Leveraging Boothless Audiometers to Implement Hearing Protection Device Fit-Testing at Military Hearing Conservation Clinics

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Outline

• Fit-testing & Military Relevance
• Project Background
• Methods
• Preliminary Data
• Next Steps
Fit-testing & Military Relevance

- Noise induced hearing loss (NIHL) is the #1 workplace health hazard to the Department of Defense (DoD) workforce
  - ~1.3 Million at-risk Active Duty, Guard, Reserve, and Civilian personnel receiving annual audiograms
  - Rates of threshold shift have plateaued (no significant improvement)

Fit-testing & Military Relevance

“A new requirement for initial hearing protector fit-testing to be conducted for all DoD personnel who have documented noise exposure > 95 dBA 8-hr time-weighted average and who are enrolled in Hearing Conservation Program (HCP)”

Additional fit-testing requirements:
- Significant threshold shift (STS) during periodic audiogram
- “early warning” hearing loss. e.g., (15 > dB loss @ 1-4 kHz)
- Physical changes to ear canal
- Primary hearing protector no longer available

Fit-testing & Military Relevance

• Assumptions based on policy change:
  ▪ A substantial proportion of the hearing damage that is currently occurring in the DoD is directly related to poorly fit hearing protection
  ▪ Individual fit-testing could help solve this problem and produce a substantial reduction in service-related auditory injury in the military

• Much is still unknown regarding the implementation of hearing protection device (HPD) fit-testing across the DoD
  ▪ Concerns of equipment/personnel/time
  ▪ Variety of different clinical workflows
  ▪ Minimum acceptable PAR
  ▪ How to improve training to reduce/eliminate failure rate for those being tested?
DCPH-A Public Health Project  “Incorporating Hearing Protection Device Fit-Testing into DoD Hearing Conservation Programs”

Purpose:
- Evaluate the logistical, technical, and procedural requirements for implementing wide-scale HPD fit-testing into the DoD

Primary Deliverables:
- Evaluate the feasibility of incorporating fit-test systems in a variety of clinical workflows
- Describe Personal Attenuation Rating (PAR) outcomes (across populations, HPDs, hearing status, noise exposure, etc)
- Subjective feedback from participants and clinicians regarding benefits of test system(s)
- Modeling PAR results using DOEHRS thresholds in place of open-ear fit-testing
## Public Health Guiding Questions

<table>
<thead>
<tr>
<th>Public Health Question(s)</th>
<th>Method</th>
<th>Data Collection Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How do service members (SM) and noise-exposed DoD personnel enrolled in a HCP perform on an initial HPD fit-test?</td>
<td>Behavioral hearing data</td>
<td>WAHTS + TabSINT</td>
</tr>
<tr>
<td>2. How does fit-testing performance vary with: (1) use and style of hearing protection (foam vs flange); (2) audiogram; demographic information (age, years of service, gender); (3) self-report of temporary changes in hearing; or (4) subjective hearing complaints and tinnitus?</td>
<td>Questionnaire + behavioral hearing data</td>
<td>WAHTS + TabSINT</td>
</tr>
<tr>
<td>3. Can thresholds obtained from the annual audiogram substitute for the unoccluded threshold in the PAR calculation to save time?</td>
<td>Behavioral hearing data</td>
<td>WAHTS + TabSINT</td>
</tr>
<tr>
<td>4. What are the logistical considerations for each potential use case of implementing HPD in DoD HCPs?</td>
<td>Survey</td>
<td>AHP Clinician Survey</td>
</tr>
<tr>
<td>5. What opportunities/challenges do DoD Audiologists encounter when providing HPD fit-testing services?</td>
<td>Survey</td>
<td>AHP Clinician Survey</td>
</tr>
<tr>
<td>6. What opportunities and challenges do SM and noise-exposed DoD personnel enrolled in a HCP encounter when included in a personal fit-testing program?</td>
<td>Questionnaire</td>
<td>WAHTS + TabSINT</td>
</tr>
<tr>
<td>7. What opportunities and challenges do commanders and supervisors of SM and DoD noise-exposed employees encounter when implementing personal fit-testing in the DoD?</td>
<td>Survey</td>
<td>Supervisor/Commander Survey</td>
</tr>
</tbody>
</table>
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**Equipment**

**Hardware**

OSHA- and ANSI-compliant calibrated headset with a built-in wireless audiometer.

**Software**

**audhere**

Occupational hearing testing and hearing protector application

**TABSINT**

Open source platform for administering tablet based hearing-related exams, as well as general-purpose questionnaires.
Performance Criteria

- Psychophysical Real Ear Attenuation at Threshold (REAT) under headphones
- Binaural 1/3 octave narrow band noise (NBN) centered @ 0.5, 1, & 2 kHz
- Hughson Westlake with machine learning algorithm to achieve rapid convergence
  - Additional constraints developed (e.g., step-size, inconsistent responses)
- Output: PAR$_{50}$ - measurement uncertainty
  - 3 dB roll-down foam, 4 dB flange

https://wahtshearing.com/fit-testing/
Procedures

- Target a network of Army Hearing Program clinics with access to the WAHTS purchased using FY20 CARES Act funds.
  - >12,000 audiograms conducted with WAHTS to supplement backlog of hearing encounters due to COVID 19.

