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Introducing universal newborn hearing screening in Denmark: Preliminary results from the city of Copenhagen

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Abstract

In 2004 funding was made available by the government to introduce universal newborn hearing screening (UNHS) in Denmark. The funding was, however, limited to a two-year project with the results of the screening to be analysed at the end of the project period. This study presents the results from two Copenhagen hospitals after twelve months of screening the Hvidovre and Frederiksberg Hospitals. Before the UNHS started The Danish National Board of Health published guidelines for the screening. There were three main goals to be met:

- The detection of permanent hearing impairment in excess of 30dB in one or both ears.
- The screening process to be finished by the age of 30 days (or within 30 days after discharge from hospital for infants from the neonatal intensive care units).
- The coverage of the screening to be better than 80% of all newborns in the first year and 90% in the second year of the project period.

The UNHS started in February 2005 and the coverage during the first year was 98.5% of all children born at the Hvidovre and Frederiksberg Hospitals ($n = 6954$). The great majority of the infants were screened when they were brought back to the hospitals at the age of four to 10 days for metabolic screening tests. The referral rate was lower than expected at 1.4% after one or two screening attempts using transiently evoked otoacoustic emissions (TEOAE). During the first full 12 months, 124 infants were referred for re-screening after the primary TEOAE and for further diagnosis. Of this group three infants (2.4%) did not show up and were lost to follow-up. The median age for the well babies when referred for re-screening was 10 days and the re-screening was completed in another five days. For six of the 95 referred well babies the total screening period exceeded the recommended 30 days. By spring 2006, 12 infants had been diagnosed with bilateral and four children with unilateral permanent hearing impairment (PHI). This indicates an incidence of moderate to profound bilateral PHI of 1.5/1000. Similarly, the incidence of unilateral PHI would be 0.5/1000 among the screened infants. These are, however, only preliminary figures, as 11% of the referred infants are still being investigated.

Key words: *universal newborn hearing screening, transiently evoked otoacoustic emissions, auditory brainstem response, hearing impairment*

Introduction

In the year 2004 funding was made available by the Government of Denmark (2005 population: 5.4 million) to introduce universal newborn hearing screening (UNHS). This funding is, however, limited to a two-year project with the results of the screening to be analysed at the end of the project period. In 2005 there were 64,189 live births in Denmark and the sum projected for the screening is equivalent to 31€ for each newborn baby during the two-year period. The single initial sum of 1.3 million €, for screening

equipment and other initial investments, was also included in the funding.

In August 2004, The National Board of Health published Guidelines for the Universal Newborn Hearing Screening in Denmark (1).

There were three main goals to be met:

- The detection of permanent hearing impairment in excess of 30dB in one or both ears.
- The screening process to be finished by the age of 30 days.

- The coverage of the screening to be better than 80% of all newborn babies in the first year and 90% in the second year of the project period.

There are 16 more or less autonomous counties in Denmark that provide the health services. In the guidelines, the counties are given several choices including a choice between the use of automated otoacoustic emissions (OAE) testing or auditory brainstem responses (ABR) as the first step of two for the primary screening of babies from the well baby nurseries (WBN). Automated ABR recording is recommended for the second stage.

The infants from the neonatal intensive care unit (NICU) (more than 48 h stay) are to be tested with both methods – automated OAE and ABR – just before discharge from hospital.

The infants lacking clear responses are referred for re-screening using ABR at an audiological department.

Infants with head and neck malformations and/or chromosomal anomalies are not to be included in the screening process, but referred directly to an audiological department.

It is recommended that the screening be performed in association with the newborn tests for metabolic abnormalities, usually between the fourth and tenth day of life for the WBN infants, and at the time of hospital discharge for the NICU infants.

There are instructions in the guidelines regarding different aspects of the screening. It is recommended that as few people as possible should perform the screening procedure to ensure sufficient expertise and quality. It is also proposed that people should only be entrusted to deal with the infants and their parents and to perform the hearing screening following proper education and training.

