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OCCUPATIONAL HEARING LOSS CAUSED BY NOISE

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ABSTRACT

When studying noise-induced hearing loss, it is essential to consider that there are other causative agents that can not only cause hearing loss regardless of exposure to noise, but also enhance its effects when combined with it. Among these agents, exposure to certain chemicals, vibrations and the use of some medications stand out, which can amplify hearing damage.

Noise-Induced Hearing Loss (NIHL) is one of the main occupational diseases, resulting from prolonged exposure to high levels of noise in work environments. This condition, of the sensorineural type, is usually bilateral, irreversible and progressive over the time of exposure. NIHL occurs due to permanent damage to the sensory cells of the cochlea and may or may not be associated with the presence of chemical substances in the work environment. Its impacts include communication difficulties, reduced worker quality of life, and increased risk of accidents.

Several terms can be used as synonyms for Noise-Induced Hearing Loss, including: hearing loss due to exposure to noise at work, occupational hearing loss, occupational deafness, occupational hearing loss, hearing loss induced by high sound pressure levels, hearing loss induced by occupational noise and sensorineural hearing loss resulting from continuous or sudden exposure to high levels of sound pressure of occupational origin. Morata and Lemasters (2001) suggested the adoption of the term "occupational hearing loss" because it is more comprehensive. This term recognizes noise as the most common causal agent, but also considers other factors that can contribute to hearing loss, covering aspects such as diagnosis, preventive measures, safety limits, and legislative issues. Harger; Barbosa-Branco (2004) highlight that the main factors that influence the risk of NIHL include the physical characteristics of the noise, such as its type, spectrum and level of sound pressure, the duration of exposure and the individual susceptibility of each worker. In addition, the risk of hearing loss increases significantly when the average exposure to noise exceeds 85 dB(A) for eight hours a day (BRASIL, 2006).

Continuous noise exposures are more harmful than intermittent ones. However, short exposures to intense noise levels can also cause hearing loss. Thus, when analyzing the

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use of hearing protectors in the occupational history of the worker, it is essential to consider relevant aspects, such as the effective attenuation of noise provided by the equipment, verifying whether the hearing protection was adequate for the exposure; the individual characteristics of the worker; and the real conditions of exposure to noise in the work environment (BRASIL, 2006).

Intense occupational noise exposure can result in different types of hearing damage, including acoustic trauma (sudden hearing loss due to a single exposure to loud noise), temporary threshold alteration (temporary elevation of the audibility threshold, which gradually recovers after noise exposure), and Hearing Loss Induced by High Sound Pressure Levels (PAINPSE), characterized by the degeneration of the hair cells of the organ of Corti.

The presence of other factors, such as vibration, heat and certain chemical agents in the environment and in work processes, can influence the development of hearing loss by interacting with occupational sound pressure levels (BRASIL; PAN AMERICAN HEALTH ORGANIZATION, 2001).

Programs such as the Hearing Conservation Program (PCA) are essential to prevent Occupational Hearing Loss (OAP). They combine surveillance, hearing health promotion and training for the proper use of Personal Protective Equipment (PPE). In addition, measures such as the use of Collective Protective Equipment (CPE), modernization and maintenance of machinery help reduce exposure to noise.

Health education and awareness campaigns are also crucial, offering courses on the risks of noise and chemicals and instructing on the correct use of PPE. These actions preserve hearing health, improve quality of life and promote safety at work.

Keywords: Audiometry, Hypoacusis, Noise-induced hearing loss, Occupational hearing loss, Vibration, Occupational health.

INTRODUCTION

The agents of exposure to occupational risks present in the work environment are those found in the various sectors where work activities occur. When these agents are above acceptable tolerance limits and/or there are prolonged periods of exposure, they can cause damage to the physical and psychological integrity of the worker (FREIRE, 2017).

The main agents of exposure to occupational hazards include noise, heat, radiation, vibration, cold, dust, chemicals, in addition to psychosocial and biological agents. It is worth noting that exposure to biological agents usually requires direct contact with people, animals, or infectious-contagious materials, while chemical agents can cause contamination by inhalation or direct and indirect contact with the skin (FREIRE, 2017). In addition, in the work environment, the worker may be exposed to multiple risk agents, including toxic products, which can result in damage to the cochlea (MURAKAMI et al., 2017).

