The Medical Aspects of Noise Induced Otologic Damage in Musicians

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Review of the medical and audiologic literature indicates that MIHL occurs among musicians, with varying incidences ranging up to 58% in classical musicians and up to 30% in rock/pop musicians. In addition, studies show that musicians routinely face sound pressure levels (SPLs) in potentially hazardous ranges, extending up to 120-130 dBA only 3 feet from the speaker in amplified rock/pop bands, 83-112 dBA on stage in various orchestras, and 80-101 dBA on stage in jazz, blues, and country and western bands.

Damage to the ear from loud noise exposure is a phenomenon that has been known about in the hearing health care community for over 100 years. Of the over 28 million people in the United States afflicted with hearing loss, approximately 10 million of these impairments are attributed to damage from exposure to loud noise.[1] However, adverse medical conditions arising from this type of damage are not limited to hearing loss alone. For example, according to the American Tinnitus Association (ATA), over 50 million Americans experience some degree of tinnitus, with 12 million severely affected enough to seek medical attention. While the possible etiologies of tinnitus are multiple, loud noise exposure is well recognized as one of the most common causes. Disorders associated with noise induced otologic damage (NIOD) exist among musicians. In one recent study, manifestations of one or more of these disorders were found in 74% of the 139 rock/jazz musicians studied.[2] The implications of NIOD are important for all of us, but they are of particular importance to musicians. Musicians' hearing requirements, as related to their livelihoods, are much greater than those of other professions, and their hearing-related injuries can become severe disabilities or even career-ending.

The purpose of this article is to familiarize the hearing health care professional with the medical conditions comprising NIOD (Table 1) as

they relate to musicians, as well as the medical evaluation and treatment of the musician afflicted with such an injury.

Table 1. Medical Conditions Comprising NIOD
Noise-Induced Hearing Loss
Tinnitus
Hyperacusis
Recruitment
Diplacusis
(Vertigo and Dysequilibrium)

Types of Noise Induced Hearing Loss and Mechanisms of Injury

A short review of the types and pathophysiology of noise induced hearing loss (NIHL) is warranted. There are two types of hearing damage that can occur from noise.[1] The first type, called acoustic trauma, is an immediate, severe, and permanent hearing loss resulting from a sudden blast of extremely intense or loud sound (eg, gunshot or explosion) causing physical disruption of the inner ear structures. The second type, what we typically refer to as NIHL, is a gradual hearing loss that results from chronic loud noise exposure. Temporary threshold shift refers to NIHL of brief duration, lasting several hours to days. Irreversible NIHL, termed permanent threshold shift, may develop after many years of exposure. The degree of NIHL is determined by intensity, duration of exposure, spectral characteristics of the noise, and individual susceptibility.[3] NIHL is the leading occupational disorder.

There are two general theories about the mechanism of injury in NIHL within the cochlea. The first proposes the concept of accumulated microtrauma and physical damage to the hair cells and/or their supporting structures. The second attributes the injury to metabolic exhaustion causing an accumulation of damaging free radicals and oxidants which, in turn, overwhelm the antioxidant buffering capacity of the cells, leading to cell death.[4]

Music Induced Hearing Loss

Gradual hearing loss resulting from chronic loud music exposure is termed music induced hearing loss (MIHL). Review of the medical and audiologic literature indicates that MIHL occurs among musicians,[5-

[9] with varying incidences ranging up to 58% in classical musicians[10] and up to 30% in rock/pop musicians.[11] In addition, studies show that musicians routinely face sound pressure levels (SPLs) in potentially hazardous ranges, extending up to 120-130 dBA only 3 feet from the speaker in amplified rock/pop bands,[11]83-112 dBA on stage in various orchestras,[12] and 80-101 dBA on stage in jazz, blues, and country and western bands.[13] These levels and the fact that many musicians practice or perform 4-8 hours a day suggest a strong causal relationship between their chronic loud music exposure and their NIHL.

