Universal Newborn Hearing Screening: Feasibility in a Community Hospital

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Background. The National Institutes of Health and the Joint Committee on Infant Hearing have recommended universal newborn hearing screening. The feasibility of universal newborn hearing screening in a community hospital, however, has not been demonstrated. We initiated a universal newborn hearing screening program using transient evoked otoacoustic emissions (TEOAE) at a community hospital to assess the feasibility of universal hearing screening in this setting.

Methods. A screening team composed of a family practice physician, family medicine resident, audiologist, and four technicians was developed. The study compared testing time between the technicians and the audiologist and assessed whether the technicians were able to perform hearing testing accurately and reliably.

Results. A total of 627 infants were screened. Of those, 11 (1.8%) failed TEOAE screening and were referred to a tertiary care center for further evaluation. Six of the 11 referrals were found to have a hearing impairment. Trained technicians were found to be capable of performing the screening accurately and reliably.

Conclusions. Universal newborn hearing screening using transient evoked otoacoustic emissions is feasible in a community hospital.

Key words. Hearing tests; hearing loss, sensorineural; hearing loss, conductive; infant, newborn; transient evoked otoacoustic emissions; hospitals, community.
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The prevalence of permanent sensorineural hearing loss is 1.5 to 6 per 1000 infants born in the United States.[1] Many more are born with conductive hearing loss.[2] Normal speech and language development requires the presence of normal hearing during the first 3 years of life.[3] During this time, even mild, unilateral hearing loss can impair learning as well as social and emotional growth.[3] Despite the consequences of undetected hearing loss, our current health system, in which screening is recommended only for infants who are at risk for hearing impairment (Table),[1] misses more than 50% of infants who are born with a sensorineural hearing loss.[4] This method of screening delays the diagnosis of hearing impairment in infants until they are between 2 and 3 years of age.[5,6] There is now evidence that early identification and intervention can improve the acquisition of speech and language skills.[5,7]

Recently, guidelines and recommendations have been developed to improve early identification of infant hearing loss. In the government publication *Healthy People 2000*, identifying and treating infants with sensorineural hearing impairment before 12 months of age was specified as a goal.[6] In March 1993, the National Institutes of Health released a consensus statement recommending universal newborn hearing screening prior to hospital discharge.[8] The position statement of the Joint Committee on Infant Hearing,[1] which was approved by the American Academy of Pediatrics, recommends that hearing-impaired infants be identified by 3 months of age and that treatment be initiated by 6 months of age.

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Table. Risk Factors for Neonatal Hearing Loss

Family history*
Congenital infections (TORCH)
Craniofacial anomalies
Hyperbilirubinemia requiring transfusion
Ototoxic medication
Birthweight < 1500 g
Bacterial meningitis
Apgar scores of 0-4 at 1 min, 0-6 at 5 min
Mechanical ventilation for at least 5 days
Syndrome associated with hearing loss

**Childhood sensorineural hearing loss.*
Modified from the American Academy of Pediatrics, Joint Committee on Infant Hearing. 1994 Position Statement. Elk Grove Village, III: American Academy of Pediatrics, 1994.
TORCH denotes toxoplasmosis, rubella, cytomegalovirus, and herpes simplex.

In 1990, the Rhode Island Hearing Assessment Project (RIHAP) began performing universal newborn hearing screening using transient evoked otoacoustic emissions (TEOAE)[9] and demonstrated that universal screening could be performed on a statewide basis. The feasibility of using TEOAE to perform universal hearing screening in a community-based hospital, however, has yet to be demonstrated.

For universal screening to be feasible, the equipment should be affordable and the procedure easily learned by technicians. The biggest criticism of using TEOAE for universal hearing screening has been that a high false-positive rate would lead to overreferral. Therefore, another feasibility criterion for universal screening is the ability to keep referral rates low. This study was designed to assess the feasibility of universal hearing screening using TEOAE in a community hospital.

Methods

Background

In 1978, physicist David T. Kemp from the University of London reported the presence of otoacoustic emissions in association with normal hearing.[10] The cochlea was found to be an active organ that not only receives and transmits sound stimuli to the brain but also generates a sound, known as otoacoustic emission, in response to sound stimuli. These emissions are transmitted from the cochlea to the external auditory canal, where they can be measured by a sensitive microphone. Healthy hair cells in the cochlea are capable of producing these evoked otoacoustic emissions. The presence of emissions indicates that the preneural cochlear receptor mechanisms are intact and the conducting system is functioning. Measurement of transient evoked otoacoustic emissions can be used to detect both sensorineural and conductive hearing loss.

Hospital

The study site is a 210-bed US Air Force hospital at which between 80 and 100 babies are delivered each month. The hospital has a level II nursery with limited capability to care for premature or ill newborns. The hospital supports a family practice residency. There is one hospital audiologist. Infants requiring team testing are referred to a nearby military facility that offers this service.

Equipment

The IL088XP desktop OAE system was used to perform hearing screening. This system was purchased in 1994 at a cost of $14,995.