According to the guidelines, the infants are to be referred to 'audiological departments with special experience in working with hearing impaired children', a definition specified and explained in the guidelines. There are also drafts of written information for parents-to-be and for parents of infants referred for re-screening.

According to the government's decision, the screening results are to be analysed by the National Board of Health at the end of the project period of two years. The guidelines specify what information is to be collected during the screening process.

Given the independence of the 16 different counties of Denmark, each may interpret and follow the guidelines of The National Board of Health as they deem appropriate. There is no central organization in Denmark to ensure that the screening is performed according to the guidelines, nor is there a central database in Denmark for the collection of

information. The information regarding the infants screened and the results of the screening are collected separately by each county and there is limited sharing of information.

The provision of newborn hearing screening is mandatory and universal in Denmark, i.e. all parents are informed of the screening and are advised to have their babies screened, but the parents are free to decline the offer. The screening, as well as re-screening and the later ascertainment and rehabilitation procedure, is completely free of charge.

The present study presents the results from two Copenhagen hospitals – the Hvidovre and Frederiksberg hospitals after 12 months of screening

Method

In the city of Copenhagen (2005 population: 0.6 million) work started in the autumn of 2004 to implement newborn hearing screening by planning, producing information brochures for the parents, producing a video/DVD with parental information, posting website information and giving courses for the staff – biomedical analysts – who were to perform the screening in Copenhagen. In early 2005 we were ready to start screening infants.

In the city area there are three hospitals with maternity clinics:

- Hvidovre Hospital (5432 deliveries/year, 2005) – UNHS started 2 February.
- Frederiksberg Hospital (1786 deliveries/year, 2005) – UNHS started 16 February.
- Rigshospitalet (3267 deliveries/year, 2005) – UNHS started in May.

There are Neonatal Intensive Care Unit (NICU) clinics at the Hvidovre Hospital and Rigshospitalet.

The hearing-screening programme starts when the prospective parents are informed about screening in the weeks before delivery and the information is repeated at the maternity clinic. The information is written, but also available as a video/DVD film and on the internet. Midwives and doctors provide this information.

At the Hvidovre Hospital and Frederiksberg Hospital, the hearing screening is conducted in association with metabolic screening tests at the age of four to 10 days for infants from the WBN. This means that the parents take their infants home from the WBN and bring them back to the hospital a few days later for the screening.

The screening method uses automatic recording and evaluation of transiently evoked otoacoustic emissions (aTEOAE), measured in both ears. An evaluation – clear response (CR) or no clear response (NCR) – of the recorded response is

automatically produced by the instrument's algorithm. The recording is repeated the same day or the next weekday if there are technical or practical problems or NCR for either or both ears is obtained at the first recording. When there are clear aTEOAE responses the parents are informed that the probability of hearing impairment (HI) is low and the infant is then discharged from the screening programme.

Infants from the NICU clinic (>48 h stay) are tested with automatic recording of TEOAE and ABR before leaving Hvidovre Hospital. CRs from both recordings and from both ears are required.

After the screening, if there is NCR, the infant is to be referred for re-screening at Bispebjerg Hospital. The re-screening is located separately from the audiological department so as not to mix parents and infants coming for re-screening and children with hearing impairment. The re-screening consists of new recordings of aTEOAE and aABR.

The aABR chirp stimulus levels are according to the manufacturer's specifications (2) and the instrument is calibrated to evoke and to detect a response if the hearing thresholds are 35dB nHL (35) and 45dB nHL (45), respectively, or better.

If there are clear TEOAE and ABR (35) responses from both ears the parents are to be informed that the tests are normal and that there is no suspicion of hearing impairment. They are also asked to remain vigilant regarding symptoms of hearing impairment and to seek audiological advice if there is later any doubt regarding hearing acuity.