It is well known that the difficulty in speech comprehension, especially in the presence of background noise, seen in NIHL is secondary to hearing loss in the high frequencies. Performing artists are not immune to this problem as well. However, high-frequency hearing loss is particularly detrimental for musicians and singers because they must also accurately match frequencies over a broad range, including frequencies above those required for understanding speech. High-frequency hearing loss may lead to excessively loud playing at higher pitches. It can also lead to arm and wrist strain as in the example of the violinist who, in order to compensate for his hearing loss, may bow harder or "overbow."13 In addition, enjoyment of music can be compromised with loss of sound color and clarity, especially in the high tones.

Unlike industrial NIHL, MIHL in a musician often is asymmetric—probably relating to the position of their instruments (or others' instruments) to their ears. In the rock drummer, for instance, it tends to be worse in the left ear owing to its closer proximity to the high-hat cymbals. It also tends to be worse in the left ear of violinists and worse in the right ear of flute and piccolo players. Because of this imbalance, it is not unusual for these musicians to complain of distortion even in their better ear.13

Tinnitus and Hyperacusis as a Component of MIHL

Tinnitus, the perception of sound in the ears when no external source exists, is the most common condition accompanying NIHL. According

to the ATA, up to 90% of all tinnitus patients have some degree of NIHL. It is usually high-pitched and commonly precedes subjective awareness of hearing loss. Hyperacusis is defined as a hypersensitivity or decreased tolerance to normal sound. It frequently accompanies tinnitus, and like tinnitus, it can present before any hearing loss is realized.

Tinnitus can get so loud and/or hyperacusis can cause such severe discomfort that they can be more debilitating than the hearing loss itself. Numerous rock musicians have admitted to suffering from tinnitus to the point that they have limited their live performances or retired from the music industry altogether. In one recent study, tinnitus was found in 37% and hyperacusis in 43% of classical musicians within a study group consisting of five major orchestras.[14] While particularly damaging to the players of string instruments—especially higher-pitched instruments (eg, violins)—tinnitus and hyperacusis pose a severe threat to any musician as continued exposure to music at any volume level can potentiate their intensity and intolerability.

Recruitment and Diplacusis

Recruitment is characterized by a sharp increase in a sound's perceived loudness after only a relatively small increase in the sound's actual intensity. Thus, even mildly loud sounds from the musician's instrument may cause him/her to perceive it as painfully loud. Diplacusis is when an increase in a frequency of a particular sound is perceived only as an increase in loudness; the perceived pitch stays the same. This may cause a musical note to sound flat or cause a musician to play out of tune.

Vertigo and Dysequilibrium

While vertigo and dysequilibrium are not common or well recognized manifestations of NIOD, several studies over the last 10 years have suggested loud noise exposure as a possible cause for vestibular damage.[15]Of particular interest is the 2001 study by Goltz et al[16] who found clinical evidence of vestibular damage among 258 military subjects exposed to intense noise only when there is asymmetric hearing loss. This is of concern for musicians as MIHL is often asymmetric.

Medical History

In obtaining a medical history from the musician, the otolaryngologist must determine if any of the conditions discussed are present and, if so, the date of onset, type of onset, subsequent progression, and the presence of other otologic symptoms (otalgia and otorhea). In those patients presenting with tinnitus, an inquiry is made as to whether the tinnitus is intermittent, continuous, or pulsatile.

Table 2. Factors that Contribute or Predispose to NIHL
Genetic Susceptibility
Smoking
Presbycusis
Age
Risk Factors for Cardiovascular Disease
Diabetes Mellitus
Hyperlipoproteinemia
Gender
Ototoxic Drugs

Factors known to contribute to or predispose to NIHL (Table 2) should be sought. Diseases known to cause other types of hearing loss (eg, stroke, head trauma, syphilis, cardiovascular disease, retrocochlear neoplasm, severe hypothyroidism, and autoimmune disorders) and tinnitus (temporomandibular joint dysfunction and depression) should be addressed. A review of past medical history must include inquiry into any otologic disorders and medication history, especially aspirin, nonsteroidal anti-inflammatory, or ototoxic drug use.

