Estimation of lifetime noise exposures based on audiograms and international noise and ageing standards

Franks JR

National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, Ohio 45226, USA, jfranks@cdc.gov

Introduction

Exposures to noise and the simple act of ageing have negative consequences for hearing sensitivity: both result in loss of hearing. When studies have been conducted to determine the effect of either ageing or noise exposure on hearing, the primary task has been sort out the hearing impairment due to each. There are two standards (3,2) that propose methods for predicting the impact of noise exposure on hearing. Each standard provides reference databases; ANSI S3.44 included the two databases contained in ISO 1999 plus one additional. Just as these standards allow prediction of hearing loss due to ageing and noise exposure, their equations may also be used in reverse to determine the amount of noise that would be responsible for an observed, age-corrected hearing loss. These noise levels may then be compared to observed noise exposures in order to determine the accuracy or error of the standards. As well, this procedure may suggest modifications to the standards= equations may be in order.

Methods

Audiometric databases from mining and manufacturing sector companies were analyzed to determine the prevalence of materials hearing impairment by worker age. These databases contained date of employment, birth date, hearing thresholds with test dates, as well as some indication of noise exposure level and the use of hearing protectors. Exposure ranges were as low as 75 to 80 dBA and as high as 110 dBA. For those workers exposed to greater than 85 dBA, hearing protector usage was ranked from seldom to more than 50% of the time.

In order to have estimates of the prevalence of hearing impairment from each data base as function of worker age, it was necessary to first Aclean@ the data by removing questionable audiograms. The NIOSH Expert System (4) was used to filter all of the audiograms in the databases. Audiograms were removed if the thresholds were not repeatable on subsequent audiograms, if there were large interaural differences suggesting poorer-ear shadow audiograms, if the audiogram appeared to be affected by excessive background noise levels in the test booth, and for other irregularities.

For each database, prevalence of hearing impairment (binaural average hearing levels for the 1000, 2000, 3000, and 4000-Hz pure-tone average equal to or greater than 25 dB HTL re ANSI S3.6-1996) was calculated for each database as a function of worker age and compared to prevalence of hearing impairment predicted by the standards due to age alone. Figure 1 shows such a comparison. By reversing the equations in the standards, the amount of noise that would be responsible for the magnitude of observed prevalence of hearing impairment in this example was calculated to be between 98 and 100 dBA (8-hour time weighted average based on a 5-dB exchange rate).

From the low-noise exposed databases an age-based prevalence of hearing impairment was established which was compared to the standards. The prevalence values from the other databases were compared to this as well.

Results

The results indicate that the standards provide a greater weight to age than to noise and the differential emphasis is particularly noticeable as the exposure levels increase. The results also indicate that the standards= assumption that age effects and noise effects are additive is probably too simplistic. While the data show most hearing loss occurring within the first few years of employment, the standards provide a linear growth with time. Finally, the standards do not accurately predict further accrual of hearing loss once and initial noise-induced hearing loss has been sustained, as occurs frequently according to the data.

