REVIEW ARTICLE

Newer Advances in Hearing Conservation Programme

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Abstract

A Hearing Conservation Programme is an important component of the strategy to prevent Noise Induced Hearing Loss (NIHL) at workplace. Recently a lot of advancement has occurred in hearing conservation programme which includes new strategies being adopted to prevent NIHL at workplace. These consist of metrics, pharmacological interventions and hair cell regeneration, noise monitoring advances, artificial neural network, audiology assessment measures, smart hearing protection etc. These topics will be briefly discussed. These strategies if incorporated will strengthen the existing Hearing Conservation Programme to prevent NIHL.

Keywords: Hearing, Conservation, Programme, Noise

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Graphical Abstract
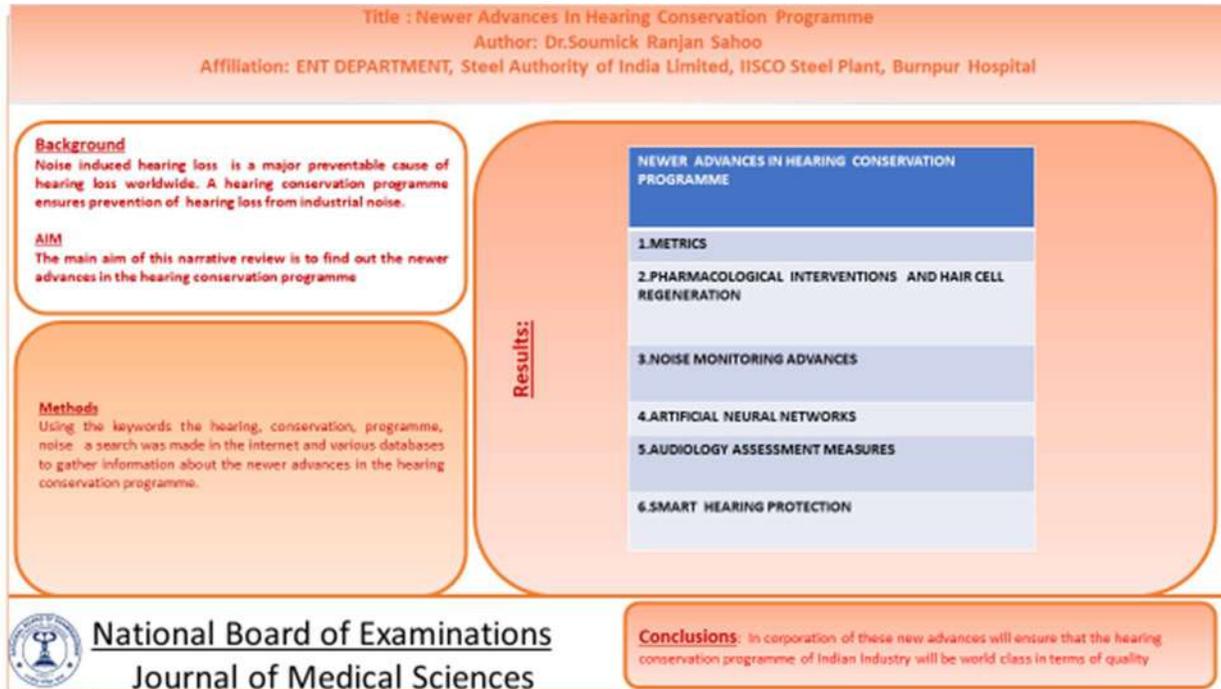
Introduction

Noise Induced Hearing loss is a major avoidable cause of hearing loss. Worldwide, 16% of the disabling hearing loss in adults is attributed to occupational noise, ranging from 7 to 21% in the various subregions [1]. Noise in addition to hearing loss also causes additional ill effects like lack of concentration, irritation, fatigue, headache, sleep disturbances.

