ANDREW J SCHUMAN, MD
SECTION EDITOR

Otoacoustic emissions hearing screening: Update and review

Today's technology makes it easy to screen kids for hearing loss, even babies or children with developmental disabilities.

According to the Centers for Disease Control and Prevention, 2 of every 1000 babies are born with a permanent hearing loss.[1] In 1994, the Joint Committee on Infant Hearing (JCIH), composed of members from the American Speech-Language Hearing Association, the American Academy of Ophthalmology and Otolaryngology, and the American Academy of Pediatrics, first recommended universal newborn hearing screening.[2] Now 2 decades later, newborn hearing screening is being performed in every state in the country, and 95% of newborns are screened.

Unfortunately despite universal screening, we still fail to identify many babies born with a permanent hearing loss because approximately 39% of newborns who are referred by the newborn screening programs are lost to follow-up.[1] Therefore, it is imperative that pediatricians ensure that all babies in our care undergo appropriate screening for hearing loss and that we remain diligent in identifying patients who may be at risk for developing permanent hearing loss in childhood. This month's Peds V2.0 discusses using otoacoustic emissions (OAE) hearing screeners in your practice to identify children who may need follow-up and intervention with an audiologist.

Revised recommendations

In 2007, the JCIH revised its recommendations regarding newborn hearing screening to include 2 separate protocols: 1) for babies born in well nurseries, and 2) for those admitted to a neonatal intensive care unit (NICU) for more than 5 days.[3] All NICU babies (representing 10% of the entire newborn population) may be at risk for neurosensory hearing loss and should undergo hearing screening using an automated auditory brainstem response (ABR) test prior to discharge. Those babies who do not pass should be referred to a pediatric audiologist for evaluation and rescreening with automated ABR. When indicated, these babies will undergo diagnostic ABR testing.

In the well nursery, there are 2 options for screening. Babies can undergo a 1-stage screening using either automated ABR testing or OAE, or a 2-stage screening with automated ABR testing used for those who do not pass an initial OAE screen. All babies who refer from the well nursery should be

rescreened by the hospital before 1 month of age, or, if this is not possible, they should be referred to a pediatric audiologist for rescreening follow-up. It should be noted that some newborns later discovered to have hearing loss (known as delayed onset hearing loss) would not be identified by newborn screening.

Screening throughout childhood

Overall in the school-aged population, as many as 9 to 10 of every 1000 children have a permanent hearing loss and about 1 in 7 (14%) will have either permanent or temporary hearing problems that impact school performance.[4]

There are numerous risk factors that can help pediatricians identify patients aged younger than 3 years who warrant close monitoring or hearing screening. These are listed in the Table and include parental history of hearing problems, parental suspicion of hearing loss, congenital cytomegalovirus infection, meningitis, and exposure to ototoxic medications.[3]

Pediatricians should screen children for hearing problems throughout childhood according to the Bright Futures guidelines. This means screening children at ages 4, 5, 6, 8, and 10 years and whenever risk factors are identified. Additionally, those children who are being monitored for developmental delays or speech problems should be subjected to hearing screening.[5]

Otoacoustic emissions

When sound enters the ear canal, the tympanic membrane vibrates and the middle ear ossicular chain transmits the sound to the cochlea.

RISK INDICATORS FOR PERMANENT CONGENITAL, DELAYED-ONSET, AND/OR PROGRESSIVE HEARING LOSS IN CHILDREN

1. Caregiver concern regarding hearing, speech, language, or developmental delay.
2. Family history of permanent childhood hearing loss.
3. Neonatal intensive care of longer than 5 days or any of the following, regardless of length of stay: extracorporeal membrane oxygenation; assisted ventilation; exposure to ototoxic medications (gentamycin and tobramycin) or loop diuretics (furosemide/Lasix); and hyperbilirubinemia that requires exchange transfusion.
4. In utero infections (eg, cytomegalovirus, herpes, rubella, syphilis, and toxoplasmosis).
5. Craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies.
6. Physical findings (eg, white forelock) associated with a syndrome known to include a sensorineural or permanent conductive hearing loss.
7. Syndromes associated with hearing loss or progressive or late-onset hearing loss: neurofibromatosis; osteopetrosis; Usher syndrome; Waardenburg syndrome; Alport syndrome; Pendred syndrome; Jervell and Lange-Nielson syndrome.
8. Neurodegenerative disorders (eg, Hunter syndrome) or sensory motor neuropathies (eg, Friedreich ataxia, Charcot-Marie-Tooth disease).
9. Culture-positive postnatal infections associated with sensorineural hearing loss, including confirmed bacterial and viral (eg, herpes viruses, varicella) meningitis.
10. Head trauma, especially basal skull/temporal bone fracture that requires hospitalization.
11. Chemotherapy.
12. Recurrent or persistent otitis media for at least 3 months.

