Medical-Legal Evaluation of Hearing Loss

Third Edition

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Preface

In the 22 years since the first edition of this book, hearing research has made great strides, and this is the main reason why the book has twice needed to be revised. In 1993, otoacoustic emissions were mostly a laboratory curiosity; today they are part of the clinical toolkit, particularly useful for medical-legal evaluation. Interrelated genetic aspects of age-related and noise-induced hearing loss were then reasonable speculations; now they are facts. We continue to learn about the biology of hearing loss, including the roles of oxidative stress, conditioning exposures, and the olivocochlear efferent reflex; drug and nutritional interventions that may prevent age-related, noise-induced, and ototoxic hearing loss continue to emerge, although none have yet proved to be clinically viable. Personal stereo players and other sources of recreational music exposure continue to be scrutinized as nonoccupational causes of hearing loss, with more enthusiasm than convincing evidence. The effects that cardiovascular risk factors, race, and socioeconomic status have on hearing loss are better established now. New population-based survey data representing the hearing thresholds of American adults have been incorporated into a new (2013) edition of ISO-1999, an international standard that continues to be very helpful in medical-legal evaluation.

Old controversies remain (e.g., solvent ototoxicity; how to estimate hearing disability, including the role of speech testing; the hypothesis of progressive hearing loss after noise cessation; the relationships among hearing loss, depression, cognition, and dementia; the appropriate exchange rate for estimating hazard for fluctuating/intermittent noise; how best to assess the hazard of impulse noise), but in every case there are new data that help to resolve uncertainty. New controversies emerge (Does inaudible infrasound from wind turbines cause symptoms via the cochlea and vestibular system? Does noise exposure cause more loss of VIIIth nerve function than other causes of sensorineural hearing loss?), leading to abundant research opportunities.

All these advances and many others are discussed in the new edition. Every chapter has been revised and updated, with over 250 new references cited.

CHAPTER 1

Introduction and Overview

Robert A. Dobie

The Problem

About 38 million Americans (16% of the adult population) report some difficulty with hearing (Blackwell, 2014). Most hearing losses in the United States are associated with aging, excessive noise exposure, or both, without any other detectable ear disease (Dobie, 2008). Age-related hearing loss is neither preventable nor treatable. Noise-induced hearing loss (NIHL), whether caused by occupational or recreational exposure, is by definition preventable but is not medically treatable. In the developed world, prevention of NIHL (by noise level reduction and use of hearing protection devices) probably reduces the societal burden of hearing loss more than medical and surgical treatment of all other ear diseases combined.

Despite the growth of hearing conservation efforts in the past 30 years, NIHL continues to be a problem. This may be partly because NIHL develops slowly and insidiously, or because most people do not fully appreciate the problems of the hearing-impaired. The *existence* of NIHL was probably widely known in occupational medicine circles by about 1950, although a textbook from that time (Johnstone, 1948) mentions neither noise nor hearing loss. A few hearing conservation programs (HCPs) began appearing in the military and in industry during the 1940s and 1950s, but were hampered by a lack of consensus about harmful levels of noise. Based on discussions with senior occupational physicians, fewer than half of American workers with hazardous noise exposures were covered by HCPs as late as 1975 or 1980. Franks (1988) estimated that about 40% of these workers were in HCPs with audiometric monitoring by 1975. Although occupational noise exposure has been extensively regulated at the national level since 1971, some industries are exempt, and the Occupational Safety and Health Administration (OSHA) has not aggressively enforced existing regulations (detailed specifications for HCPs were not promulgated by OSHA until 1983). HCPs can be expensive, and there has been little financial incentive for industry to prevent NIHL other than the desire to avoid compensation costs, which have generally been modest.

The financial risks faced by companies with noise-exposed workers are rising. In 2003, OSHA introduced stricter rules requiring employers to report changes in

hearing as work-related illnesses; such reports can affect employers' insurance premiums. More workers are filing for and receiving awards from state workers' compensation systems as awareness of NIHL spreads within the general population. Workers in industries not covered by workers' compensation systems are suing their employers in court and receiving some very large judgments. Groups of workers constrained from suing their employers by workers' compensation coverage have filed suit against the manufacturers of the noisy machines used in their workplaces or against the owners of premises in which they had to work.