If there is no clear TEOAE response, but a clear aABR (35) response the parents are informed that the probability of hearing impairment is low, but the infant's hearing should be checked after six to eight months. If there is no CR from either recording (TEOAE and aABR 35), in either or both ears, the infant is rapidly referred to the Department of Audiology at the same hospital for diagnostic evaluation.

All the biomedical analysts who perform the screening at Hvidovre Hospital (13 people) and at Frederiksberg Hospital (nine people) have attended a week's training course in newborn hearing screening.

The course includes elements of hearing physiology, psychology, hygiene and practical information as well as training in using the screening equipment.

The equipment used for the screening and re-screening is the GN Otometrics Accuscreen (2), which is capable of automated TEOAE and ABR recordings and response evaluation. The instruments are calibrated, maintained and used according to the manufacturer's specifications.

Results

The coverage of the hearing screening during the first year of screening (February to December 2005) was 98.5% of all children ($n = 6594$) born at the Hvidovre Hospital and Frederiksberg Hospital (Table I). The coverage for the NICU infants ($n = 227$) is somewhat lower or 86.8% in the period. Similar data from Rigshospitalet are not available.

In 96.1% of cases there was a clear response from both ears in the first screening and the rate of referred infants for re-screening after one or two screening attempts (TEOAE) was lower than expected (1.4% of the total – Table II).

In the first full 12-month period (February 2005 to February 2006) 124 infants were referred to Bispebjerg Hospital for re-screening. Two children were referred from Rigshospitalet, and the remaining 122 from Frederiksberg Hospital and Hvidovre Hospital. Of this group, three children (2.4%) did not attend and were lost to follow-up.

The great majority of the infants were screened when they were brought back to the hospital at the age of four to 10 days for metabolic screening tests (Figure 1).

The median age of the WBN infants when referred for re-screening was 10 days (range 4–58 days). The re-screening was completed in another five days (range 0–28 days). For six of the 95 referred WBN infants the total screening period exceeded 30 days (32–59 days).

The results of the re-screening as well as ascertainment at Bispebjerg Hospital are shown in Table III. The number of infants with no clear TEOAE response from one or both ears, but with clear responses

Table I. Screening coverage during the first 11 months (2005) – Frederiksberg Hospital (FH) and Hvidovre Hospital (HH).

| Hospital | FH | HH | HH | FH+HH |
|---------------------------|------------|-----------|------------|-------------|
| Infants from: | WBN | WBN | >48 h NICU | All infants |
| Period | 16/2–31/12 | 8/2–31/12 | 8/2–31/12 | |
| Number of newborn infants | 1583 | 4784 | 227 | 6594 |
| Screened | 1572 | 4724 | 197 | 6493 |
| Not screened | 11 | 60 | 30 | 101 |
| Coverage in% | 99.3% | 98.8% | 86.8% | 98.5% |

Table II. Referral rate after primary screening – all infants (February to December 2005) – Frederiksberg Hospital (FH) and Hvidovre Hospital (HH).

| | <i>n</i> | % |
|---|----------|-------|
| Clear responses after 1st primary screening (TEOAE) | 6248 | 96.2% |
| Additional CR after 2nd primary screening (TEOAE) | 123 | 1.9% |
| Screening not completed | 33 | 0.5% |
| Referred to re-screening | 89 | 1.4% |
| All infants | 6493 | 100% |

for aABR (35) in both ears is relatively high, or 19% of the total.

By February 2006, 12 infants have been diagnosed with bilateral and four infants with unilateral hearing impairment. The results from diagnostic ABR thresholds (2 and 4 kHz tone bursts) indicate that, of this group of 12 infants with bilateral hearing impairment, there is one infant with mild, five with moderate, two with severe and four infants with profound hearing impairment.

According to the Guidelines of The National Board of Health the goal for screening coverage during the first year of universal neonatal hearing screening in Denmark was 80% of the newborns. For the infants born in the Hvidovre Hospital and Frederiksberg Hospital and screened during the first 11 months of the screening programme this goal was well achieved (98.5%).