Adapted from American Academy of Pediatrics, Joint Committee on Infant Hearing.[3]
Note: Risk indicators marked in orange are of greater concern for delayed-onset hearing loss.

The sound waves in the cochlea excite the outer hair cells and a backwash of sound energy—OAE—travels in the reverse direction, from the cochlea through the middle ear into the ear canal. In an abnormal ear, the intensity of the emissions is much weaker than in a normal ear.

Transient OAE is produced by the outer hair cells of the cochlea when a "click" sound stimulus is presented to the ear. In contrast, distortion product otoacoustic emissions (DPOAE) are the emissions produced by the outer hair cells in the cochlea when sound stimulus is provided by the simultaneous presentation of 2 pure tones of equal intensity but different frequencies. In either situation, an

OAE screening instrument, using a sensitive microphone in the ear canal, assigns a pass or fail grade for the child's hearing based on an algorithm stored in memory.

Otoacoustic emissions screeners test hearing at 2, 3, 4, and 5 kHz in a matter of minutes. An infant or child who "refers" should be examined for evidence of ear canal obstruction with cerumen, otitis media, or serous otitis, with treatment as indicated. In the absence of a treatable cause, or watchful waiting in the case of a serous otitis, repeat testing should occur in 2 to 4 weeks' time, and if there is no improvement, the child should be referred to a pediatric audiologist.

The OAE technology, which was developed as a test of cochlear function, is sensitive to conductive hearing loss and the integrity of the hearing apparatus. It does have limitations, however, because abnormal results do not distinguish between a conductive hearing loss and a neurosensory loss. A hearing deficit caused by a conductive loss will disappear along with a middle ear effusion, but neurosensory hearing loss will not. Neurosensory hearing loss in children beyond the newborn period is relatively rare, usually on the order of 1 per 10,000 children.[6]

Otoacoustic emissions can be used as a screening test for any age. The technology is especially convenient with infants and toddlers for whom audiometry can be difficult or impossible to perform. It is also helpful in deciding if surgical management is needed for bilateral middle ear effusion of longer than 3 months' duration.

Efficacy of OAE for hearing screening

Several studies have shown that OAE hearing screening can be easily performed in pediatric practice and it will identify children with hearing problems. The technology was examined by Eiserman et al in a study published in 2007.[7] In this study, 3486 children aged from birth to 3 years from 52 different Head Start Program sites were screened by Head Start staff, using OAE screening technology. Of the 3486 children screened, 183 (5%) were referred for medical or audiologic follow-up. Of these 183 children, 80 were identified with a hearing loss or disorder requiring treatment or monitoring. Six of these 80 were diagnosed as having permanent hearing loss; 63 were identified with otitis media; 2 were treated for occluded pressure equalization tubes; and 9 were treated for excessive earwax or congestion.

This study suggests that OAE screening in early childhood settings helps identify approximately 1 of every 43 children as needing audiologic treatment or monitoring and 1 of every 600 children as having a permanent hearing loss that was not previously identified.[7] In a more recent study involving 3 federally funded clinics, 846 preschool children were screened during routine visits to their primary care providers using a DPOAE instrument. Of the 846 children screened, 814 (96%) ultimately passed the test and 3 were identified with permanent hearing loss.[8]

Choosing your screener

Excellent OAE screeners are available from several manufacturers. Keep in mind that the Current Procedural Terminology (CPT) coding for OAE screening changed in 2012. Pediatricians who used to use CPT code 92587 should now be using the screening code 92558. Typically insurance companies are reimbursing $10 or higher per screen, unfortunately not as high as the $65 that used to be reimbursed under the previous CPT code.