Noise pollution, unlike other types of pollution, does not leave physical residues, being present only while it is generated. This aspect makes it particularly dangerous, and it is sometimes neglected. However, continuous exposure to this risk agent can cause temporary, chronic, and irreversible sequelae in the hearing system, compromising health, social relationships, and the quality of work performance. It is important to highlight that noise pollution is a threatening risk agent. Noise, an invisible pollutant, gradually attacks individuals, causes hearing damage, and negatively affects the body as a whole (QUEIROZ et al., 2017).

Noise is widely recognized as a serious problem in modern society, as it affects not only hearing, but also various aspects of physical and mental health (FARIAS et al., 2012). In addition, it is one of the most common occupational risk agents in the workplace (SAKAE et al., 2006).

Exposure to chemicals can aggravate health damage, as many of these substances are toxic and can damage hearing. Studies generally assess exposure to a single chemical agent or a single type of risk, neglecting combined chemical substances and multiple exposure to other risk agents present in the work environment to which the individual is exposed (MURAKAMI et al., 2017).

Frequent and prolonged exposure to occupational risk agents can cause damage to the inner ear, injuring the outer hair cells located in the cochlea, resulting in PAO (SOUZA et al., 2001). In the workplace, this exposure often leads workers to initially report discomfort with loud sounds, irritability, concentration difficulties, and problems identifying sounds (OLIVEIRA et al., 2015; SCHETTINI et al., 2017; BITAR et al., 2018).

Staying in unhealthy work environments, characterized by conditions such as excessive physical exertion, extreme heat, long working hours and the absence of adequate protection against risk agents, evidences flaws in the work model adopted. In view of this, it is essential to prioritize the reformulation of the production model, with a focus on valuing the health and life of workers (MURAKAMI et al., 2017).

THE HEALTH OF THE WORKER

Organic Law No. 8,080, of September 19, 1990, establishes the execution of sanitary, epidemiological and occupational health surveillance actions as part of the Unified Health System (SUS), reformulating the concept of health in Brazil (BRASIL, 1990). Occupational health is structured with a focus on the investigation of the determinants of health damage, through the collection of data on accidents and occupational diseases. This reformulation aims to improve the surveillance strategies for work-related diseases, organizing information to identify the agents present in the work environment and proposing prevention and control measures (VASCONCELLOS et al., 1997). Integrated into the care sector, workers' health seeks to promote epidemiological and sanitary surveillance actions, in addition to monitoring the work-related health/disease process, creating a more effective occupational health profile.

Sanitary practice is central in the relationship between health, environment and work processes, with the rules of health surveillance aimed at improving the living conditions and health of the economically active population. It addresses the determinant factors of health problems related to work processes and environments, including technological, social, organizational and epidemiological aspects, with the objective of planning, executing and evaluating safety measures. Occupational health, within public health, encompasses several valuable themes and studies, although it is not always possible to establish a clear causal link between work and the health/disease process. However, it contributes to the understanding of issues such as the agents of exposure to occupational risks in workplaces or in specific sectors of a professional category (MINAYO-GOMEZ et al., 1997).

For workers' health, it is essential to know all the risk agents present in the work environment, in order to ensure that prevention strategies are effective (IZUMI et al., 2006). The empowerment of those involved in occupational health and safety practices is crucial so that they can develop and implement efficient actions, aiming to reduce occupational risks and promote protection and well-being (BITAR et al., 2018). Environmental and health challenges exemplify the complexities in work environments, which can result in factors that favor health or increase vulnerability to occupational risks.

OCCUPATIONAL HEARING LOSS IN BRAZIL AND WORLDWIDE

In Brazil, there is a lack of information on risk exposure agents in the economically active population, which makes it difficult to estimate the number of exposed workers and to identify the sectors with the highest occupational risk. This information is essential for epidemiological surveillance, control and prevention of occupational diseases and accidents (CAVALCANTE et al., 2013).

According to data from the 2000 Census of the Brazilian Institute of Geography and Statistics (BRASIL, 2010), 24.5 million Brazilians (14.5% of the population) have some type of disability or disability. Of these, 16.7% have hearing loss, which is equivalent to 5.7 million people, and 176,067 are unable to hear. Hearing loss is more common among men, possibly due to the type of occupational activity and the associated accident risks. The definition of hearing loss in the 2000 Census covers different degrees of disability, making it difficult to identify cases of occupational hearing loss (BRASIL, 2010).

