Impact and benefits of early hearing screening

Korver, A.M.H.

6 NEWBORN HEARING SCREENING AND EARLY START OF INTERVENTION: HOW EARLY IS EARLY?

A.M.H. KORVER
S. KONINGS
F.W. DEKKER
C.C. WEVER
J.H.M. FRIJNS
A.M. OUDESLUYS-MURPHY

ABSTRACT

Background

Newborn Hearing Screening (NHS) is supposed to have positive consequences for developmental outcome, but can only be expected when intervention and counseling are started soon after the confirmation of permanent childhood hearing impairment (PCHI). The Joint Committee on Infant Hearing formulated recommendations on age of diagnosis of PCHI and age at start of habilition. However, to date, no information on the periods of time following a positive screen for hearing loss at hearing screening is available in our country.

Objectives

To study the age at diagnosis of PCHI and the age at first amplification in the years following implementation of NHS.

Methods:

Nationwide retrospective follow-up study. The inclusion criteria were: born in the Netherlands between 1 January 2003 and 31 December 2005, a positive screen for hearing loss at the final (third) stage of the three-stage NHS and PCHI confirmed at diagnostic evaluation at an Audiology Center. Outcome measures: age at confirmation of PCHI, age amplification was started, degree of hearing loss, Audiology Center at first visit and the year of birth.

Results

Available for analysis were 159 (89.8%) of all children fulfilling the inclusion criteria. Over time the mean age at first diagnostic evaluation and start of amplification decreased. Half of the children were diagnosed before the age of 1.5 months and received amplification before the age of 6 months in 2005. The age at amplification was related to the degree of hearing loss, with children with moderate PCHI being amplified at the oldest age (median age 7.0 months). The mean delay between diagnosis and first amplification was 43 weeks in 2004 (CI95% 15.7-71.3) and 18 weeks in 2005 (CI95% 10.1-25.1), for children with profound and severe hearing loss. Between university and non-university Audiology Centers the age at first diagnostic evaluation was comparable but a difference was found in age at start of amplification (mean (SD) 10.6 (12.6) and 6.8 (7.0) months), with children visiting a university Audiology Center being amplified later.

Conclusion

The international recommendations of the JCIH are better achieved in time. The findings emphasize that also children with moderate PCHI should be amplified early.

INTRODUCTION

Newborn Hearing Screening (NHS) has been introduced to identify permanent conductive or sensorineural hearing loss early in life in many countries. NHS is supposed to have positive consequences for developmental outcome in children with a positive screen for hearing loss, but this can only be expected when intervention and counseling are started soon after the confirmation of permanent childhood hearing impairment (PCHI).[28;31;97;98]

In the Netherlands NHS was gradually introduced from 2002 onwards and is offered to all well babies living in our country before the age of 6 weeks since 2006. This nationwide implementation involved an enormous effort.

To maintain and optimize the performance of the NHS program, regular evaluation is essential. However, administrators of the hearing screening program are permitted to register and monitor individual data only up to referral to health care services. Information on the period of time following a positive screen for hearing loss is not accessible and because there is no reliable nationwide track and chase system for longitudinal follow-up insight in these data is missing.

The Joint Committee on Infant Hearing (JCIH) published recommendations on the period of time in which the diagnosis of PCHI should be established and habilitation started. These state that children with a positive screen for hearing loss should have a comprehensive evaluation of hearing at no later than 3 months of age. Infants with confirmed hearing loss should receive appropriate intervention as soon as possible following diagnosis, but at no later than 6 months of age. Fitting of a hearing aid should be performed within one month of the initial diagnosis even when additional diagnostic evaluation is still ongoing. Since habilitation is guided by individual needs some suggestions concerning intervention services and counseling are given.[15]

Within the framework of the nationwide DECIBEL-study we had the opportunity to evaluate the time-periods in a nationwide sample of children with PCHI. The objectives of this nationwide study are (1) to study the age at diagnosis of PCHI and (2) to study the age at first amplification in the years following implementation of NHS in our country. We hypothesize that over time the recommendations of the JCIH will be better achieved.