In many screening programmes the relatively high referral rate after OAE screening soon after birth is considered to be a problem, which, in many

programmes, is addressed by introducing a second stage aABR screen. In some screening programmes this two-stage procedure seems to bring down the referral rate (3). This effect has, however, not been confirmed in all studies (4). In the present programme only 1.5% of the infants are referred for re-screening after one or two aTEOAE screening recordings. This relatively low rate limits the need for implementing aABR as a part of the primary screening process for the sole purpose of reducing the referral rate. The low referral rate also indicates that screening the infants when they are four to 10 days old (Figure 1) is a favourable period for the screening procedure.

A recent report indicates that a considerable number of infants with mild to moderate hearing impairment may be lost in the screening process when aABR is implemented as the second stage of the screening programme (5). The declared goal of hearing screening in Denmark is to detect infants with permanent hearing impairment >30dB, which also underlines the importance of appropriate test procedures and equipment for the detection of hearing impairment of this magnitude.

Of the 124 infants referred after the primary screening, three (2.4%) failed to show up for the re-screening and were lost to follow-up. This was in spite of letters sent to the families encouraging them to bring their infants to the hospital for further investigation. Two of the infants lost to follow-up were NICU babies and one was from the well baby nursery. The relatively high follow-up rate (97.6%) indicates definite parental interest in the screening process and an understanding of the importance of early detection of permanent hearing impairment.

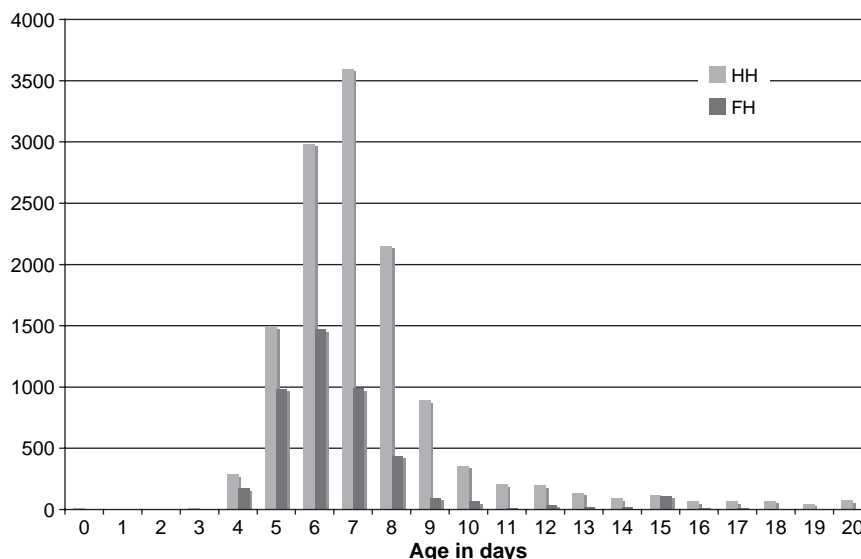


Figure 1. Age in days at which the infants were screened. All measurements from February to December 2005. HH: Hvidovre Hospital; FH: Frederiksberg Hospital.

Table III. Results of re-screening/ascertainment, Bispebjerg Hospital. Referred infants from HH and FH February 2005 to February 2006.

| | NICU | WBN | Total | |
|---------------------------------------|----------|----------|----------|------|
| | <i>n</i> | <i>n</i> | <i>n</i> | % |
| Bilateral hearing impairment | 2 | 10 | 12 | 10% |
| Unilateral hearing impairment | 0 | 4 | 4 | 3% |
| Under investigation (suspected HI) | 3 | 10 | 13 | 11% |
| Lost to follow-up | 2 | 1 | 3 | 2% |
| No clear TEOAE responses (bilateral) | 3 | 2 | 5 | 4% |
| No clear TEOAE responses (unilateral) | 3 | 16 | 19 | 15% |
| Clear responses (TEOAE and aABR 35dB) | 16 | 52 | 68 | 55% |
| Referred infants from HH and FH | 29 | 95 | 124 | 100% |

This interest among parents may be explained by the information given by the screeners and midwives as well as the written information and the video/DVD delivered during the pregnancy. The parental interest in the newborn metabolic screening tests is very high in Denmark (99.0% coverage in 2005) (6), which also contributes to the high hearing screening coverage as the two tests – hearing and metabolic – are linked together at the two Copenhagen hospitals.