Globally, about 360 million people, which corresponds to 5% of the world's population, have some type of hearing impairment, highlighting the importance of preventive actions. In October 1997, the World Health Organization (WHO) held an informal consultation to discuss strategies for the prevention of hearing loss and deafness. The meeting concluded that, in developed countries, excessive noise is, at least in part, responsible for hearing loss in the population with this deficiency (WHO, 1997).

In developing countries, occupational, urban and environmental noise is on the rise, resulting in an increase in the number of people with hearing impairment and a worsening of the degree of hearing loss. Thus, it is observed that, with the increase in life expectancy and industrialization, there is also an increase in the risk of occurrence of occupational diseases and accidents (WHO, 1997). In addition, simultaneous exposure to multiple risk agents, such as noise combined with chemical agents, can further aggravate hearing damage (ZEIGELBOIM et al., 2015).

OCCUPATIONAL HEARING LOSS AND RISK FACTORS

Hearing within normal standards, measured at up to 25 dB, is essential for efficient sound perception. When there is hearing loss, there is a change in the auditory threshold, compromising the ability to hear sounds below normal limits. This condition is classified into degrees: mild, moderate, severe, and profound, and can affect one or both ears. The origin of the loss can be congenital, when present since birth, or acquired, arising throughout life.

Types of hearing loss include:

- **Conductive:** Problems in the outer and/or middle ear, making it difficult to transmit sound.
- **Sensorineural**
- **Mixed:** Simultaneous combination of conductive and sensorineural losses.

In the occupational environment, occupational hearing loss is one of the main work-related health problems. It is characterized by a progressive decrease in hearing, especially at high frequencies. It is usually sensorineural The development of OEF is often associated with continuous exposure to high levels of noise.

Occupational Hearing Loss is widely recognized as one of the most significant occupational health problems worldwide, especially in industrialized countries, due to its irreversible nature (HOLANDA et al., 2011). This condition is a direct result of occupational exposure to risk agents, such as loud noise, in work environments without adequate protection. Its main characteristics include irreversibility and gradual progression of the auditory threshold, which is directly related to exposure time.

Initially, hearing loss affects specific frequencies, between 3,000 Hz and 6,000 Hz, while other frequency ranges may remain preserved for longer (METIDIERI et al., 2013). A characteristic aspect of PAO is the audiometric notch observed in this frequency range, followed by a slight recovery at 8,000 Hz. This pattern has been documented in studies of individuals with a history of chronic or traumatic exposure to risk agents (PHILLIPS et al., 2015). However, once exposure is stopped, there is no further progression of the disease, despite the condition being irreversible.

In Brazil, OEF is a condition of high incidence among workers in various industrial sectors. Due to the absence of effective treatment to reverse the changes caused by OEF, prevention is the fundamental strategy to combat it. Continuous and intense exposure to risk agents without proper protection can cause irreparable damage to the internal structure of the cochlea, resulting in hearing loss (PRESADO et al., 2011).

The implementation of preventive measures, such as the use of PPE, hearing conservation programs, and control of the work environment, is essential to minimize risks and protect the hearing health of workers.

The most frequent occupational risk exposure agents can be classified as physical, chemical, biological and psychosocial, each one contributing significantly to the emergence of work-related diseases and conditions (FERNANDES et al., 2002). The agents of exposure to physical occupational risk are listed below:

Sound and noise

Sound is a physical agent originated by the vibration of air molecules, propagating as a longitudinal wave, and is therefore a form of mechanical energy (WHO, 1980). The peripheral receptor responsible for capturing this energy and transforming it into electrical nerve impulses is the ear. The human auditory system is capable of detecting air pressure variations in the range of 0.00002 to 200 Newton/m², within the threshold of frequency audibility, which varies from 16 to 20,000 Hz. Thus, not every sound wave is perceived as sound by humans.