METHODS

NEWBORN HEARING SCREENING IN THE NETHERLANDS

The NHS for well babies is either performed during home-visits, together with newborn bloodspot screening, or at a well-baby clinic. NHS is a three stage hearing screening program using transient evoked oto-acoustic emissions (OAE) in the first two stages and automated auditory

brain stem response (A-ABR) in the third stage. A uni- or bilateral positive screening for hearing loss at one stage will be followed by a second hearing screening step and a positive screen at the third stage will be followed by referral to an Audiology Center for diagnostic investigation and confirmation. For children with PCHI the Audiology Center is the designated organisation for diagnostic evaluation and amplification. Counselling is organized by affiliated family care organisations.

STUDY POPULATION

All Audiology Centers (n=22) in the Netherlands agreed to collaborate in the DECIBEL-study and participated in the identification of children who were known to the Audiology Center and fulfilled the inclusion criteria. The inclusion criteria for the present study were: born in the Netherlands between 1 January 2003 and 31 December 2005, a positive screen for hearing loss at the final (third) stage of the three-stage NHS and PCHI confirmed at diagnostic evaluation at an Audiology Center. PCHI was defined as a bilateral permanent conductive or sensorineural hearing loss of ≥40dB in the better ear. Inclusion was restricted to (1) children whose parents agreed to start with amplification and (2) children not admitted to a neonatal intensive care unit (NICU) or (3) children not suffering from severe medical conditions which a priori prohibited timely amplification.

STUDY-DESIGN

Data on the periods of time and child characteristics were (anonymously) collected from the audiology records of all children fulfilling the inclusion criteria.

Data on the periods of time included: (1) age at confirmation of PCHI and (2) age amplification was started. The degree of hearing loss, the Audiology Center at first visit and the year of birth were also collected.

The age at confirmation of PCHI was defined as the child's age at first extensive audiological evaluation at the Audiology Center. Although diagnostic evaluation can be still ongoing after the first visit, the probability of the presence or absence of a hearing disorder can most often be established. In cases where, at first evaluation, a milder hearing loss was found, age at confirmation was registered when PCHI was confirmed during audiological follow-up sometime in childhood.

The age at first amplification was used to mark the start of auditory input. Although educational intervention and counselling may precede the start of amplification, in most children with PCHI the intervention starts with hearing aid fitting. Children were initially fitted with an analog or digital behind-the-ear amplification or a bone-anchored hearing aid.

The degree of hearing loss was classified on the basis of the hearing test performed by the audiologist at the first diagnostic evaluation (computed using 500, 1000 en 2000 Hz). Hearing loss was categorized as moderate (40-60dB), severe (61-90dB) or profound (>90dB).
The children were classified by the Audiology Center first visited. This is not necessarily the Audiology Center that invited them to participate in the DECIBEL-study. The Audiology Center was either a University Audiology Center (affiliated to a University Medical Center) or a non-university Audiology Center.

STATISTICAL ANALYSIS

Descriptive statistics were used to generate data on the period of elapsed time between screening and diagnosis and diagnosis and intervention. To evaluate the performance of the screening program from the implementation, the periods of time were grouped by year of birth. Additionally the data were grouped by degree of hearing loss. The effect was quantified by using the interquartile range (IQR). Survival regression was used to determine the proportion of children awaiting amplification grouped by degree of hearing loss.
It is not unlikely that the timing of amplification is intentionally long delayed in children with moderate hearing loss. There may be uncertainty about the expected benefits of amplification and/or doubts about the possible role of a temporary conductive component in these children. In the survival regression analysis these children were therefore excluded. An independent samples T-test was used to compare the time-frame measures of children visiting a university Audiology Center and a non-university Audiology Center. All statistical tests were carried out using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). The significance level was set at $p< 0.05$.

RESULTS

In total 210 children fulfilled the inclusion criteria. At first diagnostic evaluation PCHI could not be confirmed in 11 children. Diagnostic evaluation of hearing was initially refused in 4 children and start of amplification was refused in 11 children. Seven children suffered from a severe medical condition which a priori prohibited timely amplification. Available for study were 177 children, of these children information on the period of time following a positive screening for hearing loss at NHS and child characteristics of 159 (89.8%) was available.
From the implementation of NHS the mean age at first diagnostic evaluation and start of amplification decreased over time. In 2005 half of the children were diagnosed before the age of 1.5 months and received amplification before the age of 6 months (Table 1.).

