Auditory Conditions Associated with Head & Neck Injuries

What Every Clinician Should Know

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NOTE: The opinions presented here are the private views of the author and do not represent the official policies of the Department of Veterans Affairs, Department of Defense, or the United States Government.
Auditory Complaints To Be Aware Of

- Tinnitus
- Hearing Loss
- Difficulty Understanding Speech in Noise
- Hyperacusis/Noise Sensitivity
- Note: When auditory complaints exist, important to ask about vestibular problems & vice versa
Collective Work Being Done at the NCRAR & Affiliated Research Centers

1. NOISE Study (PI: Henry; Co-I Theodoroff)
2. CENC (PIs: Carlson; Henry)
3. Auditory Processing After Blast (PI: Gallun)
4. Auditory Rehabilitation for Blast-exposed Veterans (PI: Saunders)
5. Effects of Blast Exposure on Sensory Gating & SPIN (PI: Papesh)
6. Tele-PTM (PI: Henry)
7. Assessment & Rehabilitation of Central Sensory Impairments for Balance in mTBI (PI: King)
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7. Assessment & Rehabilitation of Central Sensory Impairments for Balance in mTBI

*Last two presentations by Drs. Parrington & Stuart*

- Funded by DoD; PI: Laurie King, PhD
- Drs. Parrington, Stuart, Kampel, Peterka, Pettigrew, & Wilhelm
Noise Outcomes In Servicemembers Epidemiology Study (NOISE Study)

Funded by DoD CDMRP (#PR121146; #JW160036)
PI: James A. Henry, PhD
NOISE Study

Overall Goal: Examine associations between military & non-military exposures (noise, ototoxins, blasts, etc.) & developing auditory-related conditions

- Longitudinal study; ongoing enrollment of Service members & Veterans
- Measures include surveys & comprehensive audiologic assessment
- Two sites: NCRAR & DoD Hearing Center of Excellence on Joint Base San Antonio (TX)
Tinnitus, Hyperacusis, & Hearing Problems

Compared to Veterans w/o TBI, those with TBI are:

• Three times more likely to report tinnitus

• Twice as likely to report a moderate or severe hearing problem
  • With multiple TBIs, likelihood to report mod-severe hearing problem increases to 6 times more likely

• Veterans with moderate-severe TBI are 2.5 times more likely to report hyperacusis
Veterans & Blast-Exposure

• Compared to Veterans without blast-exposure, those who have experienced a blast are two times more likely to report tinnitus or hyperacusis.

• Baseline data on 245 Veterans
  – 44% (108 out of 245) experienced at least one blast
  – 75% (81 out of 108) reported tinnitus
  – 48% (52 out of 108) reported hyperacusis
Impact of these Auditory Conditions

• Communication problems

• Difficulties with job performance

• Associated with concentration problems, poor sleep, anxiety, depression, sound avoidance, social isolation, etc.

• Overall reduced quality of life
## NOISE Study Acknowledgements

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What is Hyperacusis?

• An intolerance of sounds at low-to-moderate intensity levels that would not be considered loud by most people.
What Does “Too Loud” Mean?

• Loudness is the perceptual correlate of the physical intensity of a sound
  – “loudness judgments depend of a variety of other variables & can vary considerably between individual listeners” (pg 176, Behler & Uppenkamp, 2016)

• For a patient with hyperacusis, everyday sounds are intense & overwhelming
  – May include physical discomfort & pain
  – Can have emotional reactions to sounds too
What is Noise Sensitivity?

• “Noise sensitivity refers to the internal states (be they physiological, psychological [including attitudinal], or related to life style or activities conducted) of any individual which increase their degree of reactivity to noise in general” (pg 59 Soames, 1999)

• Heightened awareness of sounds

• Negative “reactions” to noise (annoyance, dissatisfaction)

• NS vs. Hyperacusis: “Loudness” not usually the issue
  • Both can have negative reaction to sounds
Hearing every footstep: Noise sensitivity in individuals following traumatic brain injury

Jason Landon, Daniel Shepherd, Stacey Stuart, Alice Theadom, and Simone Freundlich
Auckland University of Technology, Auckland, New Zealand

Noise sensitivity is an important and under-researched symptom that can result from traumatic brain injury (TBI). Interpretative phenomenological analysis (IPA) was used to analyse the experiences of noise sensitivity of six individuals with TBI. The results revealed four major themes through which participants described a process of having to find information for themselves to understand what they were experiencing and their changed relationship with sounds. The participants also described feeling overwhelmed as they struggled to cope with the changes to their lives and being able to plan and take some control over their lives. The findings are of importance for both health professionals involved in rehabilitation and individuals recovering from TBI.

Keywords: Noise sensitivity; Traumatic brain injury; Post-concussive syndrome; Rehabilitation.
Chronic Effects of Neurotrauma Consortium (CENC)

“Longitudinal Effects of Mild TBI & Other Military Exposures on Auditory Functioning in Recently-Discharged Veterans and Active Duty Service Members – CENC Study 1”

Funded by VA & DoD; PIs: Kathleen Carlson, PhD MPH; James A. Henry, PhD
Co-I: Tim Duncan, MD, neuroradiologist; Maya O’Neil, PhD, neuropsychologist
Study Coordinator: Stephanie Edmunds, MS
CENC Study 1

Overall Goal: Establish large, longitudinal cohort of former U.S. OEF/OIF/OND combatants – focus on mTBI

- Measuring chronic sequelae & comorbidities
- Primary focus: Neurodegeneration & cognitive decline
- Extra focus: Auditory sequelae
- Site: VA RR&D NCRAR and HSR&D Center to Improve Veteran Involvement in Care (CIVIC)
CENC Study 1: Auditory Sequelae

