Influence of postconceptional age on universal newborn hearing screening in NICU-babies

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Abstract

The feasibility of universal newborn hearing screening (UNHS) using automated auditory brainstem response (AABR) devices in the neonatal intensive care unit (NICU) is already well demonstrated. The aim of this study was to find out whether the postconceptional age (PCA) of the babies at the time of the AABR measurement has an influence on the measuring results and to determine the earliest time point for a reliable hearing screening in preterm neonates. Hearing screening measurements of 634 neonates (NICU-Babies) were included. We had complete data for 577 of these babies. The babies were born between 24 and 42 weeks of gestation in the years 2007-2008 and were screened in the Neonatal Unit of the Marburg University hospital. In this group, the hearing screening had been performed at or after 32 weeks of PCA. The AABR measurements showed a specificity of 93.9% (babies tested between 32 and 34 weeks of PCA), 95.8% (tested between 35 and 37 weeks), 95.9% (tested between 38 and 40 weeks of PCA) and 92.1% (tested after 40 weeks of PCA). Hearing screening yields reliable results at 32 weeks PCA. Therefore, an UNHS can be already performed before term without risking a higher rate of false positive results. However, individual factors such as cardiorespiratory and temperature stability of the baby should be considered.

Introduction

The feasibility and reliability of universal newborn hearing screening (UNHS) with automated auditory brainstem response (AABR) devices in preterm and term neonatal intensive care unit (NICU) patients is already well demonstrated,[1-11] but there is no information about the postconceptional age (PCA) of the babies at the time of testing. For the last nine years the Department of Phoniatrics and Pedaudiology, Philipps University Marburg has gained experience in the use of AABR machines for the UNHS of newborn infants.[12] Since 2004 systematic UNHS has been conducted on risk and high-risk babies at the NICU of the Marburg University Hospital. The aim of this study was to find out whether the PCA of the babies at the time of the AABR measurement has an influence on the specificity of the hearing screening measurements. Particularly the PCA at the point of screening, regarding the specificity is of special interest, because of an early point of detection of hearing losses. This is because if one can screen the babies in a reasonable measurement time and with a high specificity, we don't come under threat that we lose these babies for the hearing screening. Furthermore one can use the time, when the babies stay calm in their NICU. If any hearing loss has been detected in that early stage, there additionally is an opportunity to do further diagnostics while the babies are still in the hospital, so all diagnostics can be done at this time.

Materials and Methods

Patients

Between January 1, 2007 and December 31, 2008, a total of n=634 infants was admitted to the NICU. Of these, n=57 were excluded because of incomplete data. Thus, n=577 infants with complete data were included into this analysis.

Methods

For the hearing screening we used the AABR device MB 11 with BERAphone® (MAICO-Diagnostics, Berlin, Germany). The screening was done at both ears sequentially to examine for unilateral and bilateral hearing loss. If the first screening was a *refer*, the babies were screened again at least once more before leaving the hospital. The MB 11 with BERAphone® uses the CE-Chirp-Stimulus at a level of 35 dB (HL). The screening was done on the NICU while the babies were sleeping in their cots. There were two stages of hearing screening. The *stage 1* was the first measurement. The *stage 2* was done on the same day for example if the baby was not calm enough during the first measurement. That means that if a baby had a *refer*, it could be measured

once again later on the same day when it sleeps more soundly. Our results show the data of stage 2.

Statistical analyses

For statistical analyses we used Microsoft Excel® and descriptive statistics (exploratory data analysis) of SPSS®.

Results

Clinical data

The babies were born between 24 and 42 weeks of gestation (Figure 1).

Screening data

For further analysis, we divided our population into four groups according to the PCA at time of testing: 32-34 weeks (n=49), 35-37 weeks (n=166), 38-40 weeks (n=185) and >40 weeks (n=177) of PCA. The babies were screened within the first up to the 87th week of postnatal age (mean 3.75 weeks, median 2.14 weeks, SD 5.95). In the 32-34 weeks age group 85.7% of the babies were screened within the first 4 weeks after birth; in the 35-37 weeks age group 81.3%, in the 38-40 weeks age group 83.2% and in the >40 weeks age group 60.5%. Figure 2 shows the distribution of the postnatal age (in weeks) at screening for the different age groups.