The term "noise" derives from the Latin *rugitu*, which means rumble. Acoustically, noise is composed of several sound waves with amplitude and phase ratios distributed in a disordered way, causing an unpleasant sensation, distinct from music. It can be classified as continuous, when there is no variation in the pressure level or sound spectrum, or as impact or impulsive noise, characterized by its high energy and duration of less than 1 second (ISO, 1973a).

Noise is widely recognized as the main cause of hearing damage related to the occupational environment, with significant impacts, especially on the inner ear (NELSON et al., 2005). In addition, noise can have systemic effects throughout the body, contributing to health problems such as stress, increased blood pressure, and fatigue.

The proper use of hearing protectors is an essential measure for the maintenance and preservation of hearing in the face of the harmful effects of noise (FERNANDES et al., 2012). However, noise is not the only physical risk agent capable of causing occupational hearing loss. Other agents present in the work environment, such as vibration, radiation and chemical products, can also be extremely harmful to the hearing and general health of the worker (RÉGIS et al., 2014).

Vibration

Vibration is a physical agent with significant impacts on both human health and the environment. Its consequences can be perceived in nearby areas, causing phenomena such as tremors and cracks in the ground and buildings, evidencing its ability to generate damage beyond the place of direct exposure (SILVA et al., 2017).

In the occupational environment, vibration is present in several work activities, especially the function of hydrojetist, where its occurrence is frequent and intense (SILVA et al., 2009). One of the great challenges associated with vibration is its subtle perception, often going unnoticed by workers, which can delay the identification of risks and the adoption of preventive measures (FERNANDES et al., 2002).

Prolonged exposure to vibration, especially without adequate protection, can cause a number of health problems, including:

- Headache and dizziness.
- Changes in the spine and chronic pain.
- Sleep disorders and hypertension.
- Anxiety, inattention and tingling in the limbs.
- Vision problems and hearing loss.

Studies indicate that workers exposed to vibration combined with noise had a higher frequency of altered audiograms than those exposed to noise alone. This reinforces the importance of considering the interaction between multiple risk factors, such as vibration and noise, in the assessment and management of occupational risks (FERNANDES et al., 2002).

Heat

Heat in the work environment can be caused both by the machinery used in the activities and by the environmental conditions in which the worker performs his function. When heat exposure is not adequately controlled, thermal overload can occur, with the body having to dissipate energy to maintain thermal balance. This imbalance can result in health problems such as dehydration, heat stroke, cramps, and even temporary changes in the auditory threshold (GOSLING et al., 2008).

In addition to the physical impacts, heat can also affect the psychological well-being of workers, contributing to fatigue, stress and dehydration. This, in turn, can lead to non-compliance with safety standards due to lack of concentration or vigilance (NUNES et al., 2012). Exposure to heat is particularly harmful for those who work outdoors, especially during the day shift when temperatures are higher.

Pressure

Barotrauma is an injury caused by pressure changes, common in work environments with exposure to excessive pressure. It occurs when there is a pressure difference between an unventilated space in the body and the circulating fluid, resulting in damage to tissues and organs. This injury is caused by the abrupt expansion or contraction of a space filled with air, which can affect blood circulation and impair functions such as hearing and breathing. The most common symptom is the sensation of blocked ears, which can lead to pain, temporary or permanent hearing loss, and damage to internal tissues. The most

affected sites are the middle ear, with possible pain and damage to the eardrum, and the lungs, with severe injuries such as pneumothorax and subcutaneous emphysema.

Lonizing and Non-Ionizing Radiations

The main difference between ionizing and non-ionizing radiation is that non-ionizing radiation does not have enough energy to ionize atoms, although it can cause cellular damage by stripping electrons from atoms. Ionizing radiation, present in X-ray machines, can ionize atoms and molecules, and is used, for example, for radiographs and inspections of welds on naval vessels. Exposure to radiation can cause damage to health, which varies according to the individual's health conditions. High doses of ionizing radiation can destroy proteins in the body and cause cancer, reproductive problems, burns, and hearing loss (ANTEBI et al., 2016). Non-ionizing radiation, such as that caused by solar radiation and industrial equipment, can excite atoms without destroying them, and their effects depend on the intensity and duration of exposure. They can cause cataracts, burns, skin cancer, hypertension, changes in the thyroid, central nervous system, and hearing loss (ASTETE et al., 2011; BRAND et al., 2011).

