What is The Best Tympanometric Protocols for Testing Newborns?

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Why Tympanograms are Different in Newborns

• The external ear and middle-ear in infants will undergo some structural changes that can affect the mechano-acoustical properties of conductive mechanism. (Keefe et al, 1993; Keefe and Levi, 1996).
  – The external auditory canal will increase in size and becomes less compliant (due the formation of the bone) post-natally until about one year of age (Anson & Donaldson (1981). This can potentially reduce the resonance gain and shift the resonant frequency of the canal to the higher value in younger infants;
  – growth of middle-ear cavity from the tympanic membrane to the stapes footplate in the first 6 months after birth Eby & Nadol (1986) and an increase in pneumatization of mastoid air cells which will contribute to the enlargement of volume in the middle-ear cavity. The volume of air is important in determining the tympanic membrane compliance and controlling the conduction of low frequencies;
  – a decrease in the overall mass of the middle-ear due to presence amniotic fluid and mesenchyme in the middle-ear cavity which may last for up to 5 months after birth Paparella et al. (1980); a decreases in the density of stapes due to internal bone erosion which could lead to a reduction in mass for this structure,
  – tightening of the ossicle joints and stapes footplate attachment to the oval window which may decrease the resistive component
What Would be the Effect of These Changes on the Tympanogram?

• The overall maturation of the external and middle-ear may result in an increase in mass at birth which will gradually decrease as infants become older. This prediction has been confirmed by multi-frequency tympanometry (Holte et al., 1993; Shahnaz, 2002)
Typical Tympanograms Seen in Normal Newborns

Shahnaz, 2002;
Typical Tympanogram Seen in an Abnormal Newborn

Margolis & Hunter, 1999
Results (Shahnaz, 2002)

• While eighteen ears had multiple peak or irregular patterns on Y tympanogram at standard low probe tone frequency (226 Hz), 22 ears had a single peak and essentially normal shape tympanogram on G component at 800 Hz and Y @ either 800 or 1000 Hz.

• One infant who failed Algo-II protocol in both ears at the time of birth and at 3-weeks of age, had an irregular Y tympanogram at 226 Hz and single peak G tympanogram at 800 Hz. This infant was later diagnosed to have a moderate to severe bilateral sensorineural
Results (Polka, Shahnaz, Zeitoni, 2002)

Figure 2: Proportion of single peak admittance (Y) tympanogram in newborn infants and young adults across four different probe tone frequency.
Results – Margolis et al, 2003

- Normative data presented for NICU graduates tested at a mean age of 3.7 weeks and full-term infants tested at 2-4 weeks who passed an otoacoustic emissions (OAE) screen.

- The 5th percentile for static admittance for NICU and full-term babies was identical, allowing a single pass-fail criterion (Static Y).
### Normative tympanometric values from 1-kHz tympanograms from 46 ears of 30 full-term babies tested at 2-4 weeks chronological age.

<table>
<thead>
<tr>
<th></th>
<th>TPP (daPa)</th>
<th>Y +200</th>
<th>Y -400</th>
<th>Y Peak</th>
<th>Comp Y (+200)</th>
<th>Comp Y (-400)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-10</td>
<td>1.4</td>
<td>0.8</td>
<td>2.7</td>
<td>1.3</td>
<td>1.9</td>
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<tr>
<td>S.D.</td>
<td>68</td>
<td>0.4</td>
<td>0.4</td>
<td>1.2</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Max</td>
<td>200</td>
<td>2.3</td>
<td>1.7</td>
<td>7.0</td>
<td>5.0</td>
<td>6.0</td>
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<tr>
<td>Min</td>
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<td>0.0</td>
<td>0.8</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>5th %ile</td>
<td>-133</td>
<td>0.8</td>
<td>0.3</td>
<td>1.2</td>
<td>0.1</td>
<td>0.6</td>
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<tr>
<td>95th %ile</td>
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<td>1.4</td>
<td>4.8</td>
<td>3.5</td>
<td>4.3</td>
</tr>
<tr>
<td>50th %ile</td>
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<td>1.4</td>
<td>0.8</td>
<td>2.5</td>
<td>1.0</td>
<td>1.7</td>
</tr>
</tbody>
</table>
Summary

• Recommend the use of 1000Hz probe tone tympanometry to test babies under 6 months using Y-tympanogram
• Adapt Margolis et al, 2003 norms until more data become available
• Tympanometry using 220 Hz should not be used.
• Equipment improvements are needed to meet audiologists’ needs for simplicity and ease of use.
• More data are need on interpretation of traces and validation of results.
Thank You