Personnel

The screening team consisted of a family practice staff physician, a family practice resident, an audiologist, and four technician volunteers. All members of the team performed hearing screening.

Training

The hospital audiologist, a family practice staff physician, and a family practice resident attended a training seminar on the use of otoacoustic emissions held at Walter Reed Army Medical Center in Bethesda, Md. Four of the study site technician volunteers were trained to perform and interpret TEOAE. The training process included background reading material[8,11,12] and videotapes on hearing screening tools, a discussion on the use of TEOAE, and hands-on application of the course material. The didactic portion required approximately 2 hours, followed by 10 1-hour supervised testing sessions. The sessions emphasized proper handling of the newborns, testing techniques, and interpretation of results.

Protocol

A universal newborn hearing screening program was initiated at the study hospital on November 1, 1994. Before hospital discharge, hearing screening was performed in the newborn nursery with the infant in an open bassinet. In general, the infants were between 6 and 48 hours of age at the time of screening. The screeners were given codes to identify them as either physician, audiologist, or technician. The screener determined pass or fail based on established criteria. Pass was defined as an emission signal with reproducibility greater than or equal to 80% at frequencies of 2.4, 3.2, and 4.0 kHz and an overall reproducibility of at least 40%. Both ears had to meet criteria for

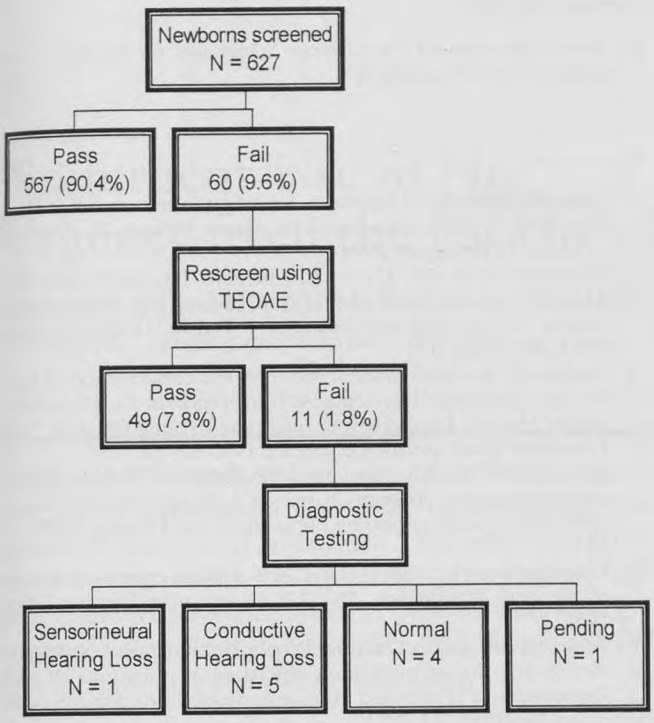

Figure. Universal hearing screening was performed using transient evoked otoacoustic emissions (TEOAE). Neonates who did not pass the initial screen were rescreened at 1 to 3 weeks of age. Infants who did not pass the screen for both ears were referred for diagnostic testing.

the newborn to pass. Neonates who did not pass the initial screen were rescreened using TEOAE between 1 and 3 weeks of age. If either ear failed to pass the rescreen, the infant was referred for diagnostic testing. The audiologist reviewed all test results to ensure appropriate testing technique and accurate interpretation of test result. Total testing time for each screening was recorded.

Results

Between November 1, 1994, and May 31, 1995, 639 infants were born at the study hospital, 627(98%) of whom were screened before hospital discharge. Seven were transferred before screening, four parents refused screening, and there was one neonatal death. Most (90.4%) of the screened infants passed the test before hospital discharge. All 60 (9.6%) who did not pass the initial test were successfully rescreened. An additional 49 neonates passed the second screening. Eleven (1.8%) neonates were referred for further evaluation. Of the referred infants, two passed repeat TEOAE at the referral site. Results of the diagnostic hearing evaluations are summarized in the figure. Six children were identified as having hearing loss. One had a unilateral mild to moderate sensorineural hearing loss and five children had conductive hearing loss. Of the six children with confirmed hearing loss, only one had a risk factor for hearing loss. The neonate with the sensorineural hearing loss had no risk factors.

The average total testing time, including equipment and infant preparation, was 12 minutes per infant. No statistically significant difference existed between technician and audiologist testing time. The audiologist concurred with 100% of the technician's test interpretations.

Discussion

Over the last 5 years, investigators have focused attention on early identification of hearing loss in infants.[1,6,8] Childhood hearing loss can pose a burden to the affected child, the family, and society.[1,3] Delay in identification of hearing loss can lead to impaired speech and language acquisition and decreased educational achievement. The current health care system relies on the use of a high-risk registry to identify infants with hearing loss (Table).[1] This system, however, fails to identify approximately 50% of the infants with hearing loss.[4] The RIHAP Study[9] demonstrated that TEOAE can be used to perform universal hearing screening in a medical center environment. This study demonstrates that universal screening using TEOAE is also feasible in a community hospital setting.