COCHLEAR FRAGILITY RESULTING FROM OCCUPATIONAL RISK AGENTS

Occupational risk agents are recognized for their ability to cause significant damage to hearing, ranging from the tympanic membrane to the central nervous system, culminating in Occupational Hearing Loss (OAP) (ARAÚJO, 2002).

The cochlea, in turn, is the main organ affected in OEF, due to the high sensitivity of the outer hair cells to ototoxic agents. This process, called metabolic exhaustion, is characterized by metabolic alterations that include enzymatic and energy reductions, impaired oxygen and nutrient availability, and, ultimately, resulting in cell death (ARAÚJO, 2002).

Almeida (2000) points out that the injured area in the cochlea is replaced by scar tissue. As a consequence of this process, there is an effective reduction in hearing capacity, manifested mainly by symptoms such as decreased hearing and the presence of tinnitus.

Tinnitus, one of the symptoms reported by PAO patients, is considered an early indicator of hearing loss (FERNANDES et al., 2012) and a direct consequence of this condition (SILVA et al., 2017). In addition to its relationship with hearing loss, tinnitus can cause significant discomfort, including headaches, insomnia, and mental disturbances (ARAÚJO, 2002). In addition, Silva (2017) states that there is a direct correlation between

the degree of hearing loss and the intensity and frequency of tinnitus, with greater severity observed in more advanced cases.

It is important to highlight that occupational hearing loss is characterized as an irreversible, progressive, silent, bilateral and symmetrical condition. Patients with this pathology often present signs and symptoms such as tinnitus, difficulty understanding speech, reduced hearing capacity, sensation of ear fullness, secretion in the ear canal, dizziness and irritability to intense sounds, among others. In addition to hearing damage, OEP can also cause extra-auditory damage, including physical and cardiovascular changes, dysfunctions in the autonomic nervous system, metabolic changes and psychic impacts (ARAÚJO, 2002).

RELEVANT LEGISLATION

The National Occupational Health Policy seeks to ensure the right to a healthy work environment and reduce accidents and occupational diseases through health promotion, rehabilitation and surveillance actions. Its guidelines include comprehensive health care, encouragement of research and training of human resources, with the objective of strengthening occupational health surveillance.

Hearing loss is recognized as a work accident and must be formally recorded through the Work Accident Communication (CAT). In Brazil, the Ministry of Labor and Employment (MTE) instituted, on June 8, 1978, the Regulatory Standards (NR) for occupational safety and medicine. These rules are mandatory for private and public companies and direct and indirect administration bodies, as well as for the Legislative and Judiciary branches, as long as they are governed by the Consolidation of Labor Laws (CLT), instituted on May 1, 1943.

Occupational Risk Management (GRO) is a set of coordinated actions aimed at prevention, with the objective of providing workers with safe and healthy working conditions and environments. The GRO includes the implementation of a Risk Management Program (PGR), which became required as of January 3, 2022, with the entry into force of the new Regulatory Standard No. 01 (NR-01), which deals with General Provisions and Management of Occupational Risks.

The PGR is the implementation of the GRO, registered in physical documents or electronic systems, with the objective of promoting continuous improvements in the conditions of exposure of workers through multidisciplinary and systematized actions. In addition, the PGR must continuously monitor the company's activities, ensuring the implementation of the measures provided for in the action plan and adjusting to changes in

the work environment that may alter the characteristics of occupational risks (BRASIL, 2022).

Regulatory Standard No. 07 (NR-07), addresses the Occupational Health Medical Control Program (PCMSO), integrates the initiatives of companies focused on workers' health, focusing on the clinical-epidemiological approach to the health-work relationship. Its objective is to prevent, track and diagnose work-related health problems early, including subclinical conditions, as well as to identify occupational diseases and irreversible damage to health. It is important to highlight that NR-07 defines the minimum procedures for evaluating and monitoring the hearing health of workers by means of reference and sequential audiological examinations (BRASIL, 1977).

Regulatory Standard No. 15 (NR-15) deals with Unhealthy Activities and Operations, establishes the limits of exposure to occupational noise: 85 dB for up to 8 hours a day, 95 dB for up to 2 hours a day and 115 dB for up to 7 minutes. These limits, which should not be exceeded even with the use of hearing protection, aim to avoid exposing the worker to serious and imminent dangers (BRASIL, 1977).

