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Effectiveness of Noise Control as Antidote to Tympanic Trauma

PATRICK IKANI EGAGA
Department of Special Education
University of Calabar, Calabar

Abstract:

The auditory organ is exposed to all kinds of noxious agents which renders it vulnerable to shift in threshold of sensitivity. The most lethal of this agent is noise which apart from resulting to instant death, depending in the degree (decibel), can result to hearing loss, perspiration, rise in blood pressure, sleep loss etc. This study examined the use of noise control as guard against tympanic trauma.

Key words: Noise control, antidote to tympanic trauma

The Tympanic Membrane: Anatomy and Functions

The tympanic membrane forms the anatomic boundary between the outer and middle ears. The tympanic membrane itself is a multilayered structure. Approximately 85% of the surface area of the tympanic membrane is composed of three types of layers:

- Lateral epithelial layer
- Medial membranous layer that is contiguous with the lining of the middle-ear cavity
- Fibrous layer sandwiched in between the epithelial and membranous layers.

These fibrous layers give the tympanic membrane considerable strength while maintaining elasticity.

The tympanic membrane forms the link between the air-filled outer ear and the fluid-filled inner ear. This link is accomplished mechanically via three tiny bones, the ossicles. The purpose of this elaborate link is to amplify or boost the sound pressure as a function of signal frequency.

A second, but less obvious function of the middle ear also involves the outer ear–inner ear link formed by the ossicles. Because of the presence of this mechanical link, the preferred pathway for sound vibrations striking the eardrum will be along the chain formed by the three ossicles. Sound energy, therefore, will be routed directly to the oval window. Another membranous window of the inner ear also lies along the inner or medial wall of the middle ear cavity. This structure is known as the round window. For the inner ear to be stimulated appropriately by the vibrations of the sound waves, the oval window and round window must not be displaced in the same direction simultaneously. This situation would arise frequently, however, if the sound wave impinged directly on the medial wall of the middle ear cavity where both the oval window and the round window are located. Thus, routing the vibrations of the eardrum directly to the oval window via the ossicles ensures appropriate stimulation of the inner ear.

Finally, the eardrum helps makes sure that when either ear is appropriately stimulated, the muscles of both ears are stimulated.

Causes of Tympanic Membrane Perforation (TMP)

Trauma to the ear could be simple blunt trauma to the pinna; laceration of the pinna avulsion of part or the whole of the pinna; uncomplicated tympanic membrane perforation; dislocation of the ossicles; longitudinal and transverse fractures of the petrous temporal bone with associated loss of inner ear and facial nerve function.

More specifically, trauma to the tympanic membrane can be caused by the following factors:

- overpressure eg: slap, fight, assault from security agents and road traffic injury (RTI)
- Loud bursts of sound such as gunshots, explosion, etc
- Thermal or caustic burns
- Blunt or penetrating injuries such as instrumentations
- Barotraumas.

Overpressure is by far the most common mechanism of trauma to the tympanic membrane. Traumatic perforation of the tympanic membrane may be caused by direct impact of fluids and direct pressure from outside. However, we will focus completely on the antidote to tympanic trauma caused by loud noises.

Noise – Induced Hearing Loss (NIHL)

Every day, we experience sound in our environment, such as the sounds from television and radio, household appliances, and traffic. Normally, these sounds are at safe levels that don't damage our hearing. But sounds can be harmful when they are too loud, even for a brief time, or when they are both loud and long-lasting. These sounds can damage sensitive structures in the inner ear and cause noise-induced hearing loss (NIHL).

NIHL can be immediate or it can take a long time to be noticeable. It can be temporary or permanent, and it can affect one ear or both ears. Even if you can't tell that you are damaging your hearing, you could have trouble hearing in the future, such as not being able to understand other people when they talk, especially on the phone or in a noisy room. Regardless of how it might affect you, one thing is certain: noise-induced hearing loss is something you can prevent.

What causes NIHL?

