Improving TEOAE Screening

A woman's voice narrates the entire video.

[Music during introduction]

[Probe Fit]
The importance of the probe fit in the ear canal during the measurement of TEOAE's cannot be over emphasized.

[A Good Probe Fit]

A good probe fit locks in the stimulus, locks out ambient noise, and increases the probability of measuring an emission.

[Factors Affecting Probe Fit]

There are a number of factors that affect a probe fit, including the size of the tip, the shape and angle of the ear canal, the presence of debris in the ear canal, the experience of the screener, the position of the cord and the probe assembly, and the state of the neonate.

[Hands Placing Probe in Baby's Ear Canal]

When placing a probe into the ear canal, the probe tip should be large enough to fit snuggly into the ear and the cord should be positioned above the baby's head. Before selecting a probe tip, observe the size, shape, and angle of the ear canal.

[Baby with Pacifier and Pink Blanket]

It's also helpful to note any abnormalities in the external ear or surrounding tissue, such as the pit in front of this baby's ear [green arrow points to pit].

[Baby Swaddled in Purple Blanket]

The pinna of a swaddled neonate should be manipulated prior to probe insertion by pulling upwards and outwards on the helix with one hand while pulling downwards on the ear just in front of the tragus with a finger from the opposite hand. This is important; manipulate the pinna. Many neonates have collapsed ear canals from being positioned on their side or have birthing debris remaining in the ear canal which may interfere with the OAE screening. Manipulating the ear will often open a collapsed canal or dislodge debris enough to change a REFER to a PASS. While inserting the probe, again pull up and out on the pinna with one hand while putting the probe tip into the ear following the angle of the canal. The fit of the probe may be checked by setting it with the push of the index finger.

[Baby Swaddled in Striped Blanket]

The probe tip should fit deeply into the ear canal and little of the white tip should be visible.

[Baby Swaddled in White Blanket]

Although some neonates sleep through the entire process, some may also react to the insertion of the probe. A reassuring hand pushing down slightly on the shoulder will often be enough to settle most neonates.

[Adequacy of Probe Fit]

The two primary components of determining the adequacy of a probe fit are visual inspection of the probe in the ear canal and observing the information displayed on the monitor.

[Baby Swaddled in Striped Blanket]

A quick visual inspection should establish that the neonate is in an acceptable test state and that the probe assembly and cord are positioned appropriately.

[Baby Swaddled in Purple Blanket]

And although all ears are different, for most neonates, little of the probe tip should be visible when it is inserted deep enough into the ear canal.

For comparison, these are examples of probe fits that could be improved and may cause problems during the TEOAE screening.

[Babies Swaddled in Plaid and Striped Blankets]

Although some neonates will pass the screening with a poorly fit probe, the overall initial REFER rate from a program or from an individual who is not focused on achieving good probe fits, will typically be higher than from those who have.

[Screening Monitor Displayed]

During the check fit portion of the screening sequence, the monitor displays information which may be used to judge the adequacy of the probe fit, the stimulus waveform, the stimulus spectrum, and the noise level indicator.

As the probe is repositioned in this baby's ear canal, the differences between a good and a poor probe fit are easily differentiated. With a poorly fit probe, the stimulus waveform typically displays more oscillation ***[green arrow pointing at stimulus waveform]*** and the stimulus spectrum is shifted towards the high frequencies ***[green arrow pointing at stimulus spectrum]***. Depending on the level of the environmental noise, the noise level indicator ***[green arrow pointing at noise level indicator]*** may shift to a higher level or may fluctuate more with a poor probe fit as well.

When the screening sequence is underway, the shape of the noise spectrum is another indicator of the status of the probe fit as the statistical information is displayed. With an appropriate probe fit, the noise floor is typically higher in the low frequencies ***[thick green line shows this location]*** where physiological and internal noise is concentrated and tapers off towards the high frequencies. With a poorly fit probe, the noise floor is often flat ***[shows flat noise spectrum]*** due to the increased noise allowed into the ear canal. If these indicators ***[multiple arrows on monitor]*** are seen at the first update, it's often more efficient to stop the session and refit the probe into the ear canal.

[Baby Swaddled in Striped Blanket]

This screening sequence highlights the differences in measurements obtained from the same ear with a poorly fit probe and with an improved probe fit.
noise.