		2003 (N=26)	2004 (N=57)	2005 (N=76)
Diagnosis	Mean age	4.2	2.8	2.1
	Median age (IQR)	1.7 (1.2-3.0)	1.8 (1.3-3.1)	1.5 (1.0-2.2)
Start of	Mean age	14.6	10.5	7.5
amplification	Median age (IQR)	6.0 (4.4-26.4)	6.7 (3.9-12.1)	5.9 (3.7-9.2)

Table 1 Age at diagnosis and start of amplification in months in children with confirmed hearing loss following a positive screen for hearing loss at newborn hearing screening per year of birth

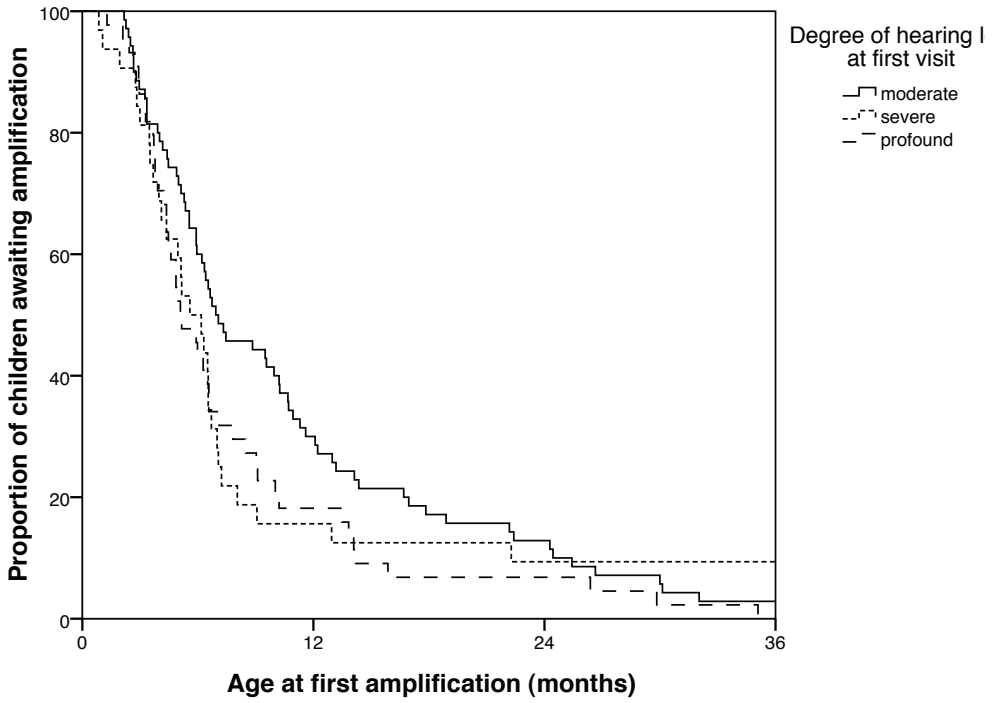
		MODERATE (N=70)	SEVERE (N=32)	PROFOUND (N=44)
Diagnosis	Mean	2.5	2.8	2.8
	Median (IQR)	1.7 (1.2-2.3)	1.6 (1.1-2.2)	1.6 (1.3-3.0)
Start of amplification	Mean	11.0	9.7	7.9
	Median (IQR)	7.0 (4.5-13.4)	5.9 (3.6-7.2)	5.1 (3.8-9.0)

Table 2 Age at diagnosis and start of amplification in months in children with confirmed hearing loss following a positive screen for hearing loss at newborn hearing screening by degree of hearing loss

The age at amplification was related to the degree of hearing loss, with children with moderate PCHI being the oldest beginning with amplification (Table 2). The more severe the degree of hearing loss at first diagnostic evaluation, the earlier in life the child received amplification (Figure 1).

When only children with severe and profound PCHI born in 2004 and 2005 were included in the analysis the mean delay between diagnosis and first amplification was 43 weeks in 2004 (CI95% 15.7-71.3) and 18 weeks in 2005 (CI95% 10.1-25.1), and the difference between the first two years following implementation of NHS was not statistically significant (p-value 0.332).