The results of the AABR-measurement for each age group of PCA are visualized in Figure 3 and the values and specificities are shown in Table 1. We calculated the specificity with the data of the single measurements. For that reason Figure 3 and Table 1 shows the amount of ears and not the amount of babies.

The results of the specificity of the four age groups are not significantly different (Cramer's V value 0.087; approximate significance level 0.032).

Discussion

The purpose of the UNHS is the early identification of hearing impairment and early intervention.[13] Therefore, UNHS should be performed as early as possible, before discharge from the hospital or transfer to another institution. In addition, the parents of a child often would like to know as soon as possible whether a hearing disturbance is present or not.

The characteristics of auditory brainstem response (ABR) in moderately preterm infants and preterm very low birth weight (VLBW) babies and the correlations between the ABR and clinical characteristics are already investigated. There were no correlations between ABR threshold and PCA.[14-16]

In our study population the earliest time of hearing screening in NICU infants was 32 weeks of PCA. PCA at the time of the AABR meas-
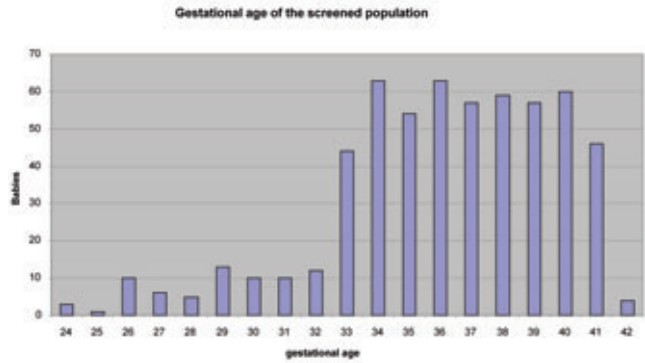

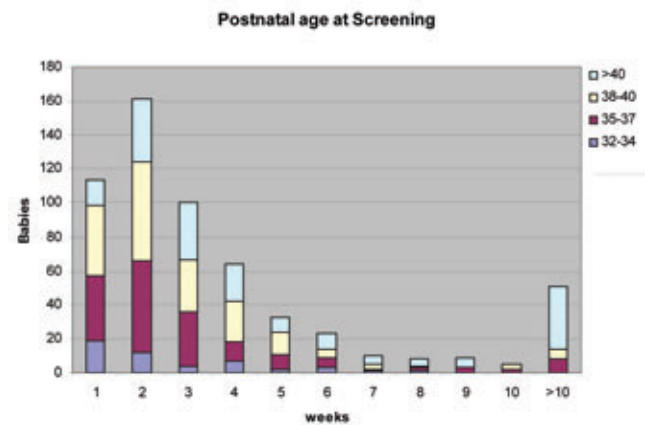Figure 1. Distribution of the gestational age of the screened population (n=577).

Figure 2. Postnatal age at screening in the four different age groups.
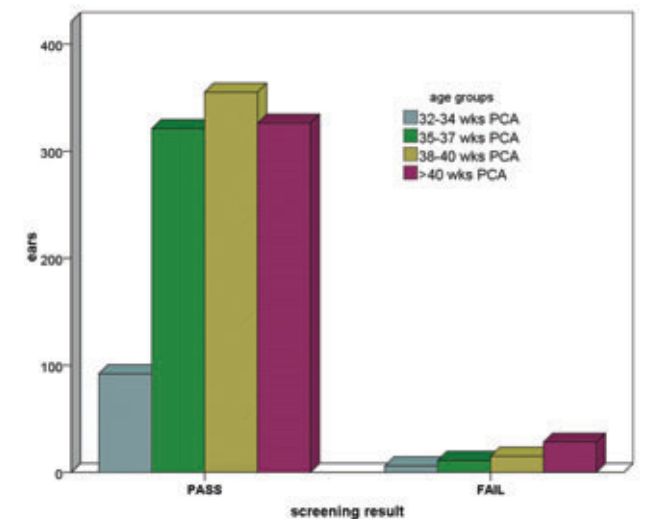
Figure 3. Results of the automated auditory brainstem response measurement for each age group of PCA (number of ears). PCA, postconceptional age.

Table 1. Specificity of the automated auditory brainstem response in the age groups (number of ears).

