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PREVALENCE AND AUDITORY EFFECTS OF BLAST-RELATED EAR INJURY IN OPERATION IRAQI FREEDOM

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Naval Health Research Center certifies that this research has been conducted in compliance with all applicable federal regulations governing the protection of human subjects in research (protocol NHRC.2003.0025).



Conflict of Interest

Dr. Erik Viirre is a patent holder and share holder in Tinnitus Otosound Products, a technology company developing equipment for diagnosis and treatment of Tinnitus.



Acknowledgment

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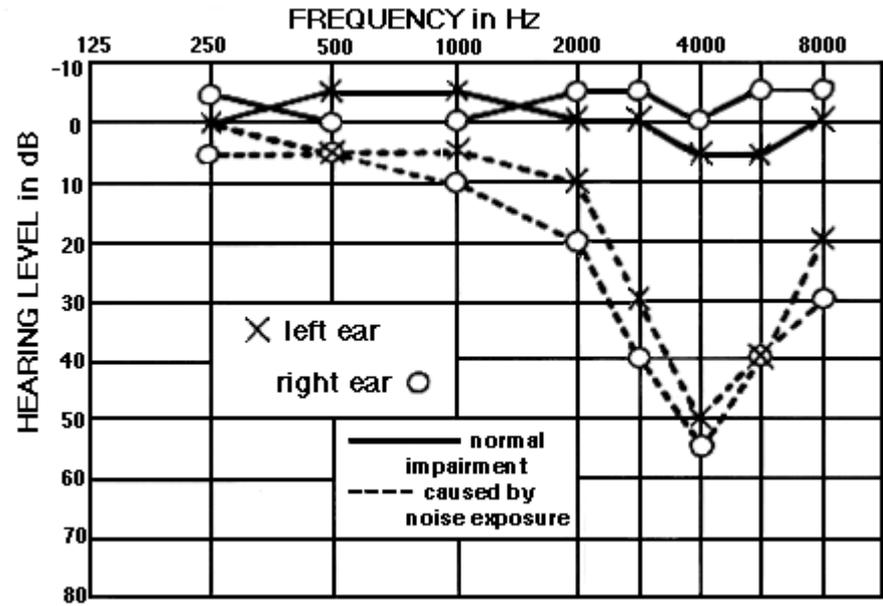
Background

- Approximately 75% of all OEF/OIF casualties are injured in a blast
- The Ear is the most vulnerable and often the 1st organ to sustain primary blast injury
- Anecdotal reports indicate some troops decline to wear hearing protection for fear of reduced situational awareness





Background





Objectives

1. Assess the prevalence and types of blast-related ear injuries among service members from OIF
2. Examine the effect of hearing protection worn during the blast injury event
3. Identify auditory outcomes associated with blast-related ear injuries within 1 year after injury



Data Source

- The Expeditionary Medical Encounter Database (EMED) was used to identify service members who survived blast-related injury in OIF from 2004-2008
 - EMED is a Navy-Marine Corps dataset from far-forward reports through all levels of continuity of care
- Demographic and injury-specific information nearest the point of injury, including hearing protection status, was obtained
- Abbreviated Injury Scale (AIS) codes were used to identify injury to the internal organs of the ear
 - Service members without these codes were placed in the non-ear/other injury comparison group



AIS Ear Injury Codes

- Ear injury, not further specified (240299.1)
- Ear canal injury (240204.1)
- Inner/middle ear injury, not further specified (240208.1)
 - bilateral (240207.1)
 - injury involving dizziness (240206.1)
 - injury involving tinnitus (240205.1)
- Ossicular chain (ear bone) dislocation (240212.1)
 - bilateral (240213.2)
- Tympanic membrane (eardrum) rupture (240216.1)
- Vestibular apparatus injury (240220.1)

