (NICU) infants who underwent NHS at Kitasato University Hospital. The prevalence of hearing loss, prevalence of MR, hearing aid use, and types of habilitation facilities were investigated retrospectively.

MATERIAL AND METHODS

Setting:

Kitasato University Hospital is located in Sagami-hara, which is a city of 700,000 people at the southern edge of Tokyo. The facility is used by people residing in northern Kanagawa Prefecture and southern Tokyo. The hospital has a Maternal Fetal Intensive Care Unit and NICU; therefore, many high-risk pregnancies and neonates with major periparturient disorders are referred to the facility. NHS was implemented at Kitasato University Hospital beginning in July 2002. Infants who failed NHS were referred to the Department of Otolaryngology for additional hearing evaluation and diagnosis, hearing aid fitting, and habilitation by otolaryngologists and speech-language-hearing therapists.

Participants:

The study was conducted between 2003 and 2012. During the study period, 178 infants were referred to the Department of Otolaryngology for further hearing evaluation. Of these, 59 infants were excluded for the following reasons: eight NICU infants diagnosed with genetic or cardiac disease died; eight infants 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. There were 53 NICU infants in the 119 participants.

Newborn hearing screening protocol and diagnosis:

The age of the infants at the hearing examination, diagnosis, hearing aid fitting, and habilitation was determined based on review of the pediatric and otorhinolaryngology department records. The patients were diagnosed based on the auditory brainstem response (ABR) threshold and infant audiometry. Hearing loss was classified as mild (26–39 dBHL), moderate (40–69 dBHL), severe

(70–89 dBHL), or profound (>90 dBHL). If the right and left sides differed in severity, then hearing was diagnosed according to 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 the infant was unable to complete the intelligence tests, then the intellectual development was gauged based on medical records from the pediatrician.

RESULTS

The results of well-baby nursery (WBN) infants were reported by coauthor, Keiko Suzuki.

Hearing examination results:

The otoacoustic emission test (OAE) was administered to nine NICU infants. Seven of nine infants failed in both ears, one failed in one ear, and one passed in both ears. Four NICU infants were tested using automated auditory brainstem response (AABR), and three failed in both ears and one failed in one ear. Twenty-four NICU infants were tested first by OAE followed by the AABR; 18 failed in both ears, five failed in one ear, and one passed in both ears. In 16 NICU infants, neither the OAE or AABR was administered; these infants were tested by ABR. The ABR threshold was elevated by at least 30 dBHL in both ears.

Mean ages at hearing evaluation:

The mean age at hearing examination in the NICU infants was 5.2 months (range 0 and 29 months). Twenty-six infants were examined within 3 months of birth, 14 within 6 months, nine within 12 months, and four over 12 months after birth.

Diagnosis of hearing loss:

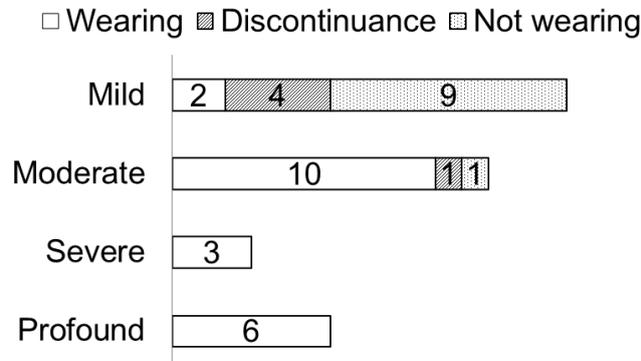
Among the 53 NICU infants, eight were diagnosed with normal hearing (15%), nine with unilateral hearing loss (17%), 15 with mild hearing loss (28%), 12 with moderate hearing loss (23%), three with severe hearing loss (6%), and six with profound hearing loss (11%).

Age at hearing aid fitting:

Figure 1 shows the use of hearing aids in the patients. Six of 15 NICU infants with mild hearing loss were fitted with a hearing aid, but four infants stopped wearing the devices. A total 11 of 12 NICU infants with moderate hearing loss received a hearing aid, and one infant stopped wearing the device. All three NICU infants with severe and all six infants with profound hearing loss were fitted with hearing aids.

The mean age at hearing aid fitting of NICU infants with mild or moderate hearing loss was 21 ± 18 months (range 3 to 74 months), and those of infants with severe or profound hearing loss was 16 ± 7.1 months (range 4 to 27 months). In NICU infants, there was no significant difference in the time of hearing aid fitting according to hearing loss severity (Wilcoxon rank-sum test, $p = 0.79$).

Figure 1 Hearing aid use in NICU infants



Data presented as the number of infants.

Habilitation and developmental delay:

Table 1 lists the distribution of habilitation facilities in the patient groups. The mean follow-up period in NICU infants was 51 ± 35 months (range 1 to 115 months). MR was diagnosed in 25 of 29 (86.2%) NICU infants with bilateral hearing loss who were followed long-term and were able to undergo intelligence testing. None of the 22 NICU infants with mild or moderate hearing loss were enrolled in schools for hearing impaired children. Eight of 22 (36%) were enrolled in general preschools and elementary schools, and 14 of 22 (64%) received special education for MR. Four of 9 NICU infants with severe or profound hearing loss (44%) were enrolled in schools for hearing impaired children, and 5 of 9 (56%) received special education for MR. All MR infants were congenital. In the NICU infants with bilateral hearing loss, the type of habilitation facility was not associated with the severity of hearing loss (chi-square test, $p = 0.62$).