The goal of completing the screening process in 30 days was not met for six of the 95 infants referred from the WBN. It is unclear whether the goal was met for the NICU infants since we have limited information regarding the time of discharge from hospital.

The group of the referred infants after re-screening with no clear aTEOAE response from one or both ears, but clear responses for aABR (35) on both ears, is relatively high (19.3% of those referred). These children will be tested again, using VRA, when they are older.

By February 2006, 12 infants were diagnosed with ABR thresholds ≥ 40 dB (2 kHz tone-burst). This indicates an incidence of moderate to profound bilateral hearing impairment of 1.5/1000 among the screened infants. Similarly the four infants diagnosed with unilateral hearing impairment indicate an incidence of 0.5/1000. These are, however, only preliminary figures as 10.5% of the infants referred after re-screening during the first year are still being investigated. It is consequently unclear if the goal to find all infants with hearing impairment exceeding 30dB has been met.

The relatively low yield from the NICU infants (two out of 14 hearing impaired infants) can partly be explained because the NICU clinic at Hvidovre Hospital is relatively small and there is a lower coverage (86.8%) among the NICU infants compared to the WBN infants (98.8%). Two of the three children lost to follow-up were from the NICU.

Why the interest of parents towards NICU infants seems to be lower than among parents of WBU infants can only be a matter of speculation. Perhaps the parents are happy and satisfied to leave the hospital environment with their baby and reluctant to submit their infant to further tests and investigations. Doctors and personnel of the NICU clinic at Hvidovre Hospital have been made aware of this lower coverage among NICU infants and measures have been taken to increase the coverage to approach the levels of the WBN infants.

The results of this study highlight the importance of giving proper information to hospital personnel and parents regarding the value of earliest possible detection of permanent hearing impairment. This is especially important for the NICU infants given the much greater risk for hearing impairment among these infants. The results also underline the importance of achieving the highest possible coverage, to adhere to the screening protocol and to secure a thorough follow-up for all newborn children.

Addendum

In late 2006, after this article was submitted for publication, the government declared that the universal newborn hearing screening will be made permanent in Denmark after the end of the two-year project period.

References

1. The National Board of Health's Guidelines of August 12 for Neonatal Hearing Screening [Danish]. Available on the Internet May 1st 2006 http://www.sst.dk/publ/Publ2004/Retningslinier_neonatal_hoerescreening.pdf
2. Accuscreen product specification. Available on the Internet, May 1 2006. http://www.gnotometrics.com/ha_infscreen_accutespec.pdf
3. Lin HC, Shu MT, Lee KS, Ho GM, Fu TY, Bruna S, et al. Comparison of hearing screening programmes between one step with transient evoked otoacoustic emissions (TEOAE) and

- two steps with TEOAE and automated auditory brainstem response. *Laryngoscope*. 2005;115:1957–62.
4. Korres SG, Balatsouras DG, Lyra C, Kandiloros D, Ferekidis E. A comparison of automated auditory brainstem responses and transiently evoked otoacoustic emissions for universal newborn hearing screening. *Med Sci Monit*. 2006;29;12:CR260–3.
 5. Johnson JL, White KR, Widen JE, Gravel JS, James M, Kennalley T, et al. Multicentre evaluation of how many infants with permanent hearing loss pass a two-stage otoacoustic emissions/automated auditory brainstem response newborn hearing screening protocol. *Pediatrics*. 2005;116:663–72.
 6. Nørgaard-Pedersen B. Statens Serum Institute, Copenhagen, Denmark. Personal communication 2006.