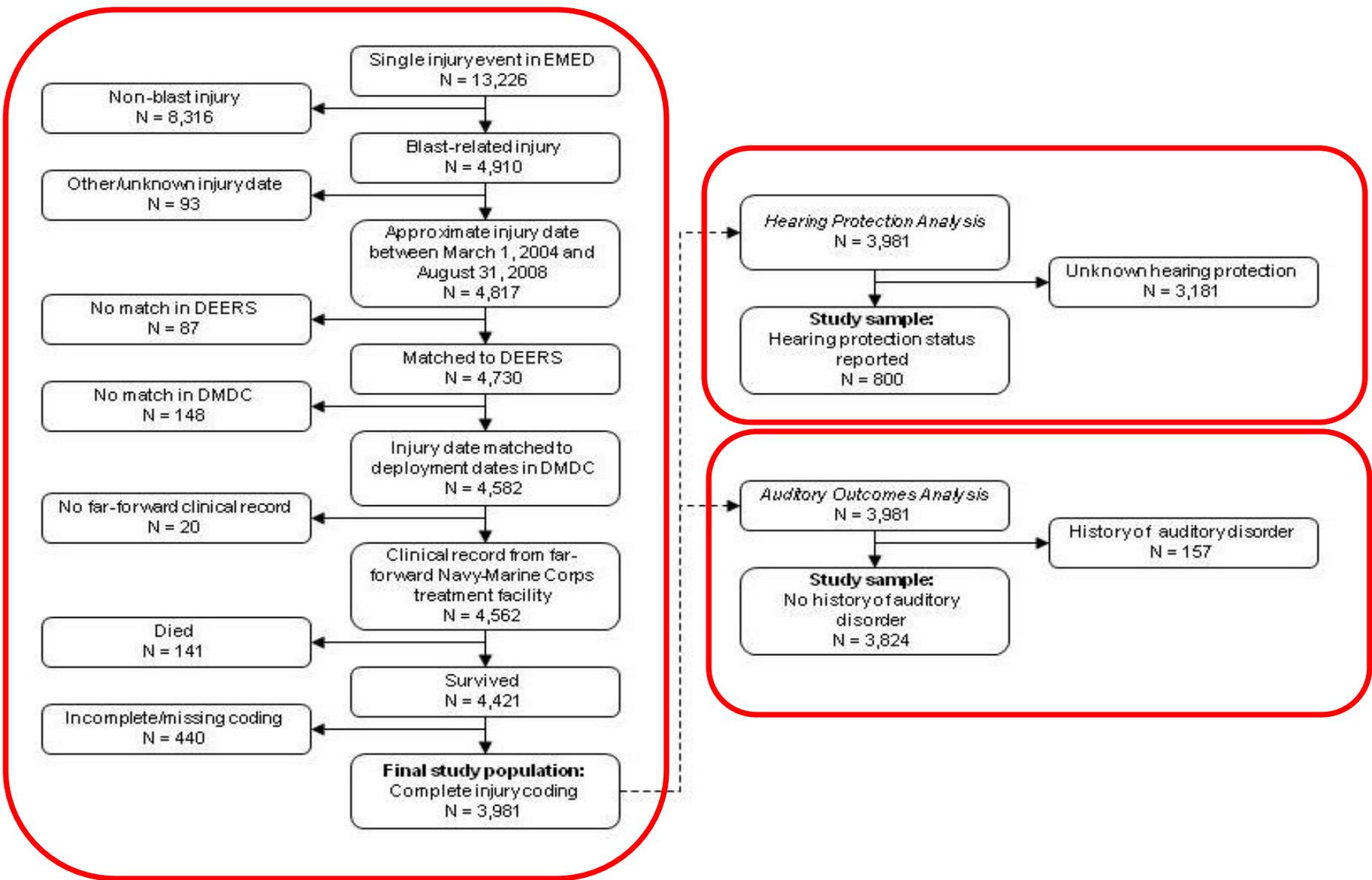


ICD-9-CM Outcome Codes

- EMED data were linked with outpatient records in the Military Health System to obtain hearing loss and tinnitus ICD-9-CM diagnosis codes for each patient
 - Hearing loss: 389.0-.9
 - Tinnitus: 388.3-.32



