

Physiopathological effects of noise: Recent approaches to the treatment of hearing loss

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Abstract

A significant problem can be exposure to noise, which is one of the negative effects of growing industry and production facilities around the world. Many individuals are exposed to high levels of noise at work, which causes problems. One of the most affected systems of exposure to noise is the auditory system. Hearing is damaged from exposure, such that individuals lose their sense of hearing. In the last 10 years, research has been done globally to prevent and treat noise-related hearing loss. When the data are examined, it can be seen there is protection and treatment for noise-induced hearing losses. The physiopathological effects of noise and new approaches are currently being examined.

Keywords: Noise, Physiopathological effects of noise, Treatment of noise-induced hearing loss

Introduction

Many people are exposed to high levels of noise in daily life, damaging physiological mechanisms in the body and creating problems. The most affected system is undoubtedly the hearing system: it becomes damaged and individuals will lose their hearing over time. When studies are considered, it is clear that noise-induced hearing loss is possible to treat and should no longer be a problem.

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Holistic approach to treat noise-induced hearing loss: Sound and noise

According to the World Health Organization, sound is "...the name given to the energy that emerges as a result of the effect of vibrations radiating from an energy source." [1]. Noise is defined as unwanted sound signals in the environment [2].

Hearing physiology

The hearing system includes factors related to hearing, as well as factors that process sensory information for the balance system. The structures that maintain balance are part of the vestibular system, which process information about spatial orientation, balance, and stabilization. To hear, air and sound must be present, as well as sound waves transmitted to the ear. The auricle, acting as a funnel when sound reaches it, collects sound waves. It sends them towards the outer ear, tympanic membrane, middle ear cavity, malleus, incus, stapes, inner ear, cochlea, vestibulocochlear nerve, and auditory cortex: hearing occurs as processed signals reach these areas.

Physiopathological damage caused by noise

Noise creates physiopathological damage to the body, both indirectly and directly; it can disrupt the physiological and psychological order, with negative effects on general health [3]. Physiopathological damage caused by exposure to noise has been identified. It was reported that the risk of cardiovascular disease increases in those who are constantly exposed to noise, i.e., high blood pressure, while success rates at work decrease [4]. Individuals exposed to intermittent noise for long periods have more attention deficits than those who are constantly exposed to it; thus, their job success decreases at a higher rate [5]. It has been found that individuals' cortisol levels increase with exposure to noise, as they experience tachycardia, plus increased mental fatigue, and communication problems [4]. Although problems caused by exposure to noise at a cellular level are not fully understood, it was observed that it creates reactive oxygen uptake in the cell, with necrotic cell death. The hearing threshold gradually deteriorates as a function of prolonged exposure, loss of cochlear nerve cells, and delayed negative effects on the auditory nerve. It was also reported that when individuals are exposed to low-intensity noise for extended periods, the reactive oxygen balance of hairy cells slowly deteriorates: with this issue, metabolic damage occurs within the cell. Tinnitus and sensorineural hearing loss are reported in those exposed to noise, as it damages vestibular organs – which in turn undermines the balance system. With exposure to noise in pregnancy, the numerical density of neurons in the medial geniculate bodies of the fetus is lower than normal, as their numerical density in the fourth and sixth layers of the auditory cortex also decreases [6]. It was found that pregnant women, fetuses, and newborns are the most vulnerable group to noise-related problems, and must be protected [7].

Safety devices for noise hearing loss

Precautions against hearing loss are designed to prevent noise-induced loss, subject to implementation with laws and regulations of the states, using international standards - that is, the use of ear protectors, protection training, noise insulation, engineering services, occupational health and safety inspections, monitoring hearing health, and regulating work hours from ambient noise.

Research: Protection from physical noise

Personal ear protectors protect from noise; they are a type of protector attached to the ears to protect individuals who work in noisy workplaces. Considering studies on auditory ear protection systems, they reduce noise exposure by about 20 decibels on average. No significant difference could be detected between noise protection with any device: muffs (noise-protecting earplugs) and earplugs where the noise is over 89 decibels [8]. Noise-induced hearing loss can be prevented with equipment and engineering controls [9]. Noise exposure in most occupations is less than 95 decibels; but use of such devices is meager, unless stipulated [10].

Research: Noise protection within the scope of occupational health and safety

Within the scope of occupational health and safety, both employers and workers must comply in our country. Protection is determined through laws and regulations, and subject to inspection by institutions, workplace physicians, and occupational inspectors. We must assess studies investigating their effectiveness, along with a comparison of legislation for occupational noise in 22 countries (Latin America, Canada, and the United States). Most countries use a noise limit of 85 decibels, while some countries limit exposure to 140 decibels. This still leaves millions of workers unprotected from occupational noise, as devices are insufficient [11]. More than 13% of the working population in the United States are adversely affected by work noise, but hearing loss cannot be prevented. This loss can damage the country's economy, when it cannot be treated. If 20% of noise-induced hearing loss was prevented, it would contribute to between 58 billion to 152 billion dollars annually to the national economy [12].