- Audiometric & immittance testing; speech understanding in noise assessment; otoacoustic emissions; tinnitus testing & survey instruments on impact of tinnitus and/or hearing problems on health & functioning

- Review of DoD/VA medical data & injury report(s); self-report health questionnaires; demographics & modeling factors; TBI & PTSD structured interviews; neuroimaging; biomarker test battery; neuroendocrine screen; neuropsychological measures; self-reported symptom & outcome measures; assessment of vision & smell; movement disorder screen; pain rating; evaluation of gait, balance & coordination; (optional saliva sample, blood draw, & neural imaging)
CENC Study 1: Auditory Sequelae

• Results will provide estimates of direct effects of TBI on short- & long-term auditory dysfunction while accounting for potentially confounding factors (noise, ototoxic exposures, PTSD, time-since-injury, etc.)
Central Auditory Processing Deficits Associated with Blast Exposure

Funded by VA RR&D (2012-2016); PI: Frederick (Erick) Gallun, PhD
Marjorie Leek, Robert Folmer, Samantha Lewis, Melissa Papesh, Heather Belding, Michelle Hunter, Tess Koerner
Auditory Processing After Blast

Overall Goals:
1. Develop an accurate estimate of the prevalence of central auditory dysfunction among Veterans exposed to blasts
2. Identify functional outcomes associated with abnormal performance on tests of central auditory processing
3. Improve understanding how blast-exposure resembles & differs from both normal aging & non-blast-related TBI in terms of performance on tests of central auditory processing
Findings

TBI associated with difficulty understanding speech in noisy environments despite normal or near-normal hearing

75% (27/36) of blast-exposed individuals showed abnormal performance on at least 1 test vs. 24% (7/29) of control subjects

47% (17/36) showed abnormal performance on 2+ tests vs. 10% (3/29) of controls subjects

Figure 2(b) page 1014 Gallun et al (2012)
Approaches to Auditory Rehabilitation for Blast-Exposed Veterans

Funded by VA RR&D (#C7054R); PI: Gabrielle (Gaby) Saunders, PhD
Teresa Chisolm, PhD; Melissa Frederick, AuD; ShienPei Silverman, MA; Michelle Arnold, PhD; Paula Myers, PhD
Approaches to Auditory Rehabilitation for Blast-Exposed Veterans

**Overall Goal:** Evaluate effectiveness of audiological rehabilitative interventions for blast-exposed Veterans (OEF/OIF) with normal or near normal peripheral hearing who report more hearing-related difficulties than would be expected.

RCT comparing outcomes of:
- Compensatory communication strategies (CCS) education
- Use of a personal FM system + CCS
- Auditory training + CCS
- Combination of all interventions

Two sites: University of South Florida; VA RR&D NCRAR
Results: Clinical Implications

• Use of FM + CCS showed significant benefit for improving speech understanding in noise & self-reported benefit

• FM + AT + CCS provided more self-reported cognitive benefits than any combination of the other interventions, but more is not necessarily better in terms of compliance

• Using an FM system (or remote mic via Bluetooth system) was beneficial for blast-exposed Veterans with normal or near-normal hearing with functional hearing difficulties

Effects of Blast Exposure on Sensory Gating and Speech Perception in Noise

Funded by VA RR&D CDA-1 (#C1820M); VA Office of Academic Affiliations Advanced Research Fellowship in Polytrauma/TBI Rehabilitation; PI: Melissa Papesh, AuD, PhD
Blast Exposure Impairs Sensory Gating

Overall Goal: Examine neurological cause of auditory deficits that are present in Veterans with normal hearing who have complaints of difficulty understanding speech in noise

- Self-report surveys of auditory & neurobehavioral status
- Auditory perceptual tasks using speech stimuli
- Physiological measures of sensory gating (e.g., prepulse inhibition, habituation of acoustic startle reflex, electrophysiological assessment using sensory gating paradigm)
Sensory Gating: Results

• Blast-exposed Veterans showed significantly reduced habituation to acoustic startle stimuli & impaired cortical filtering of redundant sensory information
  – Physiological measures of sensory gating were significant predictors of performance on a degraded speech perception task
  – Poorer sensory gating influenced by TBI diagnosis
  – Reduced habituation influenced by PTSD diagnosis

Telephone-Based Progressive Tinnitus Management (PTM)

Funded by VA RR&D ; PI: James A. Henry, PhD
Tara Zaugg, Emily Theilman, Christine Kaelin, Caroline Schmidt,
Paula Myers, Garnett McMillan
Overview: Tele-PTM

**Rationale:** TBI is associated with tinnitus & hearing loss
(Gondusky & Reiter, 2005; Lew et al, 2012; Oleksiak et al, 2012)

**Overall Goal:** Evaluate the feasibility & potential efficacy of delivering PTM over the phone for individuals with & w/o TBI

- **Benefits of home-based telehealth:**
  - Allows for frequent & brief one-on-one intervention (helpful for people with memory problems, limited concentration, & other cognitive difficulties associated with TBI)
  - Easily accessible regardless of geographic location
Findings

• Framework of PTM feasible as a telephone intervention

• Adapted in-person visits into 5 telephone sessions:
  • 2 sessions w/ audiologist teaching how to use therapeutic sound
  • 3 sessions w/ psychologist teaching coping skills derived from CBT

• Benefit sustained at least 3 months post-intervention
Overall Take Home Messages

- Patients have difficulty articulating complaints

- Important to ask about these auditory conditions which affect functioning & overall quality of life

- Consider audiological referral when these conditions are identified
Thank You For Listening

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