NIHL can be caused by a one-time exposure to an intense “impulse” sound, such as an explosion, or by continuous exposure to loud sounds over an extended period of time, such as noise generated in a woodworking shop.

Recreational activities that can put you at risk for NIHL include target shooting and hunting, snowmobile riding, listening to MP3 players at high volume through earbuds or headphones, playing in a band, and attending loud concerts. Harmful noises at home may come from sources including lawnmowers, leaf blowers, and woodworking tools.

Sound is measured in units called decibels. Sounds of less than 75 decibels, even after long exposure, are unlikely to cause hearing loss. However, long or repeated exposure to sounds at or above 85 decibels can cause hearing loss. The louder the sound, the shorter the amount of time it takes for NIHL to happen.

Here are the average decibel ratings of some familiar sounds:

- The humming of a refrigerator – 45 decibels
- Normal conversation – 60 decibels
- Noise from heavy city traffic – 85 decibels
- Motorcyles – 95 decibels
- An MP3 player at maximum volume – 105 decibels
- Sirens – 120 decibels
- Firecrackers and firearms – 150 decibels

Your distance from the source of the sound and the length of time you are exposed to the sound are also important factors in protecting your hearing. A good rule of thumb is to avoid noises that are too loud, too close, or last too long.

Sound Physics and Noise Control

There are four basic types of noise control. They are sound insulation, sound absorption, vibration damping and vibration isolation. Each of these works differently and is better suited for some situations than others.

The first type of noise control is **sound insulation**. This occurs when a solid barrier is introduced to a work space in an effort to mitigate the amount of noise and vibration inherent to that environment. This solid barrier helps reduce the reverberation of the offending sound waves by blocking them. The more difficult the solid barrier is to penetrate, the great its efficiency as a form of noise control will be. As a result, very dense materials such as concrete and steel are often used for this purpose.

Sound absorption is based on the premise that energy can neither be created nor destroyed. Instead, it can only be converted into another form. With this form of noise control, the energy found in sound waves is simply transformed into heat. A reduction in noise is a natural by-product of this process because the conversion of sound wave energy into heat energy drastically reduces the amount of ambient noise left in the environment.

Not surprisingly, porous materials are the most effective choice for this process. Like a sponge, these materials are actually able to absorb the excess sound in the surrounding air. Therefore, highly permeable materials such as foam products are excellent for this type of application.

Vibration damping is used to control excess noise and vibration associated with solid surfaces, rather than from actual sound waves. This process works by extracting the vibration energy from the surface material and converting it into heat energy. This method of noise control is similar to sound absorption in that it relies upon energy conversion rather than obstruction. However, like the other major forms of noise control, the primary purpose of employing vibration damping mechanisms is to minimize the impact of the unwanted noise and vibration on the surrounding environment.

Vibration isolation is the fourth form of noise control. As the name implies, this method involves protecting an area or its inhabitants from the source of the unwanted noise or vibration. Adding a physical barrier to the work space is the most common method of accomplishing this and can be quite effective as long as the barrier is able to adequately block the area to be protected from the source of the offending noise.

Noise Control as Antidote to Tympanic Trauma

Fortunately, NIHL is the only type of hearing loss that can be completely prevented. The most recommended antidote to tympanic trauma caused by loud burst of sound is active noise control. Finding effective methods of noise control has become an ongoing concern excessive noise levels and environmental vibrations can have negative long-term consequences for both human beings and sensitive equipment.

If excess noise and vibration aren't somehow mitigated in the work environment, they can lead to much higher operating costs. For instance, workers exposed to high levels of uncontrolled noise are likely to experience adverse psychological and physical ramifications such as higher stress levels, loss of hearing, and migraine headaches. These conditions can then lead to higher turnover rates and more lost time from work.

In the face of this predicament, the four techniques explained under sound physics and noise control has been the panacea hitherto applied for the benefit of all concerned. In view of the undeniable effectiveness of sound insulation, sound absorption, vibration damping and vibration isolation, it is recommended that they be applied wherever possible to prevent tympanic trauma.

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