Regardless, all screeners from Natus Medical (San Carlos, California), Welch Allyn (Skaneateles Falls, New York), and Maico Diagnostics (Eden Prairie, Minnesota) cost about $4000 and have similar features that include a full-color screen, automated testing, push-button operation, the ability to print results using a thermal printer, and the ability to connect to a software database provided by each company. Maico Diagnostics' product is the **EroScan Screener Plus**; the Welch Allyn product is the **OAE Hearing Screener**; and Natus makes the **AuDX** device.

▲ **Maico EroScan Screener Plus features fully automated testing.**

AUTHOR SUPPLIED IMAGES

▲ **Welch Allyn OAE Hearing Screener features push-button controls and a full-color screen.**

All these products use rechargeable batteries, making the units portable so they can be brought into the exam room with the patient. Additionally, they have long cords to connect to the ear probe and soft disposable ear tips that make it easy to achieve a snug but comfortable fit for the testing. All units test at 4 frequencies and will display a pass response if the child passes the test at 3 of the 4 frequencies. Testing of an ear with a cooperative child can be achieved in less than 2 minutes. It would not be a bad idea for a practice to have available a standard audiometer, such as the Maico **Pilot** ($2500) that uses picture identification, to confirm and quantify a hearing loss when detected in a child aged older than 3 years. A tympanometry device is also useful in documenting an ear effusion associated with a hearing loss. I usually recommend the Welch Allyn **MicroTymp3** ($3500) or the **Maico Race Car Tympanometer** ($3100).

▲ **Maico Race Car Tympanometer documents ear effusion with hearing loss.**

▲ **Maico Pilot audiometer uses picture identification to confirm hearing loss in older children.**

Closing thoughts

It is easy to forget that a considerable number of children in your practice may have a permanent hearing loss and would benefit from early detection and intervention. Today's OAE technology makes it easy for your staff to perform screening quickly and easily, even in babies or children with developmental disabilities. This is just another good example of how using the right technology in pediatric practice can make a profound difference in the lives of your patients. ■

REFERENCES

1. Centers for Disease Control and Prevention, National Center on Birth Defects and Developmental Disabilities. Summary of 2010 National CDC EHDI Data. Atlanta, GA: Centers for Disease Control and Prevention, 2012. Available at: http://www.cdc.gov/ncbddd/hearingloss/2010-data/2010_ehdi_hsfs_summary.pdf. Accessed July 23, 2014.

2. Joint Committee on Infant Hearing. 1994 position statement. *AAO-HNS Bull.* 1994;12:13.

3. American Academy of Pediatrics, Joint Committee on Infant Hearing. Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. *Pediatrics.* 2007;120(4):898-921.

4. Shargorodsky J, Curhan SG, Curhan GC, Eavey R. Change in prevalence of hearing loss in US adolescents. *JAMA.* 2010;304(7):772-778.

5. Harlor AD Jr, Bower C; Committee on Practice and Ambulatory Medicine; Section on Otolaryngology-Head and Neck Surgery. Hearing assessment in infants and children: recommendations beyond neonatal screening. *Pediatrics.* 2009;124(4):1252-1263.

6. Foerst A, Beutner D, Lang-Roth R, Huttenbrink KB, von Wedel H, Walger M. Prevalence of auditory neuropathy/synaptopathy in a population of children with profound hearing loss. *Int J Pediatr Otorhinolaryngol*, 2006;70(8):1415-1422.

7. Eiserman WD, Shisler L, Foust T, Buhrmann J, Winston R, White KR. Screening for hearing loss in early childhood programs. *Early Child Res Q.* 2007;22(1):105-117.

8. Foust T, Eiserman W, Shisler L, Geroso A. Using otoacoustic emissions to screen young children for hearing loss in primary care settings. *Pediatrics.* 2013;132(1:118-123.

Are you attending the American Academy of Pediatrics' National Conference and Exhibition in San Diego, October 11-14? Don't miss Dr. Andrew Schuman, *Contemporary Pediatrics'* tech guru, as he presents the best new technologies for your practice, including the latest mobile apps, screeners, and diagnostic/therapeutic devices: Interactive Group Forum Sessions, #I3137: Must-have gadgets, gizmos, and technology for the pediatric office; Monday, October 13, 2014; 4:00-5:30 pm; Convention Center. For more information, go to www.aapexperience.org

AUTHOR SUPPLIED IMAGES