The medical history must include a detailed noise exposure history. For a musician, not only does it include the number of years playing, but also his/her typical practice and performance schedule history, position of instrument, position in relation to the other musicians, or amplifiers/speakers/monitors, and the use of hearing protection. Non-occupational sources of noise should also be discussed.

Physical Examination

A general head and neck physical examination is performed with special attention to the otologic exam. Pneumatic otoscopy, tuning forks, and microscopic visualization should be included. Otoneurologic

examination may be needed if symptoms indicate. Radiographic exams (MRIs and CT scans) and disease-specific blood tests may need to be ordered if any of the previously noted diseases are suspected. Audiometric assessment and, if warranted, vestibular function tests are subsequently obtained.

Treatment of NIHL/MIHL

Currently, there is no FDA-approved medical therapy to treat or prevent NIHL. However, advancements in the preclinical, animal-based investigations of compounds (especially antioxidants) showing otoprotective capability against noise have led to the recent development of clinical drug trials. The most promising of these treatments involve agents that boost the cell's own antioxidant capacity (ebselen and N-acetylcysteine) or magnesium supplements. It is quite possible that safe, effective, orally-administered drugs may be approved within the next 5 years as the first medications used to either prevent or treat NIHL.4 Until then, treatment for MIHL among musicians remains rehabilitative employing the use of hearing instruments (as discussed by Chasin in this issue of The Hearing Review). Means of prevention should be discussed, including high-fidelity hearing protection devices and hearing protection measures for musicians.[13] Additionally, all musicians should be advised to refrain from unprotected, non-occupational loud noise exposure and ototoxic medication. Medical disorders that contribute or predispose to NIHL (as discussed) should be medically treated.

Table 3. Treatment Options for Tinnitus

Amplification (Hearing Aids)
Biofeedback
Counseling
Drug Therapy
Antidepressants
Antianxiety agents

- Antihistamines
- Anticonvulsants
- Anesthetics

Electrical Stimulation

Homeopathic Therapy

- Niacin
- Histamine
- Ginkgo biloba
- Vitamin B
- Magnesium or Zinc
- Acupuncture

Masking

Tinnitus Retraining Therapy

Temporomandibular Joint Treatment

The medical management of musicians with tinnitus and hyperacusis depends primarily on the severity of the condition. Table 3 summarizes the current treatment options for tinnitus. Attempts have been made to determine which options to employ based on the degree of tinnitus as perceived by the patient utilizing the Tinnitus Handicap Inventory.[17] While, at the present time, no drug has been shown to cure tinnitus, many studies indicate that certain medications can reduce the tinnitus severity for some patients. The most common medications used are amitriptyline (Elavil), alprazolam (Xanax), diazepam (Valium), and histamine.[18] All of these medications possess side effects (eg, sedation, dry mouth, etc) that may adversely affect a musician's performance, and therefore must be discussed with the musician and monitored.

The treatment that is of special interest and which seems to be the most popular among tinnitus centers in the United States and Europe is Tinnitus Retraining Therapy (TRT). Developed by Jastreboff & Hazell,[18] it is an outgrowth of the neurophysiologic theory of tinnitus. TRT uses a combination of counseling and low level, broadband noise delivered through wearable noise generators to achieve the habituation (to grow unaware) of tinnitus, except when they focus their attention on it (though, even then, not bothersome). Jastreboff has treated over 800 patients and reports a success rate of 82%,18 a result which has been substantiated by various reports worldwide.

Current treatment options for hyperacusis are limited. TRT is the most successful means of treating hyperacusis with 80-90% of patients reporting marked improvement. An alternative method is de-sensitization utilizing low frequency sound, or pink sound, delivered

either through special fitted sound generators or on a compact disc. While not curative, antidepressants and anti-anxiety medications may be needed to aid the patient in coping with their hyperacusis.

Conclusion

There are many issues concerning NIOD in musicians that need to be examined further, especially in regards to newer treatments and improving acceptance of prevention methods. However, what is certain is that NIOD in musicians exists and, if left unrecognized, can become a significant impairment. It is imperative that all otolaryngologists examining musicians be aware of its existence, be able to diagnose its presence, provide appropriate treatment and counseling, and educate as to means of prevention.

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