In the RIHAP study,[9] 26.9% failed the initial TEOAE screening, and 6.2% of the total group failed rescreening and required diagnostic evaluation. The RIHAP data, however, include testing of neonatal intensive care unit (NICU) patients and, therefore, are not directly comparable to our data. Our rescreening (9.6%) and referral (1.8%) rates are better than those initially reported by RIHAP but are consistent with the most recent data collected by the National Consortium for Universal Newborn Hearing Screening (Personal correspondence, Karl White, December 18, 1995), which suggest an initial failure rate of 5% to 12% with approximately 90% of these passing the rescreening.

The steps involved in establishing a program include facility approval, equipment purchase, staff training, protocol development, newborn screening, patient tracking, and quality assurance. Initial equipment costs can run as high as $15,000, but laptop versions are available for less than $9000. Staff and technicians can be trained in a relatively short time. The screening process takes approximately 12 minutes per child and can be performed in the newborn nursery. Using a two-step screening process, a low referral rate can be achieved, minimizing the cost of diagnostic evaluations.

This study also confirms the inadequacy of using the

high-risk registry to determine which newborns require screening. Six infants with hearing impairment were detected. One infant had unilateral mild to moderate sensorineural hearing loss, and five infants had conductive hearing loss. Of these six, five had no risk factors for hearing impairment and would not have been identified by the high-risk registry.

Early detection of hearing loss permits early intervention. In each case, parental education was performed and a program of close observation and monitoring was initiated. One infant underwent myringotomy and pressure-equalizing tube placement at the age of 6 months.

Several limitations to this study should be recognized. Although the study hospital is similar in size and capabilities to many community hospitals, differences may exist between civilian and military medical facilities. This study does not assess the cost effectiveness of universal newborn screening. Data published by the RIHAP demonstrate that screening can be performed for less than $25 per child.[13] In that study, the cost of identifying a child with a sensorineural hearing loss was $3364, which compares favorably with the $41,000 expended to identify a child with phenylketonuria or hypothyroidism.[13] Our study also does not compare screening using TEOAE with screening using automated auditory brain stem response. Large-scale multicenter studies should be performed to further address these questions.

Conclusions

Whether hearing loss is unilateral or bilateral, sensorineural or conductive, it can have significant negative impact on speech and language acquisition. This study demonstrates that universal newborn hearing screening using TEOAE is feasible in a community hospital and will increase the detection of significant hearing loss.

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References

1. American Academy of Pediatrics. Joint Committee on Infant Hearing. 1994 Position Statement. Elk Grove Village, Ill: American Academy of Pediatrics, 1994.
2. White KR, Vohr BR, Maxon AB, Behrens TR, McPherson MG, Mauk GW. Screening all newborns for hearing loss using transient evoked otoacoustic emissions. Int J Pediatr Otorhinolaryngol 1994; 29(3):203–17.
3. Brackett D. Social/emotional and academic consequences of hearing loss. Consensus Development Conference on Early Identification of Hearing Impairment in Infants and Young Children. NIH Consensus Development Conference 1993:57–61.
4. Mauk GW, White KR, Mortensen LB, Behrens TR. The effectiveness of screening programs based on high-risk characteristics in early identification of hearing impairment. Ear Hearing 1991; 12: 312–9.
5. Commission on Education of the Deaf. Toward equality: education of the deaf. Washington, DC: US Government Printing Office, 1988:3.
6. Public Health Service. Healthy People 2000: national health promotion and disease prevention objectives. Washington, DC: US Department of Health and Human Services, 1990. DHHS publication No.(PHS) 91-50212.
7. Brackett D, Maxon AB, Blackwell PM. Intervention issues created by successful universal newborn hearing screening. Semin Hear 1993; 14:88–101.
8. National Institutes of Health Consensus Statement. Early identification of hearing loss in infants and young children. NIH Consensus Statement, 1993; 11:1–24.
9. White KR, Vohr BR, Behrens TR. Universal newborn hearing screening using transient evoked otoacoustic emissions: results of the Rhode Island Hearing Assessment Project. Semin Hear 1993; 14:18–29.
10. Kemp DT. Stimulated acoustic emissions from within the human auditory system. J Acoust Soc Am 1978; 64:1386–91.
11. Kemp DT, Ryan S. The use of transient evoked otoacoustic emissions in neonatal hearing screening programs. Semin Hear 1993; 14:30–45.
12. Vohr BR, White KR, Maxon AB, Johnson MJ. Factors affecting the interpretation of transient evoked otoacoustic emission results in neonatal hearing screening. Semin Hear 1993; 14:57–72.
13. Johnson JL, Mauk GW, Takekawa KM, Simon PR, Sia CC, Blackwell PM. Implementing a statewide system of services for infants and toddlers with hearing disabilities. Semin Hear 1993; 14:105–18.