According to current legislation, all workers exposed to sound pressure levels higher than the tolerance limits established in annexes 1 and 2 of NR-15 and in Ordinance No. 3,214 of the MTE must be submitted to audiometry tests, both reference and sequential, regardless of the use of hearing protection (BRASIL, 1977). The audiometry test must be performed at the time of admission, in the 6th month after hiring, annually and at the time of the worker's dismissal. The interval between examinations may be reduced at the discretion of the coordinating physician of the PCMSO, based on notification by the physician responsible for the labor inspection or through collective bargaining (BRASIL, 1997).

For Marque (2006), the audiometric alterations identified in the audiometry test can directly affect the worker's professional capacity. Therefore, it is essential that health professionals recognize the initial characteristics of hearing damage early, according to the parameters of current legislation.

Lopes (2017) states that occupational accidents and diseases can compromise the worker's ability to perform their duties. To grant social security benefits, it is necessary to confirm the incapacity for work and establish the relationship with the causal link of the activity performed. In typical accidents, where it occurs in the workplace, it is easier to justify the benefit; In atypical accidents, proving the injury as a work accident may be more difficult.

OCCUPATIONAL HEARING LOSS PREVENTIVE METHOD

According to Lokhande (2014), occupational medical examination and complementary tests, such as audiometry, are essential practices for the early detection of diseases. These tests play a crucial role in identifying pathologies, facilitating early interventions that help reduce the number of absences from work, as well as morbidity and mortality. In this way, they contribute to the promotion of good health among workers.

Considering the risk of hearing loss in the occupational environment, it is essential that preventive conducts become a priority (PRESADO et al., 2011). Although occupational hearing loss is preventable, its consequences affect quality of life, compromising communication both in social relationships and in the work environment. This highlights the importance of preventive actions, both collective and individual, aimed at preserving hearing and promoting health in general (LOPES et al., 2009).

The exposure limits defined by the legislation, as well as the risk prevention and control programs, must be strictly implemented and supervised by the contracting company. For this action to be effective, it is necessary that the analysis of the production process identifies the cases of hearing risk, the type of exposure agent, the characteristics of the functions performed and the shift with the highest production pace (PRESADO et al., 2011). However, the monitoring of environmental risk is often done in isolation, considering each component separately, without taking into account the interaction between these elements, which can intensify the damage to health (AUGUSTO et al., 1998).

In this way, the Hearing Conservation Program (PCA) has as fundamental principles the supervision, promotion of hearing health and prevention of hearing loss. In addition, it should encourage the appropriate use of Personal Protective Equipment (PPE), alerting to the importance of periodic audiometry exams, with the objective of preventing, early detecting and controlling the progression of occupational hearing loss (Presado et al., 2011). It is worth mentioning that the implementation of Collective Protection Equipment (CPE) is also a priority action to mitigate environmental risks, with improvements such as the enclosure of machines, the replacement of old equipment with more modern models and frequent maintenance to reduce noise intensity (PRESADO et al., 2011).

The formulation of flexible schedules to meet deadlines and contracts, together with efficient training for work activities and the correct use of PPE and EPCs, are measures that reduce vulnerability to occupational accidents and, consequently, minimize damage to workers' health (DYNIEWICZ et al., 2009). In practice, the Hearing Conservation Program (PCA), as a measure of surveillance of risk factors, should address the prevention of occupational hearing loss, aligning the effectiveness of health in the workplace with the

