Early prognosis of noise-induced hearing loss: prioritising prevention over prediction

Christa L Themann, David C Byrne, Rickie R Davis, Thais C Morata, William J Murphy, Mark R Stephenson

Moshammer *et al*[1] have recommended routine implementation of a temporary threshold shift (TTS) screening test to identify workers particularly at risk of developing noise-induced hearing loss (NIHL) from occupational exposure to hazardous noise. Their work addresses an important occupational health problem. NIHL ranks among the most common work-related injuries in many countries, with an estimated global annual incidence of 1.6 million cases, and accounts for approximately 16% of disabling adult hearing losses worldwide.[2 3] Individuals vary in their susceptibility to the damaging effects of noise and no suitable method currently exists to predict the susceptibility of a particular worker.

In their study, Moshammer *et al* measured TTS in newly hired employees following exposure to a 20 min, high-intensity, low-frequency experimental noise. They then followed the workers over time to see who ultimately developed a permanent threshold shift (PTS). The authors report that a TTS of 14 dB or more measured 2.5 min after the experimental exposure identifies workers at greater risk for PTS. They recommend routinely using this procedure to screen for susceptibility to noise in workplace hearing loss prevention programmes.

However, this recommendation is premature in view of the study results. The TTS measure had a sensitivity of 82%, meaning that 18% of those who developed PTS were not identified by the TTS screening—a high false-negative rate, particularly as we already know how to prevent PTS through reduction of noise exposures and consistent use of properly fit hearing protection. Specificity was 70% at best, corresponding to a false-positive rate of 30%. If this procedure was implemented, approximately a third of the workers would be told that they are particularly at risk for NIHL when they are not, raising unnecessary alarm and opening the door to potential discrimination in work assignments, promotions, etc.

The hypothesis that TTS might be predictive of future PTS is not new and has resulted in extensive research stretching as far back as the 1930s.[4–7] However, decades of study have produced mixed results regarding the relationship between TTS and PTS and no simple, replicable relationship between TTS and PTS has yet been identified. The relationship between TTS and PTS appears even more complex when occupational exposures are intermittent or impulsive. While Moshammer's work contributes to the literature on the topic, its findings must be considered in light of the whole body of research. Even if the recommended TTS screening was highly prognostic for workers exposed to continuous noise such as those in the Moshammer study, it may not be appropriate for workers exposed to other types of noise.

Many factors in addition to individual susceptibility influence the amount of PTS a person develops. These factors include parameters of the occupational noise exposure, noise reduction obtained from hearing protectors, noise exposure off-the-job, other risks to hearing such as ototoxicants, disease and trauma, general health conditions, and biological factors including age, gender and race.[5 8] Confounding variables need to be accurately measured and tightly controlled when assessing the correlation between a measured TTS and future NIHL. All participants in the current study were young white males; the applicability of the TTS screening to other workers cannot be concluded from the data. Details of the noise measurement procedures, assessment of hearing protector attenuation and use, and identification of other hearing risks in this study are not described, but could obscure the true relationship between the TTS and PTS.

Recent research in animal models indicates that the underlying mechanisms for PTS and TTS may be different and unrelated,[9] which could further explain why a consistent relationship between TTS and PTS has been elusive. In addition, new evidence indicates that TTS-inducing exposures create irreversible loss of neural synapses and degeneration of the cochlear nerve in experimental animals even after audiometric thresholds have completely recovered.[10] The possibility that a TTS screening test might contribute to permanent auditory damage deserves serious consideration before it is put into practice.

TTS testing requires accurate measurement of pre-exposure thresholds, which demands a test environment with background noise levels sufficiently quiet to test below audiometric zero. Precautions must be put in place to ensure that the most susceptible individuals do not develop too much threshold shift from the test exposure.[11] The authors do not describe the details of their background noise environment or protocols to protect noise-sensitive workers from developing an excessive TTS (indeed, at least one worker sustained a TTS of 38 dB). However, these issues must be worked out before implementing TTS screening in the workplace.

Finally, the ethics of utilising TTS-inducing noise exposures to evaluate an individual's suitability to work in noise should be discussed and weighed against other potential measures for preventing NIHL. The TTS exposure used in the study exceeded noise exposure limits in many countries, including Australia, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden and the UK;[12] and some workers in the study experienced alarming temporary hearing shifts. Regardless of the relationship between TTS and PTS, we must have very good reasons to purposely put someone's hearing at risk before we recommend it as routine practice in hearing loss prevention programmes.

Methods to identify susceptibility to NIHL are an important research topic in the field of occupational hearing loss prevention and have implications for millions of workers exposed to noise on-the-job. Eventually, effective prognostic techniques might help prevent NIHL. However, the large proportion of mis-identified workers, the many factors that influence susceptibility, the evidence of permanent auditory damage from TTS-inducing exposures, the ambient noise environment and protective protocols required to safely implement TTS screening on worksites, and the regulatory limits in many countries all argue against broadly implementing prognostic TTS

Division of Applied Research and Technology, National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA

Correspondence to Christa L Themann, Division of Applied Research and Technology, National Institute for Occupational Safety and Health, 1090 Tusculum Avenue, MS C-27, Cincinnati, OH 45226, USA; CLT6@cdc.gov

screening at this time. Proven methods of prevention—reduction of noise exposure levels and consistent use of properly fit hearing protection devices—remain the surest approaches to reducing the burden of NIHL.

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