To prevent NIHL a hearing conservation programme is followed in an industrial setup at the workplace. The hearing conservation programme consists of Engineering Control, Administrative Control, Hearing Surveillance and Hearing Protection Devices. A variety of measures have been implemented in Indian Industry setup to prevent NIHL. Some of these measures (Figure 1) include replacement of old machinery with new machinery which emit less noise and periodic maintenance and check up of the machinery. In addition to that workers are provided with ear plugs or ear puffs for protection from noise, pure tone audiometry done periodically to monitor the hearing staus of the worker, noise monitoring done at workplace to measure noise levels, health education imparted by doctors regarding importance of hearing and the proper use of hearing protection devices.

However sometimes compliance of workers in using hearing protection devices remains poor. So alternative strategies and advanced ear protection devices are required. A lot of newer advances in strategies to address noise induced hearing loss at workplace have taken place in the world. The aim of this narrative review is to briefly discuss these recent advances in hearing conservation programme. At the end a roadmap is provided for implementation of these advances.

Figure 1. Important Components of Hearing Conservation Programme Followed in Indian Industry Setup.

Methods

A search on the above topic was done on the internet and various databases by using the keywords Hearing, Conservation, Programme, Noise. Information was gathered from various review articles and original articles written by researchers.

Discussion

These new advances consist of metrics, pharmacological interventions and hair cell regeneration, noise monitoring advances, artificial neural network, audiology assessment measures, smart hearing protection etc. which are briefly discussed.

Metrics

They may be defined as a set of quantitative tools which can be used for assessment, monitoring, improving or evaluating the programme's compliance and success so as to set and track goals of the implemented programme [2,3].

Examples include statistical metric kurtosis and energy metric [2,4].

A static feedback-based noise monitoring model is also proposed by some researchers [2,5].

Metrics have been proposed based on excitation patterns. [2,6]

The risk of exposure to noise can be assessed and monitored by using metrics [2,7].

Noise emissions can be measured and attenuated by using metrics [2,8].

They may also be used in administrative controls, audiometric evaluations, personal hearing protection,education and training, monitoring and record keeping [2,5].

Pharmacological Interventions and Hair Cell Regeneration

They may be defined as approaches which are used for the prevention or treatment of NIHL using antioxidant drugs. Balance is restored between antioxidant defence and the formation of free radicals in the cochlea by using these drugs [2,9,10]. These approaches may be divided into approaches that aim at prevention of NIHL and those approaches which aim at treatment or reversing the problem.

Review has been conducted on the therapeutic benefit of antioxidant drugs for treating NIHL [2,10].

Zheng and Zuo in their study have commented on medications for reversing loss of hair cell and promoting regeneration of hair cells [2,11].

Some researchers have discussed NIHL pathophysiology, underlying molecular mechanisms and the therapies for improving the function of auditory system [2,12].

Santaolalla et al. have discussed the clinical application of inner ear hair cell regeneration [2,13].

Noise Monitoring Advances

A wireless headset noise exposure dosimeter has been invented for noise monitoring [2,14] .

A hearing protection device is now available which consists of two microphones for calculating the exposure dosage of periods [2,15].

A noise monitoring device is now available comprising of a dosimeter carried in a pocket or worn on a belt or helmet [2,16].

Some researchers have measured the noise exposure inside hearing protection device by fitting it with a dosimeter attached to a microphone [2,17,18]. The benefits are appropriate and timely intervention.

Artificial Neural Networks (ANN)

They are defined as analytical techniques which are based on the learning processes of human cognitive system and the neurological functions of the brain.

Information is processed like biological neurons in the brain. [2,19].

Aliabadi et al. [2,20] and Badri [2,21] have described neural network models.

Artificial intelligence has also been for determining the hearing loss thresholds [2,22].

In a workshop the main noise source has been found out using ANN [2,23].

There are many benefits of ANN. They may be used as an alternative method in engineering analysis. Large and complex systems can be handled effectively. Quicker and more practical predictions can be provided by using ANN. They are immune to noise [2,24].

