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Concussion Management Guidelines Neglect Auditory Symptoms

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Abstract

Tinnitus, noise sensitivity, and hearing difficulties are commonly reported secondary to head injury. These auditory deficits have been shown to negatively impact daily functioning, and yet, often go unnoticed by health care professionals. The purpose of this editorial is to explain why it is essential for clinical practice guidelines that address the management of patients who have experienced a head injury to incorporate assessment and rehabilitation of auditory symptoms.

Keywords

Hearing Disorders; Tinnitus; Noise; Practice Guideline

Background

Evidence-based guidelines are essential to promote and provide best practices. They present a logical framework for clinicians to find established criteria for diagnostic purposes and treatment recommendations. Unfortunately, many published guidelines for the assessment and management of patients with traumatic brain injury (TBI) or concussion fail to synthesize current knowledge pertaining to the occurrence of auditory symptoms at the time of injury, or the recovery timeline for these symptoms (Gómez & Hergenroeder, 2013; Doperak et al, 2019; Harmon et al, 2019; Rebbeck et al, 2019; Scorza et al, 2019; Silverberg et al, 2019).

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The underlying mechanisms for many auditory symptoms following head injury are poorly understood, which complicates classifying these symptoms as either “post-TBI-related” or in the case of mild TBI (mTBI), “post-concussive-related.” Identifying auditory symptoms that manifest secondary to head injury will aid in the assessment and treatment of these conditions. Most importantly, and the main issue addressed in this editorial, is that there are a number of auditory deficits besides vestibular injury that occur secondary to head injury, and yet, often go unnoticed by health care professionals.

Auditory Symptoms

The primary auditory symptoms associated with head injury are tinnitus, noise sensitivity, and difficulty understanding speech in complex listening environments (i.e., auditory processing deficits; Papesh et al, 2018). There is a growing body of literature reporting these auditory symptoms following sports-related head injuries, blast-injuries, falls, and motor vehicle accidents (Bergemalm & Borg 2005; Turgeon et al., 2011; Gallun et al, 2012; Saunders et al, 2015; Biały ska & Salvatore, 2017; Gallun et al, 2017; Hiploylee et al, 2017; Papesh et al., 2018).

Despite many attempts to create symptom profiles and subtypes to assist in the management of concussion patients, a clinical consensus on this subject does not currently exist (Reynolds et al, 2014). While many concussion subtypes include a vestibular category, rarely do they include an auditory category. Often, meta-analytic approaches are used to identify subtypes, but this effort is hindered by poor documentation of auditory symptoms in the majority of studies. Emphasizing this point, Lumba-Brown et al (2020) acknowledge an auditory subtype of concussion exists, but is not commonly assessed. Due to the heterogeneity of concussion symptom profiles, persistence of auditory symptoms post-head injury beyond expected physiologic recovery thresholds (i.e., three months) could refine classification processes of TBI and concussion subtypes. Taking this into consideration, screening for common auditory symptoms as part of the clinical interview might greatly assist with the clinical management of TBI and concussion patients (see Table 1).

Treatment Considerations

Screening patients for tinnitus, noise sensitivity, and hearing difficulty following head injury will aid the clinician in providing targeted rehabilitation to best meet the patient’s needs. When patients screen positive for one or more of these issues, it is important to determine if the auditory symptom(s) occurred pre- or post-head injury, and for any symptoms that were pre-occurring, to ask if they became exacerbated. Referral to an audiologist or otologist is recommended for these patients as these healthcare professionals are uniquely trained to diagnose and treat auditory conditions. For example, hearing loss is not uncommon following closed head injury (Bergemalm, 2003; Tambs et al, 2003) and both structural and functional changes that occur in the peripheral and central auditory system post-head injury contribute to many of the auditory symptoms reported by patients. In these instances, provision of hearing aids may improve patients’ symptoms and ability to communicate. However, many patients will experience symptoms in the absence of hearing loss (Bergemalm & Borg, 2005; Vander Werff, 2016). For these patients, additional testing

may be recommended to aid with a differential diagnosis, such as tests of speech-in-noise comprehension or other tests of auditory processing (Tepe et al, 2020).

Many of the auditory symptoms reported following head injury have subtypes and identifying these features can help to guide treatment protocols. For example, when tinnitus occurs secondary to head injury, the perceptual attributes (i.e., loudness, pitch, timbre) may change following head and neck maneuvers, forceful muscle contractions or jaw movements. This clinical phenotype is classified as somatosensory tinnitus (Michiels et al, 2016; Ralli et al, 2017). Patients with somatosensory tinnitus often have an underlying biomechanical deficit, such as temporomandibular joint dysfunction, or injury to their cervical spine, that may trigger or exacerbate the tinnitus. In these instances, patients may benefit from individualized physiotherapy to address both the tinnitus and underlying musculoskeletal issue simultaneously (Sanchez & Rocha 2011; Cherian et al, 2013; Cote et al, 2019).

