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Universal Newborn Hearing Screening: Current Testing Techniques

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There has been increased interest in screening all newborns for hearing loss across the U.S. and around the world. This interest is motivated, in part, by the significant impact hearing loss can have on speech and language development. While speech and language skills improve throughout life, the brain appears to be particularly suited for learning the building blocks of speech and language in the first few years of life. This is sometimes referred to as a "critical period" for speech and language development. While this critical period occurs early in life, the impact lasts a lifetime because so much depends on our communication skills. An individual's ability to use speech and language will have a major impact on social, educational, and economic success. Thus, society has a long-term interest in the successful identification, diagnosis, and remediation of hearing loss early in life. Many technological developments now make it possible to identify and quantify hearing loss in newborns. These include acoustical (otoacoustic emission - OAE) and electrophysiological (auditory brainstem response - ABR) tests.

Otoacoustic Emissions (OAE)

- The normal cochlea produces sound in response to external stimulation; this internally generated sound is the measured response during OAE tests.
- To measure OAEs, a small probe is placed in the infant's ear canal and sound is presented by either one or two tiny loudspeakers. Any response generated by the ear is recorded with a small microphone housed inside the probe.
- Signal averaging is used to reduce the level of background noise, which comes primarily from breathing or movement.
- If an infant's cochlea is functioning normally, internally generated sounds will be recorded.
- If cochlear hearing loss exists, the cochlea either will not generate a response or it will generate a response that falls below the level that is expected from an ear with normal hearing.
- Normal external and middle ear function is important if OAE measurements are to be interpreted correctly as tests of cochlear function. Even if a cochlea is functioning normally and produces an OAE, the response may not be recorded if it is attenuated by fluid in the middle ear or any external ear canal anomalies.
- Transient evoked and distortion product OAEs are in the most widespread clinical use. They differ somewhat in the way that they are generated and recorded, but both provide accurate frequency-specific information.

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Auditory Brainstem Response (ABR)

- The normal auditory system generates small electrical currents when excited. These electrical responses are the measured response during ABR tests.
- To record and ABR, small surface electrodes are attached to the head at several places. An earphone is place in the ear, brief sounds are played, and the electrical signals across the electrodes are recorded.
- These electrical signals, which include the ABR, are amplified and then fed to a computer, where they are averaged. Signal averaging is used to reduce the recorded level of other ongoing brain activity (electroencephalogic "noise") and to resolve the small electrical responses generated by the auditory system.
- If hearing is normal, these electrophysiological responses should be observed for low-level stimuli.
- If hearing loss exists, the threshold of these responses will be elevated.
- ABRs are less dependent on the status of the middle ear, compared to OAE tests, because the response is recorded across surface electrodes and does not have to travel back out through the middle and external ear.

Comparison of OAE and ABR Measures

- Several studies have demonstrated that both OAE and ABR measurements can be used in UNHS programs to accurately identify infants with hearing loss.
- Both techniques can be implemented with automatic response-detection algorithms. This means that the personnel performing either test to screen newborns for hearing loss do not require extensive special training.
- OAE tests tend to be quicker and less expensive because they do not require the use of electrodes. Costs for ABR electrodes vary, but many health-care organizations require the use of disposable electrodes in efforts related to infectious-disease control.
- The accuracy of OAE measurements depends on the status of the external and middle ear. More infants fail OAE screenings compared to ABR tests primarily because of the presence of fluid in the middle ear or vernix in the ear canal at birth.
- ABR tests typically require more time than OAE tests and tend to be more expensive.
- ABRs are less susceptible to the status of the middle ear, and are more sensitive than OAEs to disorders such as auditory neuropathy or other neural problems.
- ABRs typically are elicited by clicks, which result in excitation of wide cochlear regions. Thus, a hearing loss restricted to a narrow range of frequencies might be missed if an ABR response is generated from other cochlear regions where function is normal.
- OAE tests, even those using clicks as stimuli, provide a more frequency-specific response than click-evoked ABR screening measures.
- Both OAE and ABR tests tend to identify mid-to-high frequency hearing losses with greater accuracy than hearing loss affecting lower frequencies. As the majority of permanent hearing losses affect mid-to-high frequencies, this should not be considered a major limitation of either test.

Newborn hearing screening programs in which clinical decisions are made after a single screening test have the highest overall referral rates. Programs that repeat the same screening test on those newborns who do not pass an initial test have lower referral rates than the one-stage screening design. Still other

programs use OAEs for the initial screening, followed by an ABR for those newborns who do not pass the OAE test. These combination-screening programs tend to have low referral rates and low overall costs.

Regardless of the screening method chosen, newborn hearing screening, though critical, is only the first stage of a comprehensive early intervention plan. Screening alone is useless unless appropriate diagnostic testing services and high quality amplification and habilitation services are in place and are implemented in a timely fashion. Screening in the newborn period does not substitute for further periodic childhood hearing screening.