Audiology Assessment Measures

For people exposed to excessive noise cochlear neuropathology is diagnosed by using these measures [2,25-28].

People who are exposed to noise may have normal audiogram findings even after they have started developing early stage hearing loss. It helps in diagnosis of hearing loss in the early stage.

In rats researchers have studied how exposure to noise is related to production of large temporary threshold shift, significant auditory brain response wave-I reduction and hearing-in-noise deficits.

Cochlear hidden hearing loss may be detected early by using this approach.

Smart Hearing Protection

They are novel strategies where integrated microphone and data transfer are utilized for monitoring and providing alerts in relation to wear rates and noise exposure. In this way action can be taken before permanent hearing loss develops [29].

Speakers and microphones are incorporated for accurate and safe reproduction of sound from the surrounding worksite.

The hearing protection wear rates can be tracked and improvised.

A guarantee is ensured of the effectiveness of the hearing protection provided. This is possible because the workers personal exposure to noise is tracked so that required intervention is done before permanent hearing loss occurs.

Improved situation awareness replaces the blindfold effect of traditional hearing protection thus improving safety at the site.

Data from smart hearing protection can be used to remove the hazards which helps in controlling unexpected noise hazards.

Complete and continuous data source is used to assess the noise risk.

Future Proposal

A model has been proposed (Figure 2) which will ensure that this aspect of otorhinolaryngology is being discussed and implemented in India by a multidisciplinary coordinated approach involving the experts in Indian Industry, academicians in medical and engineering field, policy makers, researchers in field of occupational health.
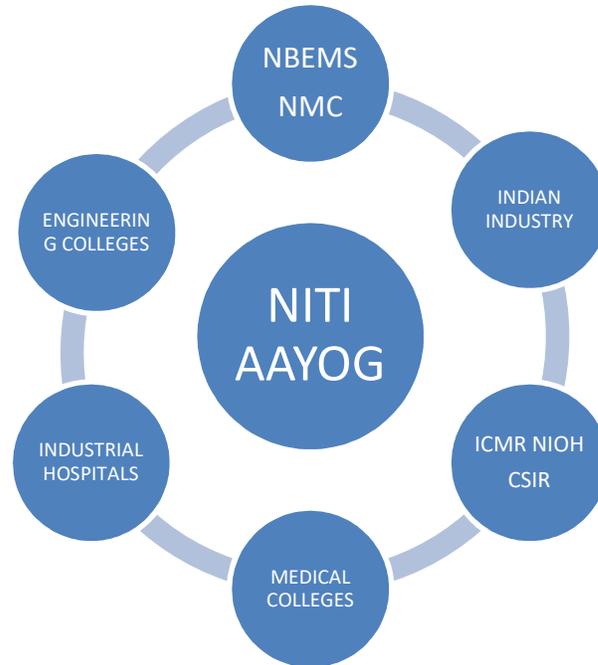
Figure 2. NBEMS Model.

Objectives

- Convergence of medical and engineering field to innovate and invent new technologies for hearing protection under Make In India initiative.
- To ensure that newer advances in hearing conservation program are made applicable in Indian Industry setup.
- This model may also be used in other occupational diseases such as occupational asthma,occupational allergic rhinitis,occupational cancers etc.
- To raise awareness among the medical students about hearing conservation program and other occupational diseases and their management by including this topic in course curriculum after consultation with NMC and NBEMS.

Conclusion

- Incorporation of these new strategies will increase the effectiveness of the hearing conservation programme in the industrial sector of India.

An effective hearing conservation programme will ensure a healthy worker free from NIHL who will be more productive in his work and lead to an economically prosperous industrial sector of India.

Ethics declarations

Funding This study did not receive any funding.

Conflict of interest

The authors declare that they have no competing interests.

Ethics approval, Consent to participate, Consent to publish, Availability of data and material, Code availability

Not applicable.

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