Among patients describing decreased sound tolerance, which includes noise sensitivity and hyperacusis, it is important to differentiate if the primary complaint is related to the “loudness” of everyday sounds, suggestive of hyperacusis, or a broader issue involving multiple factors that contribute to being overwhelmed by all the “noise.” Hyperacusis is an intolerance of sounds at low-to-moderate intensity levels that may include physical discomfort, stress, and anxiety (Aazh et al, 2016). Noise sensitivity addresses an individual’s reactivity to noise, theorized to be a manifestation of a state of hyperarousal resulting in negative attitudes to sound including annoyance and feelings of being overwhelmed (Shepherd et al, 2019). However, because distinguishing auditory signals such as speech from background noise is a particularly challenging task for the central auditory system, patients may also endorse symptoms of noise sensitivity stemming from poorer auditory functioning in environments with competing noise sources following head injury (Tepe et al., 2020). Thus, asking the patient to give examples is necessary to distinguish hyperacusis from noise sensitivity and hearing difficulties related to background noise. There are multiple types of decreased sound tolerance conditions and they are not mutually exclusive (Theodoroff et al, 2019).

Patients with noise sensitivity should consistently use hearing protection when exposed to loud sounds (e.g., band practice, concerts), but using hearing protection in quiet environments (e.g., classrooms) can result in the auditory system becoming more sensitive, not less (Formby et al, 2003). In some instances, it may be appropriate for patients to initially use hearing protection sparingly in quiet environments and slowly reintroduce listening to sounds at tolerable levels. When patients reacclimate to environmental sounds in this fashion, it is essential to monitor that using hearing protection in this way does not exacerbate their auditory symptoms.

Summary

Due to the complex clinical presentation of patients with head injuries, auditory symptoms may not receive equivalent attention as other clinical signs and symptoms. This fact, along with the lack of familiarity regarding these auditory symptoms, results in many missed

opportunities to delineate the type and nature of auditory symptoms relevant for treatment triage. Additionally, because patients may find it difficult to articulate their complaints and experiences, many symptoms and their negative consequences often go unaddressed (Landon et al, 2012). Further, a lack of consistent terminology used to describe auditory symptoms associated with head injury (e.g., hearing difficulty, auditory processing deficits, noise sensitivity, phonophobia, hyperacusis) contributes to this problem. Due to various terms being used in different disciplines and the lack of a gold standard to diagnose many of these conditions, it is challenging to estimate the prevalence of auditory symptoms in this patient population.

In contrast to the sports medicine literature, there are many accounts of auditory symptoms documented for military service-related head injuries, most likely because of the inherent co-occurring noise exposure with those events (Theodoroff et al, 2015). This is also evident in the joint Department of Veterans Affairs (VA) and Department of Defense (DoD) clinical practice guidelines for the management of mTBI, which uses an algorithm-based stepped-care approach to derive appropriate assessment and management plans for each patient. Auditory symptoms are listed in the category of physical symptoms post-head injury, but specific management recommendations are not made due to a lack of published scientific findings. Therefore, to provide the necessary evidence to inform clinical care decision-making, research is critically needed to address the auditory symptoms and deficits that are caused or exacerbated by head injury.

Although the mechanism of injury might vary for mTBI associated with blasts compared to sports-related injuries, both types of exposures result in auditory symptom reporting (Knoll et al, 2020; O'Connor et al, 2017; Wasserman et al, 2016). It is noteworthy that 92% of a cohort with non-blast mTBI (e.g., motor vehicle accident, falls, sports-related, etc.) endorsed auditory symptoms (Knoll et al, 2020). In comparison, an ongoing chart review of over 1000 patients seen at the Oregon Health & Science University Concussion Clinic has similarly revealed that over 50% of those diagnosed with concussion endorsed one or more auditory complaint at their intake appointment. These data suggest auditory symptoms occur secondary to a variety of head injuries and are not particular to a specific mechanism of injury. This work highlights the need to develop an auditory subtype to complement the other more established subtypes mentioned in clinical practice guidelines to date.

It is essential to increase the research and clinical efforts to address the taxonomy of auditory symptoms associated with head injury, as well as the temporal recovery gradient of specific symptoms or clusters of symptoms, and how auditory symptoms may or may not relate to other injury/individual characteristics. Research is needed to better isolate the mechanism of injury that gives rise to auditory symptoms associated with head injuries. Identifying the separate peripheral versus central auditory deficits that result in these symptoms will also help to explain patient-specific characteristics and risk factors for these conditions. Additionally, it is likely a combination of peripheral, subcortical, and cortical maladaptive changes that result in the persistence of these auditory symptoms months after the head-injury.

Addressing these unanswered questions will help fill the gaps in our knowledge of the etiology, clinical manifestation, and associated risk factors for post-head injury auditory symptoms. In addition to our goal of highlighting and characterizing the auditory consequences associated with head injury, immediate next steps are to (1) further develop a model-based auditory subtype of concussion and (2) involve the scientific and clinical community to gain consensus on how this information will assist with patient assessment and recovery from injury. These efforts are necessary to inform best practices and update clinical practice guidelines for the management of patients with TBI and concussion.

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Table 1.

Common auditory symptoms associated with concussion defined and suggested screening questions.

Auditory Symptom	Definition	Screening Question
Tinnitus	Perception of sound in the absence of an external [acoustic] source.	Do you experience ringing in the ears (tinnitus) that lasts for at least 5 minutes?
Noise Sensitivity	General intolerance to everyday sounds that encompasses a range of psychological attributes that contribute to the degree an individual is reactive to noise.	Do you have a problem tolerating sounds because they often seem too loud or bother you for other reasons?
Hearing difficulty	Trouble understanding speech or other sounds in quiet or noisy environments.	Do you have any difficulties understanding speech or other sounds? Do you feel like you have more difficulties hearing in noise compared to others?

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