DOI: 10.61782/fa.2025.0172

FORUM ACUSTICUM EURONOISE 2025

BEYOND THE STANDARD AUDIOGRAM: THE NEED FOR COMPREHENSIVE ASSESSMENT OF COMBAT NOISE AUDITORY TRAUMA

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ABSTRACT

Combat noise exposure poses significant risks to auditory health, including high-frequency sensorineural hearing loss, synaptopathy, and central auditory processing deficits. However, sometimes, combat noise acoustic trauma results in undetectable damage using standard audiometric evaluations. Such impairments, frequently caused by blast-related injuries, may manifest as difficulty in understanding speech in noise, tinnitus, or other auditory complaints, even when conventional audiograms indicate normal thresholds. This work emphasizes the need for comprehensive audiological protocol designed to address these diagnostic limitations. The protocol should integrate conventional and extended high-frequency audiometry, otoacoustic emissions, speech-in-noise testing, and immittance measures while incorporating patient-reported outcomes and detailed noise exposure histories. Utilizing a multifaceted approach, this protocol aims to identify subtle auditory dysfunctions and provide clinicians with robust tools for early diagnosis and targeted management. Clinical examples highlight the necessity of each of these auditory tests. The diagnostic protocol should emphasize the clinical importance of thorough auditory evaluations. It should enable the detection of subclinical impairment and supports tailored rehabilitation strategies. It also highlights the need for continuous monitoring of at-risk populations. These suggestions advocate for a shift in the clinical perspective in evaluating and caring for individuals exposed to combat, with implications for clinical and operational settings.

Keywords: *combat noise, auditory complaints, hearing loss, diagnostic protocol.*

INTRODUCTION

Combat noise exposure, particularly from blasts, firearms, and explosions, is a distinct form of acoustic trauma that can result in complex and multifactorial auditory damage. Unlike continuous industrial or environmental noise, combat noise often involves short-duration, high-intensity pressure waves that may lead to both peripheral and central auditory injuries. These include, cochlear damage, disruptions at the level of the auditory nerve or brainstem, and if blast is involved tympanic membrane perforation and ossicular chain disarticulation [1]. Additionally, exposure to blast waves may also result in vestibular dysfunction and

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concomitant mild traumatic brain injury (mTBI), further complicating the clinical presentation [2–4].
Individuals exposed to such noise frequently report a range of auditory symptoms: tinnitus, hyperacusis, decreased sound tolerance, auditory fatigue, and difficulty understanding speech in noisy environments. While some may present with measurable hearing loss, others show normal audiograms despite persistent functional difficulties. This has given rise to the concept of "hidden hearing loss," referring to synaptic or neural damage undetected by standard pure-tone testing [5,6]. Understanding the full range of potential auditory pathologies resulting from combat noise is essential to developing appropriate diagnostic and rehabilitation strategies.

CLINICAL GAP AND DIAGNOSTIC CHALLENGE

Current clinical practices remain heavily reliant on pure-tone audiometry as the primary diagnostic tool. This creates a substantial gap in care: individuals who report persistent auditory difficulties, such as difficulty understanding speech in noise, sensitivity to sound, or auditory fatigue, are told their hearing is "normal" based solely on standard thresholds. As a result, they are often left without diagnosis, treatment, or acknowledgment of their difficulties [3,4].
This diagnostic limitation has important clinical implications. In current practice, medical treatment for acoustic auditory trauma and the subsequent eligibility for treatment and compensation, is typically contingent upon the demonstration of hearing loss in standard audiometry [7,8]. However, individuals who report significant auditory symptoms following combat noise exposure, such as difficulty hearing in noise or tinnitus, may show normal pure-tone thresholds [9,10]. As a result, these individuals are often not diagnosed with hearing damage and do not receive appropriate treatment or rehabilitation services. This reliance on the audiogram as the primary diagnostic criterion creates a gap in care for patients with functional auditory impairments that remain "invisible" to conventional testing.
A shift in clinical perspective is urgently needed. Rather than relying exclusively on audiometric thresholds, clinicians should adopt a more functional, patient-centered approach that validates subjective complaints and incorporates a broader range of diagnostic tools. Only by acknowledging the limitations of conventional testing can we begin to close the gap between patient auditory complaints and clinical action.

TOWARD A STRUCTURED ASSESSMENT APPROACH

To effectively identify and manage the spectrum of auditory dysfunctions associated with combat noise exposure, a more comprehensive and structured assessment protocol is needed. While pure-tone audiometry provides valuable information about threshold sensitivity, it fails to detect many of the suprathreshold deficits that impact real-world communication, particularly in noisy or cognitively demanding environments. Clinical evidence supports the need for advanced diagnostic tools such as extended high-frequency audiometry (EHF), speech-in-noise tests and distortion product otoacoustic emissions (DPOAEs) which offer critical insights into auditory integrity.
An essential component of such protocols is the use of a dedicated case history (structured auditory anamnesis) designed specifically for individuals exposed to combat noise. Unlike general intake forms, this targeted anamnesis includes questions about the acoustic characteristics of the exposure (e.g., blast proximity, use of hearing protection), timing and progression of symptoms, co-occurring complaints such as tinnitus or sound intolerance, and contextual factors like post-exposure stress or cognitive fatigue. It also considers prior auditory health and service-related functional impairments. This information is vital for tailoring the diagnostic approach and for differentiating between peripheral, central, and non-auditory contributors to the patient's complaints.
This suggested protocol integrates traditional and advanced audiological measures, along with the dedicated anamnesis, in a tiered manner. It guides clinicians through the diagnostic process while validating patient complaints that may otherwise be overlooked. Importantly, the protocol is designed not only to improve diagnostic accuracy but also to inform rehabilitative planning, ensuring that patients with normal audiograms but real functional deficits receive appropriate care.
Implementing such models represents a critical evolution in clinical audiology—one that aligns diagnostic strategies with the complexity of auditory trauma and bridges the longstanding gap between subjective experience and objective findings.

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