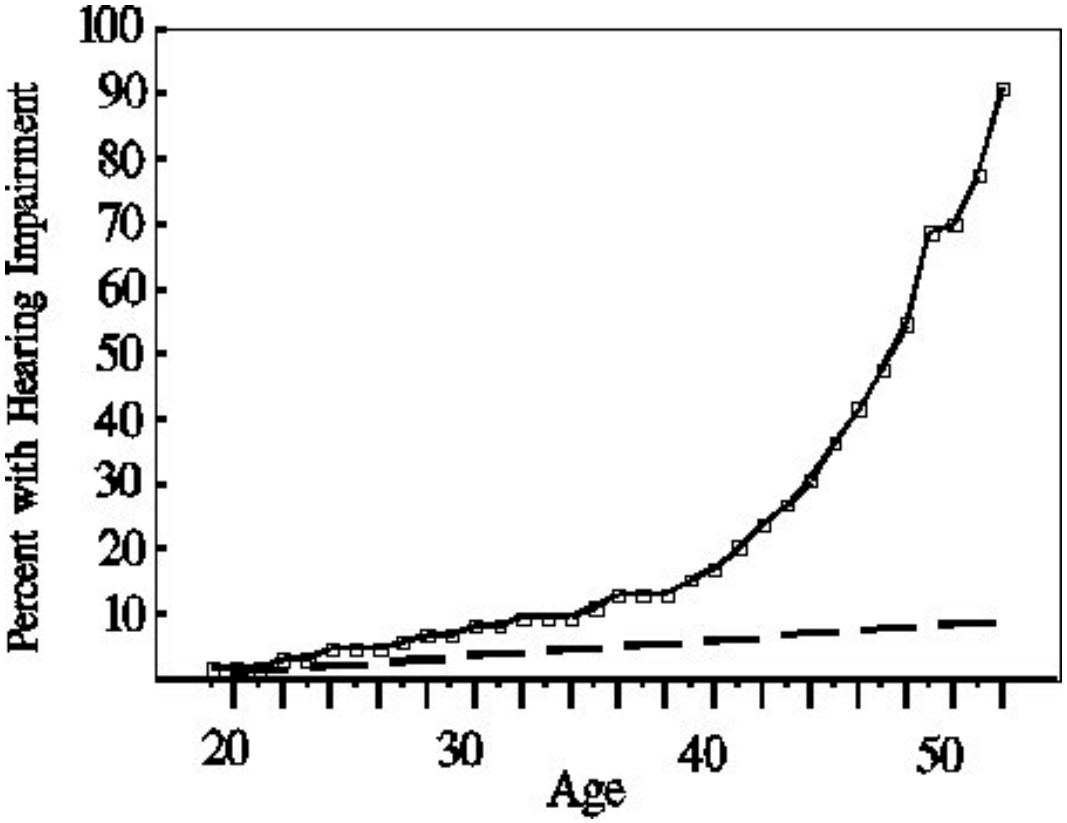

Figure 1. Percent of miners with NIOSH defined hearing impairment (average of 1000, 2000, 3000, and 4000 Hz => 25 dB) by age - solid line - compared to the percent of the non-occupationally exposed population having hearing impaired as calculated from ISO-1999- dashed line.

References

1. American National Standards Institute, ANSI S3.6-1996. American national standard: specification for audiometers. New York, New York
2. American National Standards Institute, ANSI S3.44-1996 American National Standard Determination of Occupational Noise Exposure and Estimation of Noise-Induced Hearing Impairment, New York, New York.

.3. International Standards Organization, ISO 1999:1990, Acoustics -- Determination of occupational noise exposure and estimation of noise-induced hearing impairment, Geneva, Switzerland.

4. NIOSH. Analysis of audiograms for a large cohort of Noise-Exposed Miners. John R. Franks, pp. 1-7, August 6, 1996. National Institute for Occupational Safety and Health, Cincinnati, Ohio.

NR 2001:10

x2001 – Exposure Assessment in Epidemiology and Practice

Mats Hagberg, Bengt Knave, Linnéa Lillienberg and Håkan Westberg (Eds)

ARBETE OCH HÄLSA | VETENSKAPLIG SKRIFTSERIE

ISBN 91-7045-607-0 ISSN 0346-7821 http://www.niwl.se/ah/

Dept of Occupational Medicine

ICOH Industrial Hygiene

National Institute for Working Life

ARBETE OCH HÄLSA

Editor-in-chief: Staffan Marklund
Co-editors: Mikael Bergenheim, Anders Kjellberg,
Birgitta Meding, Gunnar Rosén and Ewa Wigaeus Tornqvist

National Institute for Working Life
S-112 79 Stockholm
Sweden

ISBN 91–7045–607–0
ISSN 0346–7821
http://www.niwl.se/ah/
Printed at CM Gruppen, Bromma

Preface

This book contains the extended abstracts to the X2001 Conference on Exposure Assessment in Epidemiology and Practice in Göteborg, Sweden, June 10-13, 2001. The excellent work performed by the contributing scientists has made this book a first-class, up-to-date, state of the art review on what is known about exposure assessment today.

The outstanding scientific quality of the extended abstracts was secured through the work of five international programme committees. The chairmen for the committees were: Chemical, Patricia Stewart; Ergonomic, Alex Burdorf; Physical, Ulf Bergqvist; Psychosocial, Annika Härenstam and Biological, Jean-Francois Caillard.

Financial support to the conference and thereby to the publishing of this book was made possible by contributions from The National Institute for Working Life, Stockholm, Sweden; The Swedish Council for Working Life and Social Research, Stockholm and Volvo. Without the excellent skills of the organizing committee - Ulrika Agby (administration and layout), Ann-Sofie Liljenskog Hill (administration) and Christina Lindström Svensson (administration) - the production of this book would not have been possible.

We want to express our gratitude to the contributing authors, session chairmen and to the participants who presented papers and contributed in the discussions, for making X2001 an outstanding meeting.

Göteborg in June 2001

Mats Hagberg
Department of Occupational Medicin
Göteborg University, Göteborg

Bengt Knave
The National Institute for Working Life
Stockholm

Linnéa Lillienberg
Occupational and Environmental Medicine
Sahlgrenska University Hospital, Göteborg

Håkan Westberg
Occupational and Environmental Medicine
Örebro Regional Hospital, Örebro