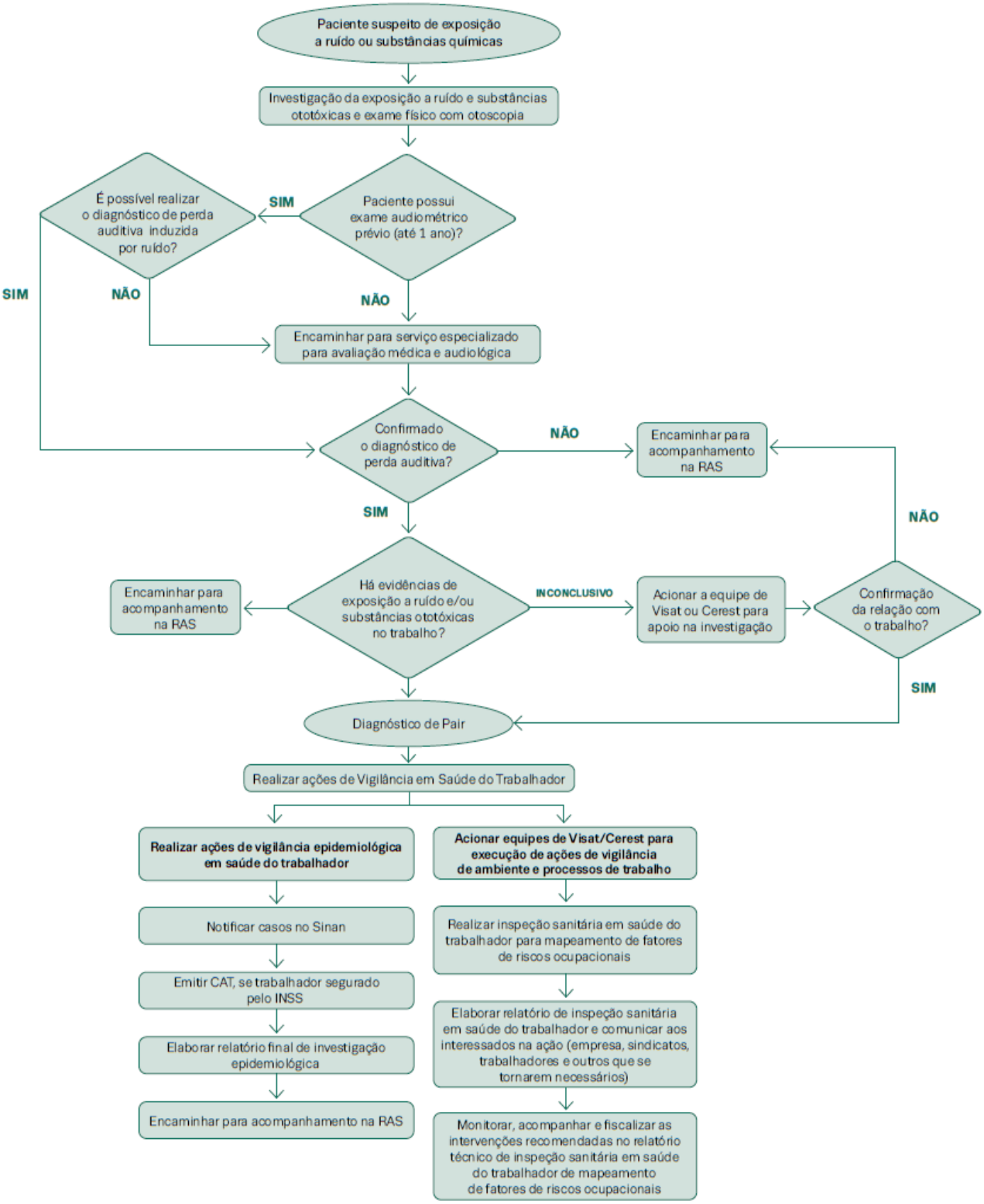
reduction of existing risks. This commitment to worker health helps mitigate the adverse impacts of risk factors present in the work environment.

Worker awareness is one of the great challenges in the prevention of occupational accidents, especially those related to hearing loss. Effective strategies include offering courses that address the importance of the use, and correct use, of protective equipment. In addition, the worker's level of education is an important factor for the success of educational and preventive actions, including the use of PPE. Studies indicate that educational level is inversely associated with the risk of hearing loss, i.e., workers with higher education tend to follow the guidelines more efficiently, reducing the risk of OAP (REDDY et al., 2012; MOREIRA et al., 2014; FONTOURA et al., 2014).

The promotion of health education and awareness about the prevention and treatment of auditory pathologies are essential strategies for self-care and for the individual and collective awareness of workers. Adequate knowledge about hearing health allows workers to take preventive measures, protecting themselves from occupational hearing loss (OAB) (FONTOURA et al., 2014; RAMOS et al., 2017). The effectiveness of this understanding is fundamental, because, by making the working class aware of occupational risks, they can adopt practices that prevent damage to health, especially those related to auditory exposure agents in the workplace (LOKHANDE, 2014).