Medical-legal assessment of noise-exposed workers is increasingly required to assist employers, courts, and compensation boards in determining the extent and work-relatedness of hearing loss. NIHL is not the only issue; suits claiming hearing loss from head injury, neck injury, and medical malpractice are common, and expert medical assessment and testimony are required in these cases as well. The principles of assessment, diagnosis, and allocation are the same, whether NIHL or other types of injury are at issue.

The natural experts for medical-legal evaluation of hearing loss are otolaryngologists (physicians who have completed 5 years or more of postgraduate training in the diagnosis and management of disorders of the ears, nose, throat, and head and neck). Some otolaryngologists limit their practices to otology (ear disorders); otologists have usually had additional training in medical and surgical treatment of ear disease but are not necessarily more qualified to assess medical-legal hearing loss cases than other otolaryngologists. Many otologists and otolaryngologists feel ill prepared in the medical-legal arena, because their training emphasized treatable disorders, especially those that are surgically treatable. The principal goal of this book is to assist these physicians in providing medical-legal assessments that are scientifically based, rational, practical, and quantitative (where that is possible). The book should also be of interest to audiologists, occupational physicians, attorneys, industrial hygienists, engineers, safety experts, and insurance and risk management professionals—all of whom play important roles in the management and prevention of hearing loss claims.

The Scope of the Book

Chapters 2 and 3 present elementary discussions of acoustics, the ear, and hearing tests. While most of this material may be superfluous for otolaryngologists and audiologists, it is essential for members of other professional groups who wish to use this book to become better-informed consumers of otologic reports.

The subtle and often-frustrating art of detecting and managing exaggerated hearing loss is discussed in Chapter 4 by the late Jack Snyder, an audiologist with extensive experience and great skill in this area. In workers' compensation, financial awards are usually based on pure-tone thresholds—the softest sounds that a subject admits to hearing. The validity of these thresholds depends on a subject's honesty and best efforts, neither of which can be assumed in the medical-legal arena. Too many audiograms are simply accepted at face value, without considering whether they may portray a more severe loss than really exists or even a hearing loss where none exists.

Chapter 5 explores the complex relationships among hearing impairment, hearing handicap, and hearing disability.

The fundamental question is how best to estimate the impact that hearing loss has on an individual. Job-related issues, such as the ability of a hearing-impaired person to hear warning signals and carry out the communicative demands of a job, are discussed, but the majority of the chapter deals with the more general problem of interference with speech understanding in everyday life. The most frequently used methods for determining hearing handicap use pure-tone thresholds for those frequencies judged most important for speech perception, but there is considerable controversy in this area.

Even without hazardous noise exposure and other types of trauma or ear disease, almost all people develop significant hearing loss as they age. The term *presbycusis* has been used to describe this phenomenon, but this term means different things to different authors. Thus, Chapter 6 discusses age-related hearing loss (ARHL) in terms of anatomical and physiological changes, possible mechanisms, and epidemiological studies. Some people lose hearing more rapidly than others, of course. Some of this variation is attributable to risk factors such as male sex, low socioeconomic status, and cardiovascular risk factors such as smoking and diabetes; genetically determined susceptibility is probably also important. It is essential to consider the *distribution* of severity of ARHL at each age in order to understand the studies of NIHL in Chapter 7, and to make reasonable estimates of the relative contributions of aging and noise in individual cases.

Chapter 7 presents the topic of NIHL from occupational exposure. The effects of continuous noise are distinguished from those of impulsive noise, acoustic trauma, and blast injury. Interactions with other forms of hearing loss, especially ARHL, are discussed, along with epidemiological studies comparing noise-exposed subjects to non-noise-exposed control subjects. The International Organization for Standardization and the American National Standards Institute have published nearly identical documents (ISO-1999 [2013] and ANSI S3.44 [1996], respectively) summarizing the combined effects of age and noise exposure on hearing at different frequencies. The ISO/ANSI model predicts the distributions of hearing loss to be expected, given age, sex, exposure level, and duration.

