The use of Otoacoustic Emissions in Noise Induced Hearing Loss prevention

Mine Medical Practitioners Association Conference
Valley Lodge Magaliesberg

9 October 2010
Acknowledgments

Angloplatinum

Mogalakwena mine management

Dr. Cas Badenhorst

Mr. Pieter van Coller

Mrs. Leonie van Coller

Volunteers
Outline of presentation

• Introduction
• Otoacoustic Emissions
• Methodology
• Results
• Conclusion
• Recommendations
NIHL continues to result in reduced worker quality of life + compensation costs

NIHL is a permanent condition – if we are to prevent it we need an approach that will allow early identification of the development of NIHL

The audiogram is a subjective method that relies on co-operation from the worker

Alternative or adjunct approach is an objective testing method
Otoacoustic Emissions (OAEs) are a feasible alternative

• Large body of research in laboratory - main clinical use on identification of hearing loss in newborn babies
• Clinically sensitive tool for assessing NIHL and the outer hair cells (OHC)
  • repeatable results
  • identify cochlear damage before evidenced on an audiogram – normal audiogram but evidence of OHC loss
• Feasible method of evaluating HPD effectiveness using temporary emission shift (TES)
• CSIR research developed a prediction model for Hearing Threshold Levels
Otoacoustic Emissions

Three types of OAEs: Spontaneous (SOAE), Transient (TEOAE), Distortion Product (DPOAE)

DPOAE measurement

- Probe in the outer ear
- Probe houses the measuring microphone and sound emitting transmitter
- Sound transmitter presents two moderate level tones in pairs (f₁ and f₂) over a range from low to high frequency
- The sounds enter the outer, middle, and inner ear
- Very small sound waves emitted back through the middle ear from the interaction of the two tones in the fluid of the cochlea
- Recording microphones pick up the small sounds coming back from the inner ear
- The computer averages and processes the responses
Otoacoustic Emissions

Reliable OAE test results require:

- Normal middle ear functioning—need tympanogram
- Relatively quiet room—there should be a 10dB difference between the emission level and the noise floor (SNR)
- Hearing threshold levels impact on results—must use DPOAEs and diagnostic test protocol
Methodology

Objectives

- To evaluate the signal-to-noise ratio of the DPOAE test results when the tests were conducted in different venues in an Occupational Health Centre by a technician;

- To evaluate the viability of DPOAE testing in a population that has been exposed to noise and therefore may have existing hearing loss;

- To evaluate the ability of DPOAE test results to identify early NIHL.
Methodology

Sample
56 platinum mine employees
Annual medical
Two venues - same tester
• on the mine premises where HPDs were being checked
  • Noisy road outside where trucks passed by periodically
• at a town clinic where contractors were tested
  • Quiet back room shared with x-ray technician
Only male subjects
Years of service - generally low
37 worked for 3 years or less
Methodology

**Procedure**
Approved by the Research Ethics Committee

Each ear a separate record - 100 ears

Conducted an otoscopic examination

Conducted a tympanogram to ensure normal middle ear function

Test conducted by a technician who had approximately two days of training

Downloaded the results and evaluated and interpreted by an audiologist

<table>
<thead>
<tr>
<th>Age category</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30 yrs</td>
<td>36</td>
</tr>
<tr>
<td>31-40 yrs</td>
<td>35</td>
</tr>
<tr>
<td>41-50 yrs</td>
<td>18</td>
</tr>
<tr>
<td>51-60 yrs</td>
<td>8</td>
</tr>
<tr>
<td>&gt;60 yrs</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>
**Methodology**

Mine-Interacoustics automated AS216 audiometer and the results were recorded using the Everest Audio program version 2.04.

Town clinic-Tremetrics RA650 automatic audiometer that was automatically recorded with the African Management Software Program

The hearing levels in this sample were on average within normal limits 20% of subjects presented with mild-to-moderate HTLs at certain test frequencies.
## Results

### Signal-to-noise ratio (SNR)

<table>
<thead>
<tr>
<th>$f_2$ Frequency</th>
<th>633Hz</th>
<th>797Hz</th>
<th>996Hz</th>
<th>1266Hz</th>
<th>1605Hz</th>
<th>2027Hz</th>
<th>2555Hz</th>
<th>3234Hz</th>
<th>4055Hz</th>
<th>5133Hz</th>
<th>6434Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic</td>
<td>8.9</td>
<td>11.3</td>
<td>13.3</td>
<td>14.6</td>
<td>15.6</td>
<td>14.6</td>
<td>12.6</td>
<td>13.7</td>
<td>19.9</td>
<td>15.2</td>
<td>7.9</td>
</tr>
<tr>
<td>Mine</td>
<td>10.0</td>
<td>12.8</td>
<td>13.4</td>
<td>15.9</td>
<td>15.2</td>
<td>14.9</td>
<td>12.5</td>
<td>14.2</td>
<td>20.3</td>
<td>17.1</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Most SNR >10dB indicates sufficient ambient noise control for reliable test results in a medical surveillance situation.
Results

Indication of early NIHL

Early identification = audiogram thresholds are within normal limits but emission levels are lower than the Vanderbijl norms expected range of normal DPOAE levels indicated on the GSI

<table>
<thead>
<tr>
<th>Hearing Level</th>
<th>Number of ears</th>
<th>Early Identification Reduced OAE for audiogram result</th>
<th>Expected OAE for audiogram result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal hearing</td>
<td>73</td>
<td>53</td>
<td>20</td>
</tr>
</tbody>
</table>
Conclusions

The study provides evidence that

DPOAE is a **feasible test** in an occupational health centre environment as ambient noise can be sufficiently controlled. A trained technician can obtain **reliable** DPOAE results in an occupational health centre. DPOAE testing appears to be a feasible tool for early indication of NIHL in the mining industry if used to counsel workers.
Recommendations

More knowledge needed:
Hearing threshold levels of miners- will DPOAE work on all NIHL populations? Years of service low and relatively normal hearing levels

Download abilities of the current equipment is not user friendly

Need a middle ear function check- tympanograms and reflex testing – good requirement then barotrauma will be fully evaluated and prevalence better understood

Early identification analysis required skilled person or improved automation

Norms for this population need to be established
Thank You