The type of AC visited was noted in 80 children with severe and profound PCHI. A university Audiology Center was visited by 41 children and non-university Audiology Center by 40. The age at first diagnostic evaluation was comparable between but a large, not statistically significant difference, was found between the two types of Audiology Centers in age at start of amplification (mean (SD) 10.6 (12.6) and 6.8 (7.0) months), with children visiting a university Audiology Center being amplified later.



Number of children included: moderate n=70, severe n=32 and profound n=44.

Figure 1 Cumulative proportion of children waiting for amplification following refer at NHS by degree of hearing loss at first diagnostic evaluation.

DISCUSSION

We studied the period of time elapsing following a positive screen for hearing loss in children born during the period immediately following implementation of NHS in our country. We found that the mean age of diagnosis and first amplification in 2005 was close to the recommendations of the JCIH. We also found that children with moderate PCHI at first extensive diagnostic evaluation, as well as children visiting a University Audiological Center, were amplified later.
To put the results of the present study in context: The results of our study strengthen the results of previous smaller studies that NHS leads to early diagnosis.[99;100] In contrast to a recent study however, we found that the age of diagnosis as well as the age at amplification were related to the degree of hearing loss in children with a positive screen for hearing loss at NHS.[99]

In this first study evaluating the period of time elapsing following a positive screen for hearing loss since gradual implementation of NHS we found, as expected, better performance of the traject after the screening (conforming to the recommendations of the JCIH) over time.

The JCIH recommends that intervention following a refer at hearing screening should start no later than at the age of 6 months.[15] In our study this recommendation was not achieved in all children. Especially, a large delay between diagnosis and amplification was found in the children with moderate PCHI. It may be hypothesized that, as well as implementation difficulties, professionals at Audiology Centres varied in their advice to parents concerning the need for amplification and/or parents varied in the priority they gave to amplification, due to their disbelief in the presence of PCHI or the importance of habilitation for PCHI. Several factors have been identified as contributing to the delay: parental time for reflection, cultural considerations, the doubt about the benefits of amplification and acceptance and wearing of hearing aids in very young children, uncertainty about the degree of hearing loss and the role of a conductive component, referral to external partners to organize amplification and even gender. Since the NHS program has now been running for some years and professionals at the Audiology Centers have greater experience with newborns it is more likely that amplification following NHS is nowadays achieved earlier in our country.

It should be acknowledged that some uncertainties might have arisen in ascertaining the periods of elapsed time. However, verification of the audiological data with parent reports from children participating in the extensive developmental studies (DECIBEL-study, study reported elsewhere) showed good agreement. When no exact date of start of amplification (or start of test-phase) could be determined, the date at which amplification was first mentioned in the correspondence was used. This may lead to some slight uncertainty about the exact time elapsed.

Implementation of NHS was an enormous effort given the characteristics of the program in our country: nationwide coverage and screening in the well baby clinic but more often at home.

The national screening program is organised by the National Institute for Public Health and Environment, administered by the Dutch Foundation for the deaf and hearing impaired child and executed by the Youth Health Care organizations and the midwifes. To date, the responsibility, the ability to regulate and the quality control system of organizers and administrators ends when preventive health care end and curative health care systems take over. The professionals working in the Audiology Centers are therefore responsible for diagnostic investigations, amplification and referral to counselling organizations. Habilitation is not uniform (between and within Audiology Centers), consists of more than amplification, and is organized by a large number of organizations. To date intervention characteristics and habilitation philosophies are more diverse than medical or audiological follow-through.

The primary indicator of quality of early intervention is how well early intervention aligns with values, expectations and wishes of well-informed parents.[101] Which type of habilitation works for whom in which circumstances, leading to an individualized counseling program needs to be evaluated. Quality control over these programs could be established by a nationwide system of tracking and monitoring.

In conclusion, the findings of the present study, in which data were collected during the implementation period of NHS, showed that the recommendations of the JCIH are better achieved each year. However, there is ample room for improvement in this respect. The findings emphasize that children with moderate PCHI early should also receive amplification early, in accordance with international recommendations.

ACKNOWLEDGEMENTS

We thank all children and their parents for participation in the DECIBEL-study.