The Occupational Health Surveillance Flowchart for Noise-Induced Hearing Loss (Figure 1) illustrates the continuous cycle of surveillance, intervention, and prevention that must be adopted to protect the hearing health of workers exposed to the risk of noise-induced hearing loss, ensuring a safer and healthier work environment.

Figure 1: Occupational health surveillance flowchart for noise-induced hearing loss



Source: Brazil, (2006)

METHODOLOGY

This article was prepared based on the bibliographic research method, based on pre-existing sources and without direct practical application. According to Boccato (2006, p. 266), bibliographic research aims to develop solutions based on theoretical references

already published, allowing analysis and discussions on these materials. In addition, it offers the researcher greater ease to access a wide range of information (GIL, 2002).

RESULTS

Occupational hearing loss reveals a number of interconnected factors that highlight the complexity of the problem. Workers are exposed to a significant set of risk factors, such as intense noise from machinery, equipment and industrial processes, as well as toxic chemical substances, such as products used in welding, electroplating and painting. The combination of these factors increases vulnerability to occupational hearing loss, a problem that is little recognized, but which compromises the quality of life and communication capacity of workers.

The lack of adequate records on occupational accidents and conditions of exposure to OEF makes it difficult to measure the magnitude of the problem. This indicates the urgent need for improvements in accident recording and notification systems, so that more effective surveillance can be carried out and more accurate data obtained. The absence of detailed information makes it difficult to plan preventive actions and develop specific public policies for the sector.

The development and implementation of hearing conservation programs and the proper use of Individual and Collective Protective Equipment are essential for the mitigation of hearing risks. Promoting awareness about the risks and importance of using hearing protection, as well as periodic audiometric tests, are preventive measures that can significantly reduce the incidence of OEF.

Occupational hearing loss not only affects the health of the worker, but also has considerable social and economic repercussions. It can impact the worker's ability to communicate and quality of life, in addition to generating costs with leaves, disability retirements, medical treatments, and rehabilitation. Therefore, the prevention of OEF is not only a matter of health, but also of economic efficiency for companies and society as a whole.

DISCUSSION

Occupational hearing loss is a significant problem, due to the exposure of workers to multiple hazards, such as loud noise and toxic chemicals. The literature points to a relationship between noise exposure and PAO, but the interaction with chemicals has not yet been sufficiently explored.

Epidemiological surveillance, hearing conservation programs, the use of Individual and Collective Protective Equipment, and the awareness of workers about the importance of hearing health care are essential to prevent OEF. In addition, the implementation of interdisciplinary studies and active surveillance are essential for early diagnosis and for reducing the social and economic impacts of OEF, which affects the quality of life of workers and generates costs for companies and society. In short, an integrated effort is needed to promote hearing health and ensure the safety of workers in this industry.

CONCLUSION

Occupational hearing loss is a significant problem that results from prolonged exposure to loud noises and toxic chemicals. This scenario is aggravated by the scarcity of detailed studies on the combination of these two risk factors, especially in the Brazilian context. Although the relationship between noise and OEF is well established, the interaction between these agents and the subsequent effects on workers' hearing health still needs further investigation.

Current legislation, such as the Regulatory Standards (NR) that deal with health and safety at work, requires regular audiometric tests and the use of Personal Protective Equipment (PPE), in order to monitor and prevent occupational hearing loss. However, the effectiveness of these actions depends on rigorous and continuous implementation by companies, in addition to raising workers' awareness of the importance of prevention and self-care.

Programs such as the Hearing Conservation Program (PCA), which include inspection actions, promotion of hearing health and the correct use of PPE, are essential to control and prevent OEF. The replacement of equipment, the use of Collective Protective Equipment (CPE) and frequent maintenance also contribute to the reduction of exposure to noise in the work environment.

Health education and continuous awareness are essential for workers to understand the importance of taking care of their hearing health and to know how to protect themselves. Courses on the use of PPE and the risks of noise and chemicals can significantly reduce OEF cases. In addition, interdisciplinary studies and active surveillance practices are key to better understanding the causes of OEF and developing effective solutions. Collaboration between companies, healthcare professionals, regulatory bodies, and workers is essential to create safer work environments, protecting hearing health, and promoting quality of life.

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