Table 1 Habilitation facilities for NICU infants (N=31) 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	0 (0%)	14 (64%)	8 (36%)
Severe to profound	4 (44%)	5 (56%)	0 (0%)
p-value*		0.62	

Data presented as the number (percentage) of infants.

*Comparison within NICU infants who were enrolled at facility specializing in mental retardation according to hearing loss severity using the chi-square test.

DISCUSSION

Hearing evaluation and diagnosis following NHS:

In this report, the mean age of NICU infants at hearing examination was significantly greater than that of WBN infants (5.2 ± 5.4 months and 2.8 ± 3.7 months, respectively). Uus and Bomford ¹⁾ reported similar results and attributed to this trend to health differences between the two infant populations. At our hospital, the initial hearing evaluation was conducted in most of the NICU infants using ABR or infant audiometry immediately before discharge once their weight reached 2,500 g. Until that time, the NICU infants received intense medical care and struggled with life-threatening conditions. The long duration of hospitalization for NICU infants is likely an essential factor helping to delay hearing evaluation.

Hearing aid fitting in infants with bilateral hearing loss:

Remarkably, in the present study, there was no significant difference in the hearing aid use between NICU infants and WBN infants. However, the mean age of hearing aid fitting was significantly greater in NICU infants than in WBN infants (19 ± 16 months and 11 ± 6.3 months, respectively).

The factors favoring delayed hearing aid fitting in NICU infants include: delayed hearing evaluation due to their longer duration of hospitalization; inability to undergo periodic hearing examination due to recurrent hospitalization after discharge from the NICU; and the higher prevalence of severe MR, which delays hearing examination. Dalzell and Orlando ²⁾ and Uus and Bamford ¹⁾ observed that the mean age of hearing aid fitting in WBN infants was significantly earlier than in NICU infants. Guidelines recommend performing NHS within 1 month of birth and a hearing examination within 3 months; if required, hearing aid fitting and habilitation should begin within 6 months ³⁾. However, in the present study, this standard was not met in a significant proportion of infants, particularly among NICU infants. As indicated by our long-term data, hearing aid fitting can be individually tailored not only in WBN infants but also in NICU infants. It is important to adjust the use of hearing aids to the infant's individual health and development rather than strictly adhering to the standard protocol.

Selection of habilitation facilities:

We found that 86.2% of NICU infants with bilateral hearing loss also had MR. There have been several reports of NICU infants with bilateral hearing loss and concurrent MR^{2),4)}. Our data suggest that in MR infants, especially NICU infants who have additional disabilities, the habilitation facility was selected not only according to the severity of hearing loss but also according to general health

and intellectual development. All infants require appropriate habilitation corresponding to their individual needs.

Otolaryngologists and speech-language-hearing therapists can advise families on the most appropriate habilitation facility for their infants based on the results of several different assessments. Some infants may need to be enrolled in schools for hearing impaired children because their primary disability is hearing loss, while others may require enrollment in a center for MR because their primary disability is developmental impairment. Otolaryngologists and speech-language-hearing therapists should coordinate their care with that of pediatricians and other clinicians to ensure that the habilitation and family support accommodates all relevant factors including the general health, mental development, and family environment of the infant. Based on the collective diagnostic findings, comprehensive decisions can be made on the best time to incorporate hearing aids and the best habilitation facility.

CONCLUSION

The ages at hearing examination and hearing aid fitting were significantly later in NICU infants than in WBN infants. However, there was no significant difference in the long-term use of hearing aids between NICU infants and WBN infants. Habilitation facilities were chosen not only based on the severity of hearing loss, but also according to the mental development of the infant. Otolaryngologists and speech-language-hearing therapists must regularly evaluate the developmental ability of their infant patients in addition to assessing hearing. Based on these evaluations, clinicians can select an appropriate habilitation facility that accommodates the hearing and developmental abilities of each individual patient.

REFERENCES

- 1) K. Uus, J. Bamford (2006). Effectiveness of population-based newborn hearing screening in England: ages of interventions and profile of cases, *Pediatrics*, 117, 887– 893.
- 2) L. Dalzell, M. Orlando (2000). The New York State universal newborn hearing screening demonstration project: ages of hearing loss identification, hearing aid fitting, and enrollment in early intervention, *Ear Hear*, 21(2), 118–130.
- 3) Joint Committee on Infant Hearing, Year 2000 position statement: principles and guidelines for early detection and intervention programs, *Pediatrics*. 106, 798–817.
- 4) C.M.T. Robertson, T.M. Howarth (2009). Permanent bilateral sensory and neural hearing loss of children after neonatal intensive care because of extreme prematurity: a thirty-year study, *Pediatrics*. 123, 797–807.