THE FUTURE IS NOW:
EIGHT WAYS OTOACOUSTIC EMISSIONS CAN BE USED TO ADVANCE HEARING CONSERVATION PROGRAMS

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SAFETY FIRST
“What we are doing in our military HCPs is documenting the failure of those programs. We measure STS, but we don’t prevent it or stop it.”

MAJOR ADVANCEMENTS

- HPDs
  - Check-fit of HPDs
  - Custom HPDs

HCP AUDITORY TESTING SLOW TO IMPROVE

- Poor pure-tone audiometry reliability, especially at 6 kHz — key freq for NIHL
- Difficult to quickly detect HCP deficiencies
- Can’t quickly evaluate whether interventions are making a difference
- Do not know who is accumulating hearing damage that has not yet resulted in STS
- Among people doing the same job, cannot predict who is most at risk of NIHL
- Difficult to convince people to take STS seriously
- Vulnerable to malingering; needs active, alert cooperation

WHAT WE'RE TRYING TO DO

Work with equipment manufacturers
- HCP systems
  - Multi-patient; tested simultaneously
  - High throughput
  - Biannual
  - Measure low-level OAEs
  - Track small change — not pass/refer
  - Automated testing of a test battery with smart algorithms
  - Automated test interpretation
  - Unskilled testers
  - Rugged systems for challenging situations

Work with researchers to translate science into clinical tests.

Work with end users to ensure needs are met.

EIGHT WAYS OAES CAN BE USED IN HCPS

<table>
<thead>
<tr>
<th>Ways</th>
<th>Science</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate HCP success and interventions for groups</td>
<td>Yes</td>
<td>Ready</td>
</tr>
<tr>
<td>Detect preclinical change</td>
<td>Field-trial needed</td>
<td>Ready</td>
</tr>
<tr>
<td>Track recovery from TTS</td>
<td>Yes</td>
<td>Ready</td>
</tr>
<tr>
<td>Predict PTS risk with low-level OAEs</td>
<td>Field-trial needed</td>
<td>Ready</td>
</tr>
<tr>
<td>Predict PTS risk with MOCR</td>
<td>Field-trial needed</td>
<td>Ready</td>
</tr>
<tr>
<td>Estimate hearing status for those unable to respond to hearing test</td>
<td>Yes</td>
<td>Ready</td>
</tr>
<tr>
<td>Functional hearing loss test</td>
<td>No</td>
<td>Not funded</td>
</tr>
<tr>
<td>Education about inner ear damage</td>
<td>Not funded</td>
<td>Not funded</td>
</tr>
</tbody>
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DOD is funding development on most of these fronts — most are ready for beta-testing, field trials, and/or clinical use.

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COLLABORATIONS?

Equipment Development

- HCP beta-testing
  - Help stress-test and refine the technology to meet HCP needs
  - Ideally 2-person booths (start small)
- Forward-deployed beta-testing
  - Ruggedized, portable system with easy-to-administer tests

Support Experiments

- Can provide more sensitive tests likely to pick up changes in hearing system faster than old-school PTA
- Noise exposure and interventions
- MOCR

Interested?

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NSMRL TTS DATA

Detection = Emission Shift

Variability

TEMPORARY EMISSION SHIFT

[Graphs and tables related to TTS data]
EARLY NIHL DATA FROM KEMP:TTS

Engdahl & Kemp (1996) examine post-exposure DPOAE microstructure changes
- Lower-level primaries show higher sensitivity to noise
- Microstructure not measurable in all subjects at all frequencies
- Frequency band average may be the best measure

MARINE BASIC TRAINING

Frequency range 2-4 kHz
- OAEs decreased in amplitude
- DPVs and TEs worsened by 1 dB
- Hearing levels did not change
- More permanent emission shifts
Do low-level OAEs predict NIHL?
Continuous noise overlaid with impact

- Observed population PTS incidence 3%
- For all ears, use pre-test OAE as predictor for whether an ear was in the PTS group or the non-shifting group.
- Probability of a PTS given a low-level OAE is up to 20%
- As OAE level decreases, PTS risk increases
- TE stimulus level 74 dB pSPL; 4 kHz half-octave band


Do low-level OAEs predict NIHL?
Impulse (weapons noise)

- Observed population STS incidence 13%
- Take ear with lowest pre-test OAE, use as predictor for whether individual got STS in either ear.
- Probability of an STS given a low-level OAE is up to 70%
- As OAE level decreases, STS risk increases
- TE stimulus level 74 dB pSPL; 4 kHz half-octave band


**EFFERENT REFLEX TEST**

A good clinical efferent reflex test will have a wide range of values between subjects and small within-subject test-retest variability

Our current research is investigating adequate test protocols
**LATEST ITERATION OF MOCR TEST**

- All-in-one system with same insert earphone
- Multi-person and individual testing
- Automated
- Flexible
- Integrated
- Configurable
- Smart test-sequences
- Reporting

Key tests:
- PTA: hearing, malingering
- MEPA: middle ear
- OAEs: inner ear
- Binaural MOCR: efferent
- FPL real-ear calibration
- High frequency audiometry