Exclusion Criteria & Sample Selection





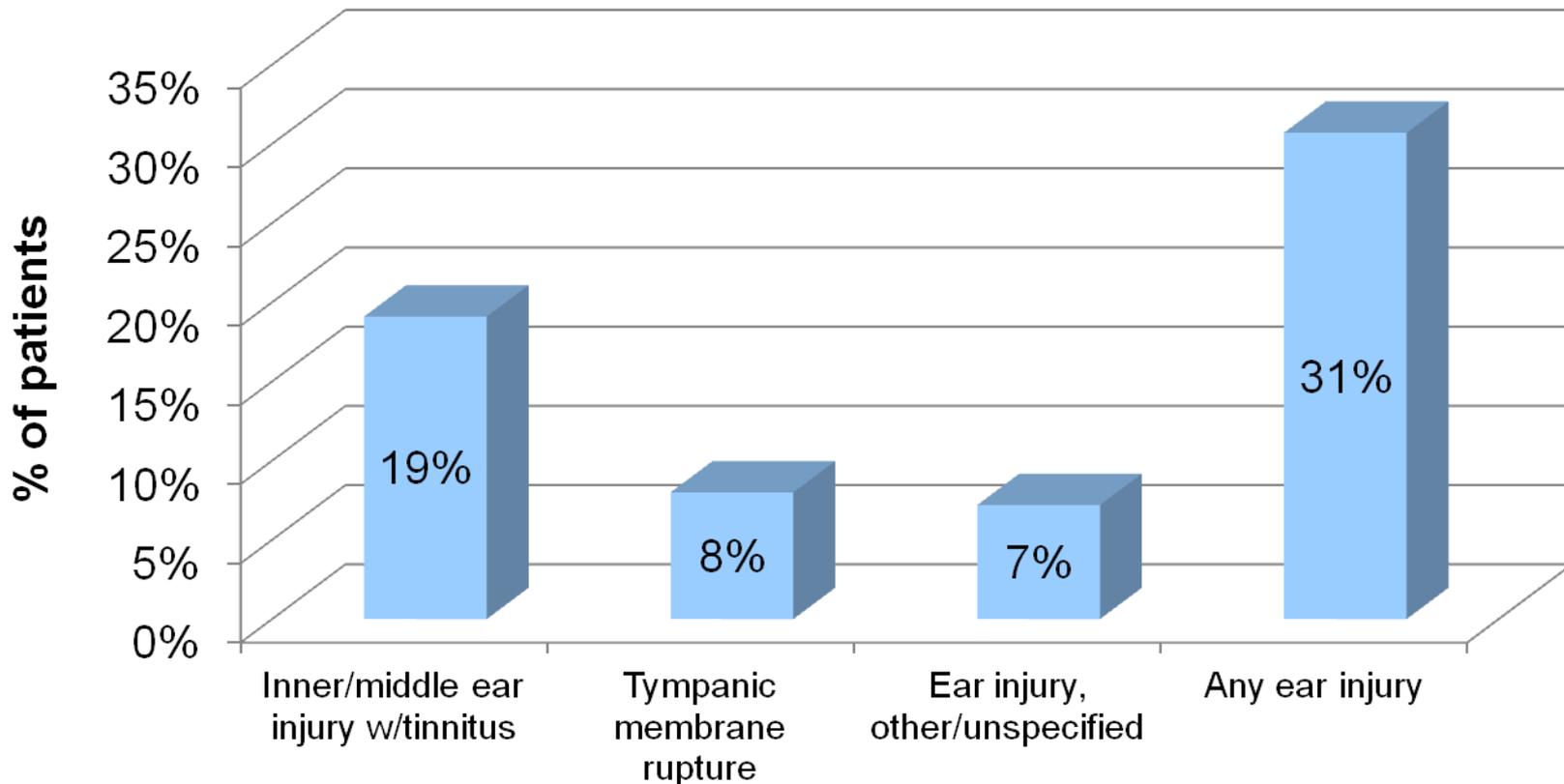
Statistical Analysis

- Ear injury prevalence
- Multiple logistic regression was used to examine:
 1. Effect of hearing protection on specific ear injuries (n=800)
 - Excludes 3181 pts without unknown HP status
 2. Association between specific ear injuries, hearing loss and tinnitus outcomes within 1 yr after injury (n=3824)
 - Excludes 157 pts with Hx of hearing loss or tinnitus