- All Service members (SMs) and noise-exposed DoD civilians personnel reporting to clinic are eligible for testing

- HPD fit-test is administered after audiogram

Audiogram (DD2216) → HPD fit-testing → DCPH-A PH Project
## Hearing Protection Device Fit-Testing Pre-Project Survey

1. What is your site location?  
   
2. Have you ever used a fit-testing system in the past?  
   - [ ] Yes  
   - [ ] No  
   
   a. If yes, which fit-test system have you used?  
      (check all that apply)  
      - FitCheck Solo  
      - 3M E-A-Rfit  
      - Veripro  
      - Other (please specify):  
      
3. Does your site have a fit-test system?  
   - [ ] Yes  
   - [ ] No  
   
   a. If yes, what system(s) do you have at your site?  
      (check all that apply)  
      - FitCheck Solo  
      - 3M E-A-Rfit  
      - Veripro  
      - Other (please specify):  
      
   b. If yes, how many units do you have?  
      - [ ] FitCheck Solo  
      - [ ] 3M E-A-Rfit  
      - [ ] Veripro  
      - [ ] Other (please specify):  
      
   c. If you have a fit-test system, how often do you use it?  
      - [ ] Never  
      - [ ] Rarely  
      - [ ] Sometimes  
      - [ ] Often  
      
   d. If you answered never, rarely, or sometimes, why isn't it used more frequently?  

4. What fit-test system would you like to have at your site?  
   (check all that apply)  
   - FitCheck Solo  
   - 3M E-A-Rfit  
   - Veripro  
   - Other (please specify):  
   
5. How would you use the fit-test system at your site?  
   
6. Do you have a CEEP request in for a fit-test system?  
   - [ ] Yes  
   - [ ] No  
   
   a. If yes, what system(s) are you requesting?  
      (check all that apply)  
      - FitCheck Solo  
      - 3M E-A-Rfit  
      - Veripro  
      - Other (please specify):  
      
   b. If yes, how many units are you requesting?  
      - [ ] FitCheck Solo  
      - [ ] 3M E-A-Rfit  
      - [ ] Veripro  
      - [ ] Other (please specify):  
      
7. What obstacles do you see in regards to implementing fit-testing at your site?  
   
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**Improving Health and Building Readiness. Anytime, Anywhere — Always**
Overview of Data Collected

Hearing Data
- Current Audiogram
- Hearing Profile
- Appointment Type

Demographic Data
- Age
- Yrs of Service
- Branch of Service

Fit-test Outcomes
- PAR
- HPD Type
- Number of fits
- Fitting Behavior
- Education & Training

Questionnaires
- THS
- AACQ
- BFASS

Hearing Related Questions
- TTS History
- HPD use
- Noise exposure hx
- Fit-test experience
- Tinnitus Symptoms

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Progress to Date

- Current Dataset represents outcomes from WRNMMC Hearing Conservation Clinic
- Data collection initiated April 2023
- Current up to 12 July 2023
- N = 407
Overall PAR Outcomes

- Initial data used 3M Classic foam plug (NRR = 29 dB)
- Mean PAR = 20.4 dB
- ~9% of participants recorded PAR < 10 dB
PAR Improvement After Education

- No specific instruction given to site(s) on how to perform intervention
  - WR HCON provides demonstration on proper fitting techniques
- PAR improvement in 39 of 41 participants
Fitting Behaviors

• Admin observes fitting behaviors upon initial fit and records techniques used to fit device
• No instruction or intervention given until re-fit
• Checklist based off 3M fitting instructions
  - e.g., roll plug, pulling ear outward/upward, wait for foam to expand
Fitting Behaviors

- Composite of “good” behaviors minus “bad” behaviors plotted based on PAR/HPD
- Moderate correlation between fitting behaviors and resulting PAR
- Some behaviors more indicative of performance than others
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Questionnaires
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Hearing Related Questions
- History of Tinnitus
- History of Noise Exposure
- History of HPD Use
- Fit-test Experience

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- Hearing Data
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Current Audiogram
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- Number of fits
- Gender
- Fitting Behavior

PAR

PTA (2, 3, 4 kHz)

- Age
- Appointment Type
- Hearing
- Symptoms
- Noise exposure
- hx
- Fit-test experience
- Tinnitus Symptoms
- Fitting Behavior
- Yrs of Service
- PTA (2,3, 4 kHz)

- Current Audiogram
- Hearing Profile
- Yrs of MOS Service
- HPD Type
- Number of fits
- Gender
- Fitting Behavior

PAR

PTA (2, 3, 4 kHz)
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- **HPD Type**
- **Number of fits**
- **PAR**
- **THS**
- **AACQ**
- **BFASS**
- **TTS**
- **History of HPD use**
- **Noise exposure hx**
- **Fit-test experience**
- **Tinnitus Symptoms**
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- **Current Audiogram:**
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  - History of HPD use
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- **Figures:**
  1. Have you ever been trained on how to properly insert your hearing protection?
  2. How frequently do you wear hearing protection?
Use of Audiometric Thresholds

- Audhere PAR vs PAR extrapolated using DOEHRs-HC thresholds
  - Better hearing threshold of L/R ears @ .5, 1, 2, kHz used to calculate unoccluded condition
- Same occluded thresholds for both conditions
- Strong correlation between use of unoccluded NBN and pure tone threshold from audiogram

\[ R^2 = 0.821 \]
Next Steps

• Data collection
  ▪ Expansion to Beta Site (Kimbrough Ambulatory Care Center, Ft. Meade, MD)
    ✓ Multi-person boothless clinic (4-6 individuals tested simultaneously)
    ✓ audhere used for annual testing + fit-testing
  ▪ Onboarding of other AHP sites with WAHTS
  ▪ Enroll sites using other HPD fit-test equipment
Conclusion

• Updates to DoD HCPs include a new requirement for HPD fit-testing

• This public health initiative is set to evaluate aspects associated with a service-wide rollout

• Ultimate goal is to provide actionable information that can be used to guide policy at the service level & to improve our understanding of the relationship between PAR and hearing health outcomes in the military.
Questions

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