[Screening Monitor Displayed]

You'll notice during the check fit portion of this session, that the stimulus waveform ***[green arrow pointing at stimulus waveform]*** shows more oscillation than is wanted due to leakage of the stimulus into the ear canal. Rather than having a smooth, rounded stimulus, the frequency spectrum ***[green arrow pointing at stimulus spectrum]*** is peaked and shifted towards the high frequencies. There's also little energy present in the lower frequency region. At the first screen refresh, you see that the noise spectrum ***[green arrow pointing at noise spectrum]*** is essentially flat and has nearly equal energy in both low and high frequency regions. Although you may see similar results during the initial stages of screening with babies who have high internal noise, ideally you would expect to see the noise level decrease towards the higher frequencies; particularly as the screen is refreshed later in the session. Another thing to notice during this measurement is that even though the baby is quiet, the noise level indicator ***[green arrow pointing at noise level indicator]*** is jumping up and down rather than concentrating in one particular area. This is due to fluctuations in the background noise level; most of which is speech, which is easily entering the ear canal around the loose probe tip. When the screening is stopped, you'll notice ***[green arrow pointing at stimulus spectrum]*** that little response is measured and the portion of the response that is present, is focused in the high frequency region. Remember that the response we're seeking is dependent on the stimulus and that since there is little low frequency energy present in the stimulus ***[green arrow pointing at noise spectrum]***, you can't expect to measure a response in that region.

As the probe is refit in the ear, notice that the tip is placed deeper into the ear canal and that little of the probe tip is visible. During the check fit phase, there's less oscillation in the stimulus waveform and the stimulus spectrum is more rounded ***[green arrows pointing at stimulus waveform and at stimulus spectrum]***. The peak that was present in the earlier measure has disappeared and more low frequency energy is being delivered. A clear response is present at the first screen refresh and the noise spectrum ***[green arrow pointing at noise spectrum]*** has the more highly desired, tapered shape. This session was completed much more rapidly than the previous one, primarily due to the improved probe fit.

Another issue that should be focused on is the interdependent relationship between probe fit, noise, response, and time in TEOAE measurements.

[Sound Level Meter Displayed on the Screen]

You're now watching a screening session that illustrates the importance of a good probe fit for reducing ambient noise. In the first segment of this session, the probe is poorly positioned in the ear canal ***[green arrow pointing at poor probe fit]***. All of the obvious signs of a poor probe fit are present. The stimulus wave form, shows too much oscillation ***[green arrow pointing at stimulus waveform]***, the stimulus spectrum ***[green arrow pointing at stimulus spectrum within the noise spectrum]*** shows a peaked high frequency shift, the noise floor ***[thick green line]*** does not taper off in the high frequencies, and a large portion of the probe tip is visible ***[green arrow pointing at probe]***, suggesting that it has not been secured deep enough into the ear canal. But a response can be measured in this neonate even with the poor probe fit, primarily because of the neonate's low internal noise level and the low level of the ambient noise in the environment.

You can see that the screener is keeping the noise reject arrow at a very low level. When screening neonates, one of the most difficult aspects of the process is learning the trade-off between time and the noise reject level. Raising the noise reject level allows more samples to be included in the average, but it may either increase or decrease the amount of time needed to reach a specified PASS criteria. You'll also notice a similarity in the response and stimulus spectra in this session. As the external noise is added to the screening environment, you'll see that with a poorly fit probe, the background noise interferes with the screening session so much that a response can't be measured. Even though the screener has moved the noise reject level as high as possible, which is not recommended under most screening circumstances, the noise level in the ear canal is so great, that quiet or acceptable samples can't be collected. You may have noticed the sound level meter playing noise levels at various intervals throughout the screening session. The initial ambient noise level, when there is no music in the background, averaged about 35 dBA. When the music was added to the background, the average ambient noise level was only increased by about 10 dB. With a poorly fit probe, the screening session couldn't be completed due to the noise leaking around the probe tip into the ear canal. With the same background noise levels and an improved probe fit, you'll notice that the stimulus wave form and stimulus spectrum are improved. At the first screen refresh, you can see that the noise spectrum tapers off towards the high frequencies as opposed to being essentially flat as was seen with the poor probe fit measurement. Although the noise level is a little bit higher than would be measured in a quiet environment, the response is clearly visible despite the background noise. One of the secrets to success in reducing the initial REFER rate in a neonatal hearing screening program, is ensuring that the screeners are properly trained in the insertion of the probe into the ear canal. Most neonates can be screened in the nursery environment without special sound shields or without moving the neonates to a separate screening room. As the decibel level of the noise in the environment is again increased, you may observe that although the screening session takes a little longer to complete, an emission can still be measured. The background noise now is averaging around 60 dBA. For this neonate, a proper probe fit allowed more than 25 dB of noise to be added to the external environment without obliterating the response. This is not uncommon. Many of the detrimental effects of background noise can be diminished by obtaining a good probe fit. As the statistical information is displayed on the screen, during this screening session, although you see that the noise spectrum has greater amplitude, it maintains the desired sloping shape by being higher in the low frequencies and decreasing towards the high frequencies. Remember that in measuring TEOAE's, noise and response are differentiated by comparing the correlated portions of the response wave form, the response, to the uncorrelated portions of the wave form, the noise. By locking the stimulus in the ear canal and locking out ambient noise, a good probe fit allows you to more efficiently complete the screening session.

[Contact Information]

MINNESOTA MDH DEPARTMENT OF HEALTH

Newborn Screening Program, 601 Robert St. N., St. Paul, MN 55155
Phone (800) 664-7772, TTY (651) 201-5797, Fax (651) 215-6285

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