COMMUNICATION HEADSET USE AND NOISE MEASUREMENT IN THE WORKPLACE

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1. INTRODUCTION

Noise in the workplace is a significant risk factor causing on average 16% of adult-onset hearing loss worldwide [1]. According to the U.S. National Health and Nutrition Examination Survey, 22 million American workers are exposed to hazardous noise on the job and approximately 10 million Americans suffer from hearing loss as a result [2].

Amongst various factors, noise exposure in the workplace can result from the use of communication headsets or other wearable listening devices. With the increasing use of wired and wireless communication headsets, they are now commonly found in many occupational settings, such as call centers, fast food outlets, airport ground and control tower operations, industrial and construction sites, military sites, etc. Some workers wear noise-excluding headphones to attenuate the very noisy background and enhance the received communication signal [3]. Other workers use hands free communication headsets or low attenuation devices in an environment where background noise is not as significant [3]. In all cases, workers are exposed to the surrounding workplace noise and to the internal acoustic signals from the communication headset. Methods for noise exposure assessment under headsets vary widely in complexity, and relatively little is known about measurement reliability and the degree of agreement between methods.

2. EXISTING METHODS

Several challenges present themselves when conducting noise measurements under communication headsets. Firstly, measurements under occluded ears are dependent on the acousto-mechanical properties of the outer ear [4]. Secondly, in-ear measurements must be converted to free field measurements in order to enable a comparison with occupational standards [4]. Finally, measurement of noise under communication headsets involves three interdependent factors: the ambient noise, the internal signal from the headset which varies in duration, and the headset attenuation. Consequently, because of the complexity of conducting noise measurements under occluded ears, specialized equipment and techniques are required for direct and indirect sound measurements under communication headsets. The equipment must 1) capture the acoustic signal path from the headset and the external background noise path passing through the device, 2) consider the headset attenuation if applicable, and 3) allow the worker to operate normally while the measurements are being taken.

2.1 Standardized Methods

The ISO 11904 describes two procedures for the direct measurement of sound under communication headsets.

For the Microphone in a Real Ear (MIRE) technique (ISO 11904-1) [5], a specially trained individual must insert a miniature or probe microphone in the worker's ear canal. While the worker is exposed to close and far sound sources, sound pressure measurements in the ear canal are obtained in 1/3 octave bands. Measurements are then converted back to the free-field levels. Although this technique provides the most direct estimate of sound exposure to the worker, its invasive nature could restrict his/her movement, and the positioning of the microphone or probe can be problematic.

The ISO 11904-2 [6] specifies sound measurements on an acoustic manikin. The standardized manikin simulates the changes that happen to sound waves as they pass a human head and torso. Sound pressure levels are measured by the artificial ear embedded in the manikin in 1/3 octave frequency bands. For direct measurements in the field, one headset is worn by the worker and a second one is placed on the manikin positioned near the worker. An alternative is to record the electrical signal from the worker's headset and to either playback the signal on a manikin in the laboratory or filter the signal according to the electrical-to-acoustic transfer function of the headset [7]. In both cases, the worker is free of any measuring device or microphone and carries out tasks in the most natural way while the noise is being measured. Unfortunately, the required equipment and instrumentation is not widely available, and the differences in shape and mechanical properties between the worker and manikin's ear can be a limiting factor.

Since the manikin method can be cumbersome to use in the workplace, the Australian and New Zealand Standards AS/NZ 1269.1 proposed a general-purpose artificial ear procedure [8]. Although this method is less expensive, more practical, and more accessible, it was not initially designed to conduct sound measurements under communication headsets and must therefore be used with care.

2.2 Calculation Method

An indirect calculation method has also been proposed that can serve as a basic tool to predict noise exposure in workplace settings where communication headsets are worn [9]. It is based on the assumption that to hear and understand the headset signal, workers must adjust the volume of the signal depending on the level of the surrounding ambient noise (L_N) and the headset attenuation (ATT). The equation below comes from the formula used to

sum sound levels from two independent sources and considers the signal from the surrounding background noise (term 1) and the communication signal from the headset (term 2) corrected for the listening duration (t) over the noise assessment period (T), assuming a listening signal-to-noise ratio (SNR) of 13.5 dB [10]:

$$L_{ex,T} = 10\log\left(10^{(L_N - ATT)/10} + \frac{t}{T}10^{(L_N - ATT + SNR)/10}\right)$$

This prediction tool offers a simple approach that industrial hygienists or safety officers can use in the early stages of a noise assessment program, or in environments where there is no access to more complex acoustical measurement equipment.

3. A FIELD MEASUREMENT GUIDE

Despite the increase of communication headsets in the workplace, guidelines are lacking regarding their safe use. Moreover, health and safety officers often have limited access to resources to conduct noise measurements under these devices. The overall goal of this project is therefore to examine, compare, and develop knowledge on the best measurement tools to evaluate the noise exposure of individuals who wear communication headsets in the workplace. Another purpose is to provide valid and practical measurement tools for health and safety officers. A four step study is suggested in order to attain the proposed goals.

3.1 Questionnaire

Due to the lack of information on communication headset use in the workplace, a questionnaire will be administered to document the extent of the problem by determining the distribution of the type of devices found in the workplace, the type of working environments and occupations where these devices are used, and the actual practices in terms of selection and usage. Health and safety officers and other stakeholders in hearing loss prevention will be surveyed on their knowledge of noise exposure from these devices, their awareness of the problem, their ability to measure sound levels, and their access to the proper measuring equipment.

3.2 Comparison of the direct measurement methods

Although both the acoustic manikin and artificial ears are suggested to take noise measurements under communication devices, the artificial ears are more compact and accessible. However, there is no data comparing the acoustic manikin and artificial ears for the measurement of noise under headsets. In a laboratory setting, the test-retest measurement variability and the degree of agreement for each of these methods will be determined.

3.3 Refinement of the indirect calculation method

Due to the complexity of conducting measurements with artificial ears and manikins, reliance on these methods may limit the workplaces where noise exposure under communication headsets is evaluated. The calculation method is an easy alternative to indirect measurement of noise under communication headsets. However, it requires further work to determine if the average SNR of 13.5 dB observed in other studies varies in different conditions. In a laboratory setting simulating the workplace environment, different conditions will be tested such as: background noise types, background noise levels, headset types, and headset configurations.

3.4 Field measurements

Field measurements will be carried out to compare the various measurement methods as they would be used in real working conditions. While conducting these measurements, it will be possible to evaluate the constraints and logistics associated with each method. A significant challenge associated with taking noise measurements under communication headsets is the necessity for the workers to continue their work duties as naturally as possible while the measurements are being conducted.

4. FINAL REMARKS

This study will help establish detailed guidelines to assist health and safety officers in selecting the best measurement method to assess noise exposure under headsets according to the available resources and best practices, and in promoting safe use of communication headsets in the workplace.

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