Ear Injury Prevalence

- 31% of pts (1223/3981) were diagnosed with blast-related ear injury in theater





Hearing Protection Analysis

- HP data available for only 20.1% of the study population (n=800)
 - Of these, 391 (48.9%) were wearing hearing protection at the time of injury
 - Type of protection not specified
- Non-wearers were younger, Marines, enlisted, and infantry



Hearing Protection Effects

- In multivariate analysis, hearing protection:
 1. Reduced the odds of inner/middle ear injury involving tinnitus
 - OR = 0.57, 95% CI = 0.39-0.82
 2. Was not statistically associated with TM rupture
 - OR = 0.86, 95% CI = 0.46-1.92



Auditory Outcomes Analysis

- 3824 service members without Hx of hearing loss or tinnitus included
 - 444 (11.6%) diagnosed with hearing loss within 1 yr after injury
 - 233 (6.1%) diagnosed with tinnitus within 1 yr after injury



Auditory Effects of Ear Injury

- Hearing loss outcome
 - In multivariate analysis:
 - Blast-injured service members with TM rupture had higher odds of hearing loss than those with other injuries
 - OR = 6.65, 95% CI = 5.04–8.78
 - Inner/middle ear injury involving tinnitus was not associated with subsequent hearing loss diagnosed within 1 yr after injury
 - OR = 1.11, 95% CI = 0.82-1.51



Auditory Effects of Ear Injury

- Tinnitus outcome
 - In multivariate analysis, both TM rupture and inner/middle ear injury w/ tinnitus were associated with increased odds of tinnitus outcome diagnosed within 1 yr after blast injury
 - TM rupture: OR = 4.34, 95% CI = 3.12-6.04
 - Inner/mid ear inj w/tinnitus: OR = 1.56, 95% CI = 1.11-1.20



Key Findings

- Blast-related ear injury is common in service members from OIF
- Hearing protection reduced the odds of inner/mid ear injury w/ tinnitus, but not TM rupture
- Hearing loss outcome was associated with TM rupture, but not ear injury w/tinnitus
- Tinnitus outcome was more strongly associated with TM rupture than ear injury w/tinnitus



Previous Literature

- Lower estimates of overall ear injury prevalence after combat blast injury (Breeze et al., 2011)
 - Varying definition of ear injury, no previous study included AIS tinnitus injury code
- Xydakis et al. (2007) found protective effect of hearing protection for TM rupture
 - Information on type was not available for this study, different types of modern hearing protection may confer more/less protection
 - Jonsson (1990) found ear plugs more protective against air shock waves than ear muffs
- TM rupture requires greater pressure differentials [higher magnitude blast] than damage to the inner ear (Mrena et al., 2004)
 - Not surprising that TM rupture was found to be more strongly associated with hearing-related morbidity
- References available upon request



Clinical Implications

- Ear/Hearing related injury is an essential evaluation in blast related injury.
- TM rupture is a measure of blast severity.
- Hearing Protection status needs to be documented.
- Long-term follow-up of hearing status is necessary after initial hearing/ear related blast injury.



Strengths and Limitations

Strengths

- First study to report the incidence of tinnitus diagnosed from field medical reports
- EMED
 - Point of injury clinical information allowed for correlation of battlefield data with long-term auditory outcomes
- Able to exclude pts with hx of hearing loss and tinnitus from outcome analysis

Limitations

- AIS tinnitus code
 - Symptom-based diagnosis may have overestimated ear injury prevalence
 - Tinnitus could also be due to head injury or ototoxic meds
- Missing data
 - Type of hearing protection was not reported and may be critical in TM rupture injuries
- Outcome data from MHS
 - Medical utilization bias



Conclusions

- Ear injuries should be closely monitored in-theater and throughout the continuum of care in order to identify hearing-related morbidity that can impact service members' operational readiness
- Otoscopic and hearing examinations should be considered for all blast-injured service members in order to diagnose and treat service members with ear injury
- Future studies should assess the validity of the tinnitus injury diagnosis with otoscopic evaluations and other audiometric measures, and control for the effect of alternative causes of tinnitus