Occupational Audiometric Testing
Part 1: Introduction

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Scope of instruction

- Purposes
- Equipment and environment
- Procedures and personnel
- Dealing with problems
- Interpretation of results

Purposes for audiometric testing

- Determine worker’s hearing status
- Identify greater-than-normal hearing loss
  - Identify sensitive workers
  - Identify poorly protected workers
- Educate and motivate the worker
- Provide proof of hearing conservation effectiveness

Audiometric process outline

- Instrument is audiometer
- Measurements
  - Lowest audible sound determined (threshold)
  - Tests over multiple frequencies
  - Each ear separately tested
  - Initial test is called baseline
  - Subsequent tests annually

Audiometers

- Manually operated
  - Inexpensive but labor intensive
  - Most training needed
- Automatic
  - Stand-alone types
  - Computer-based
  - Expensive, but simple to operate

Photo used with permission of Audiometrics, Inc.
Procedures

- Pure tones used
  - 500, 1000, 2000, 3000, 4000, 6000, [8000] Hz
- Subject indicates whenever tone heard
- Sound level decreased to inaudibility, then increased back to audible level
- Lowest audible tone at each frequency recorded as threshold

Audiometric Environment

- Low noise to avoid threshold elevation
- Normally inside special booth
- May test outside booth
  - Claustrophobic subjects
  - Occasional testing
  - Avoid clicks, squeaks that give clues

Background Noise Levels

- Measured with octave band analyzer
- OSHA limits are marginally acceptable
- American National Standards Institute (ANSI) should be goal

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<th>Frequency</th>
<th>OSHA</th>
<th>ANSI</th>
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<td>8000</td>
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Audiometric personnel

- Trained technician
  - Certified course (CAOHC - Council for Accreditation in Occupational Hearing Conservation)
  - Locally supervised
- Professional supervisor
- Audiologist
- Specialist physician
- Occupational physician

Occupational Audiometric Testing
Part 2: Quality Control
Quality control for audiometry

- Instrument calibration
- Procedural consistency
- Subject factors
- Goals
  - Accuracy
  - Consistency

Instrument calibration

- Daily sound level check
  - On an individual
  - On an instrument
- Daily listening check
  - Static, distortion, etc
- Annual instrument calibration
  - Only adjust if necessary

Quality control - procedures

- Instructions
- Headphone placement
  - Placement and removal by technician, not the subject!
  - Place and remove from front
  - Check to ensure headphone centered over ear canal
  - Check with last year’s results

Instructions to subject

- Emphasize purpose of test
  - To see if hearing is changing
  - To determine the softest sound the subject can hear
- Describe what will be heard
  - Soft beep-beep-beep sound
  - At first will be louder, then softer
- Explain action needed
  - “When you hear the beeps, press and quickly release the button”

Instructions (2)

- Be consistent with instructions
  - Have them written down
  - Give same instructions to all subjects
  - Provide in the subject’s language
  - Offer to discuss results
  - Offer to answer questions
  - Re-instruct if necessary
Quality control – TTS
- Temporary hearing loss (TTS - temporary threshold shift)
- 14 hours away from noise to minimize
- When to test to avoid TTS
  - Beginning of work shift (before exposure)
  - During work shift if protected
  - Good hearing protection will be adequate to avoid TTS

Quality control – ear blockage
- Cold, allergy, sinus problems
- Collapsing ear canal
- Impacted earwax

Quality control – Instruction compliance
- Language barriers
- Misunderstanding of purpose
- Fatigue and sleepiness
- Deliberate lack of cooperation

Quality control – ear differences
- Cross hearing
  - 40 dB or more difference between ears
  - Better ear may hear sound before poorer ear
  - Poorer ear threshold inaccuracy
  - Corrected by masking noise in better ear
  - Requires special equipment
  - Requires special training - audiologist

Summary
- Procedures, personnel, environment
  - Threshold determination, multiple frequencies
  - Quiet location (normally special booth)
  - Technician to test, specialist to supervise
- Quality control
  - Calibration and procedures
  - Subject instructions
  - Other subject factors
Interpretation of results