Current medical approaches

Those exposed to noise at work may experience hearing loss, as it is impossible to eliminate noise completely. Given legislation in many countries, ear plugs and noise isolation systems are available, but these systems cannot fully protect hearing. Research is being conducted to prevent hearing loss from deficiencies: medical research is comprised of 3 groups: pharmacological research, traditional complementary medical research, and genetic therapy research.

Pharmacological research

In pharmacological studies, substances are tested on those exposed to daily noise. Promising results have been achieved to prevent hearing loss. Examining the curative effect of oleuropein, an antioxidant for noise-induced hearing loss, it is beneficial if used with noise-induced hearing loss [13]. In one study, examining the protective effect of alpha lipoic acid against hearing loss, it showed therapeutic efficacy against noise-induced ototoxicity [14]. A large-scale study with various types of antioxidants for hearing loss reported that glutathione, D-methionine, ebselen, resveratrol, ascorbic acid, and water-soluble coenzyme Q10 antioxidants have a positive effect on noise-induced hearing loss if used before exposure [15]. In another study, in which glutathione (GSH), a powerful intracellular antioxidant, and reactive oxygen species (ROS), a cleansing anti-apoptotic agent were applied together - their application protects the cochlea from negative effects of noise and possible ototoxic damage [16]. It was reported that a decrease in noise-induced

hearing loss was seen in cases where adenosine amine congener (ADAC), a selective A1 adenosine receptor agonist, was administered regularly in acute noise-induced hearing loss [17]. With the combined use of vitamins and minerals for hearing loss, an injection of beta carotene, vitamin C, vitamin E, and magnesium, the damage in auditory sensory cells was prevented [18].

Traditional and complementary medical studies

Traditional complementary medical studies are carried out to treat hearing loss. If we examine traditional studies, in which the effect of propolis is assessed, it shows a significant protective effect [19]. In one study on curcuma longa (curcumin), the roots of the turmeric plant, it was shown to be effective against noise-induced hearing loss with antioxidant activity [20]. Korean Red Ginseng was also investigated, and found to be a strong antioxidant [21].

Genetic therapy studies

In recent genome studies, it was shown that those with a genetic susceptibility are more likely to experience loss when exposed to noise [22]. Genetic research on C57BL/6J mice found that compared to other mouse species, they were more likely to experience noise-induced hearing loss [23]. Genetic factors play a key role in the formation of noise-induced hearing loss. The medical realm must detect related genes and develop therapies to correct them. In the future, this therapy will yield treatment for noise-induced hearing loss.

If we assess recent studies, genes encoding procadherin and myosin carry risk factors for noise-induced hearing loss, with gene mutations that cause hearing impairment and tinnitus [23]. Research on the Vglut3 gene found that existing hearing loss was treated and improved with inner ear gene therapy [24]. It is clear that some types of hearing loss can be fully prevented by rapid genetic screening studies in childhood, so that the public health is protected [25]. Given the genome study using the Beethoven model, engineered genome editing agents that disrupt preference for the dominant deafness-associated allele were applied. The next step involved Cas9-guide RNA lipid complexes from the neonatal *tmc1bth/+* strain (targeting the *Tmc1bth* allele gene) injected into the cochlea: a significant reduction in hearing loss was seen with this study [26]. With similar studies, there is great promise for progressive noise-induced hearing loss.

Discussion

Those with noise-induced hearing loss is increasing. When studies in the last 10 years are assessed, we show that existing noise protection and controls are inadequate. With economy-based studies, individuals with hearing loss increase, dragging economies into financial loss. Pharmacological agents and gene therapies will be of great importance.

Conclusion

The measures implemented to prevent noise-induced hearing loss within the scope of occupational health and safety assists sound insulation services, personal protective equipment, and noise protection training, as the occurrence of hearing loss is reduced. It is estimated that the incidence of noise-induced hearing loss will decrease more with the development of preventive methods. As studies on the formation and treatment of

hearing loss are better evaluated, there are some genes more affected by noise, such that hearing loss can be prevented and treated with new gene therapy. Hearing loss can be eliminated with the development of pharmacological agents and complementary medical products when exposed to noise. In cases of prevention or treatment, the existing economic damage around the world can be prevented. It was also observed that the added value of new studies in this field is extremely high, with greater reductions.

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