Age groups (PCA in weeks)	32-34	35-37	38-40	>40
Total (ears)	98	332	370	354
Pass	92	318	355	326
Fail/refer	6	14	15	28
Specificity [%]	93.9	95.8	95.9	92.1

PCA, postconceptional age.

urement had no significantly different influence on the result of the measurement. Particularly no higher fail/refer rate could be noted for the exclusion of binaural hearing disorders. Because of the very good specificity in all four groups, UNHS should not be delayed unnecessarily. In addition, mechanical ventilation, sepsis or antibiotic treatment did not have a negative influence on the specificity of the AABR. It should be performed in NICU patients as soon as possible according to the clinical condition of the patient (cardiorespiratory and temperature stability). However further research is needed considering specific situations for the UNHS in the NICU setting. For identification of delayed-onset hearing loss in an infant without known risk factors a close audiologic and speech/language follow-up should be part of the developmental screening of NICU patients.[17]

References

1. Xu Z, Li J. Performance of two hearing screening protocols in the NICU. B-ENT 2005;1:11-5.
2. Wu J, Ye Y, Wang S, Xing G. [Newborn hearing screening in the neonatal intensive care unit: a preliminary study]. Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi 2009;23:445-7.[Article in Chinese].
3. van den Berg E, Deiman C, van Straaten HL. MB11 BERAphone) hearing screening compared to ALGOportable in a Dutch NICU: a pilot study. Int J Pediatr Otorhinolaryngol 2010;74:1189-92.
4. Saitoh Y, Hazama M, Sakoda T, Hamada H, Ikeda H, Seno S, et al. [Outcome of neonatal screening for hearing loss in neonatal intensive care unit and well-born nursery infants]. Nippon Jibiinkoka Gakkai Kaiho 2002;105:1205-11.[Article in Japanese].
5. Lima GM, Marba ST, Santos MF. Hearing screening in a neonatal intensive care unit. J Pediatr (Rio J) 2006;82:110-4.
6. Coenraad S, Hoeve LJ, Goedegebure A. Incidence and clinical value of prolonged I-V interval in NICU infants after failing neonatal hearing screening. Eur Arch Otorhinolaryngol 2011;268:501-5.
7. Coenraad S, Goedegebure A, van Goudoever JB, Hoeve LJ. Risk factors for sensorineural hearing loss in NICU infants compared to normal hearing NICU controls. Int J Pediatr Otorhinolaryngol 2010;74:999-1002.
8. van Straaten HL, Hille ET, Kok JH, Verkerk PH, Dutch NICU Neonatal Hearing Screening Working Group. Implementation of a nation-wide automated auditory brainstem response hearing screening programme in neonatal intensive care units. Acta Paediatr 2003;92:332-8.
9. van Straaten HL, Tibosch CH, Dorrepaal C, Dekker FW, Kok JH. Efficacy of automated auditory brainstem response hearing screening in very preterm newborns. J Pediatr 2001;138:674-8.
10. Hille ET, van Straaten HI, Verkerk PH, Dutch NICU Neonatal Hearing Screening Working Group. Prevalence and independent risk factors for hearing loss in NICU infants. Acta Paediatr 2007; 96:1155-8.
11. van Straaten HL. Automated auditory brainstem response in neonatal hearing screening. Acta Paediatr Suppl 1999;88:76-9.
12. Berger R, Hanschmann H, Muller-Mazzotta J, Weitzel D. Newborn hearing screening. Experiences and results from Marburg. Monatsschrift Kinderheilkunde 2010;158:868-74.
13. Vohr BR, Simon P, Letourneau K. Public health implications of universal hearing screening. Semin Hear 2000;21:295-308.
14. Wang X, Luo R, Wen R, Chen Q, Zhou J, Zou Y. [The characteristics of auditory brainstem response in preterm very low birth weight babies]. Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi 2009; 23:746-8, 51.[Article in Chinese].
15. Yoshikawa S, Ikeda K, Kudo T, Kobayashi T. The effects of hypoxia, premature birth, infection, ototoxic drugs, circulatory system and congenital disease on neonatal hearing loss. Auris Nasus Larynx 2004;31:361-8.
16. Jiang ZD, Wilkinson AR. Normal brainstem responses in moderately preterm infants. Acta Paediatr 2008;97:1366-9.
17. Yoon PJ, Price M, Gallagher K, Fleisher BE, Messner AH. The need for long-term audiologic follow-up of neonatal intensive care unit (NICU) graduates. Int J Pediatr Otorhinolaryngol 2003;67:353-7.