- Comparison of annual to baseline, one ear at a time
  - Threshold_{annual} - Threshold_{baseline} = threshold shift

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<td>Threshold shift</td>
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Standard Threshold Shift (STS)

- ≥10 dB average shift at 2, 3 & 4 kHz
- Each ear computed separately
- ≥10 dB average shift in either ear is STS
- Either average shifts or subtract threshold averages

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<td>10</td>
<td>11.7</td>
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Other factors in STS determination

- Test error or short term loss
  - Retest allowed within 30 days
- Age correction allowed
  - Subtracts normal aging loss from threshold shift

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<td>4.3</td>
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STS - work related?

- Determination by health care professional
- Factors for determination
  - Workplace noise exposure
  - Hearing protection on the job
  - Non-occupational factors
    - Noisy hobbies, sports, other jobs
    - Lack of protection
- Only make determination of non-work-related if no significant contribution to hearing loss due to workplace factors
STS actions
- Notify worker in writing within 21 days
- Re-train and re-fit hearing protectors
- Change to new baseline if STS persistent
- Possibly record as occupational illness or injury
- Refer for medical evaluation if ear infection caused/aggravated by HPD

Baseline revision
- STS - if present on two consecutive audiograms
- Improvement - ≥5dB average (2,3,4 kHz) on two consecutive audiograms
- General rules:
  - Revise to the better (or earlier) audiogram
  - Revise each ear separately
  - Revise all frequencies in each ear together
  - Subject to professional judgment

Recordability of hearing loss
- Meets all STS requirements and
- Average hearing level ≥25 dB at 2, 3 & 4 kHz in the same ear
- Recording requirements
  - Within 7 days of test on OSHA 300 log
  - May later be deleted if change isn’t permanent

Occupational Audiometric Testing
Part 4: Impairment & Referral

Determination of hearing impairment
- Average thresholds at 0.5, 1, 2, & 3 kHz
- Determine degree of impairment, if any
  - 0-24 dB, normal range
  - 25-39 dB, mild hearing loss
  - 40-54 dB, moderate loss
  - 55-70 dB, moderately severe loss
  - 70-84 dB, severe loss
  - >85 dB, profound loss
Percentage of hearing loss

- Average thresholds at 0.5, 1, 2, & 3 kHz
- Subtract 25 dB from result (normal hearing)
- Multiply result by 1.5%
- Repeat for each ear

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<tr>
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<th>3000</th>
<th>Avg</th>
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<td>25</td>
<td>40</td>
<td>27.5</td>
<td>4</td>
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<td>35</td>
<td>45</td>
<td>32.5</td>
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</table>

Binaural impairment calculation

- Since hearing isn't averaged by ears, consider better ear more strongly
- Multiply loss in better ear by 5
- Add loss in poorer ear
- Divide total by 6 for binaural loss
  \[(4\% \times 5 + 11\%) = 31\% \]
  \[31\% + 6 = 5\%\]

Problem audiograms - medical

- Large shift in short period
- Large shift in one ear only
- Ear pain, dizziness, onset of tinnitus

Problem audiograms - measurement

- Cross hearing situation
- Uncooperative or difficult subject
- Hearing impaired subject

Referral to specialist

- Medical problems
- Employer payment?
- Measurement problems
- Interpretation problems
  - Standard threshold shift - work related?
  - Recordable on OSHA log - work related?
  - Baseline revision
Recordkeeping

- What audiometric records must be kept
  - Name of employee & examiner, date of test
  - Threshold results
  - Calibration date of audiometer
  - Noise exposure assessment of employee
- How long to keep
  - OSHA: duration of employment
  - Others: extended period
- Other records to keep
  - Background noise, hearing history, training of examiner, daily calibration log

Summary

- Interpretation
  - STS calculation - 10 dB shift @ 2,3,4 kHz
  - STS actions and recordability
  - Impairment - 500 to 3000 Hz, >25 dB
- Referral of problem audiograms
  - Medical
  - Measurement
- Recordkeeping