In almost all claims for compensation for NIHL, it is important to consider both aging and occupational noise exposure as possible causal factors. A third important factor, often overlooked, is nonoccupational noise exposure. Chapter 8 reviews the evidence that such exposures, especially through hunting and target shooting, are both common and hazardous. "Dose-response" data (like those in ISO-1999 and ANSI S3.44) relating severity of exposure to magnitude of hearing loss are not available for gunfire, but a history of regular shooting must be considered as contributory in noise-exposed workers.

In Chapter 9, Dennis Driscoll, an experienced and prominent acoustical engineer, discusses the evolution of hearing conservation in industry. When workplace exposure levels can be brought below 85 dBA, occupational NIHL will be negligible and claims can be strongly defended. Even when exposure levels cannot be kept below potentially hazardous levels, a well-managed HCP can minimize occupational NIHL and can provide data regarding exposures (both occupational and nonoccupational) and serial audiometry which can be quite helpful in managing later claims. Otologic referral during the course of employment, based on baseline abnormalities or shifts seen on annual testing, also yields information useful for both prevention and analysis of

claims. On the other hand, a poorly managed effort or one that merely documents hearing loss without adequate intervention leaves an employer deservedly vulnerable to successful claims.

While most medical-legal claims for hearing loss involve occupational noise exposure or acoustic trauma, some will involve claims of head or neck injury or ototoxicity; in others, all or part of their losses are attributable to any of a variety of ear disorders unrelated to the legal claim. Chapter 10 surveys the spectrum of causes for hearing loss other than noise (including blast injury) and aging. Some of these disorders cause otolaryngologists little diagnostic difficulty (e.g., chronic otitis media or temporal bone fracture). Otolaryngologists vary substantially in their criteria for diagnosing other disorders, such as Ménière's disease. Otologists and otolaryngologists will find summaries of relevant literature in this chapter, while nonphysician readers will find this chapter helpful in interpreting physicians' reports.

In Chapter 11, Tom Jayne, an attorney with wide experience in hearing loss litigation, summarizes the legal aspects of hearing loss claims and the different ways that these claims are adjudicated and paid in the United States. Variation among jurisdictions is wide, regarding issues such as formulae for hearing handicap, allowance for presbycusis, consideration of tinnitus, and aggravation of preexisting loss.

Chapter 12 describes what happens when the claimant comes to the otolaryngologist's office. A structured interview is essential, and questionnaires can help. Review of prior audiograms and noise exposure measurements, when available, is also essential. The otolaryngologist should work closely with the audiologist to gather a data set that will permit valid conclusions regarding severity and causation of hearing loss. This sometimes requires repeat visits to resolve issues of exaggerated hearing loss or reversible outer and middle ear conditions.

The otolaryngologist has no laboratory test or x-ray available to prove the diagnosis of NIHL or ARHL; these diagnoses rely primarily on history (including noise exposure history and serial hearing tests). Most patients claiming compensation for NIHL have ARHL, with or without additional loss attributable to NIHL. Chapter 13 describes the well-known process of differential diagnosis (identifying the cause or causes of hearing loss) and the much less well-known process of allocation (estimating the relative contributions of different causes to the total hearing loss, or to the total hearing handicap). The allocation methods presented in this chapter are based on epidemiological data (especially the ISO/ANSI standards) and common sense, and use the hearing handicap formula proposed by the American Academy of Otolaryngology (AAO, 1979) (adopted the same year by the American Medical Association, and now referred to as "binaural hearing impairment"). Several case studies illustrate the use of these methods, which do not usually require calculations more complex than those used in the AAO hearing handicap formula. However, sound professional judgment is essential to determine when to allocate, which method to use, and how to use it.

The physician's report must completely and succinctly describe the data collected, the conclusions reached, and the reasons for those conclusions. Chapter 14 continues the use of case studies to demonstrate the elements of good medical-legal reports in hearing loss cases.

In Chapter 15, Tom Jayne covers an area many physicians and audiologists find uncomfortable: testimony in deposition and in court. Most cases never come

to this, but any clinician seeing medical-legal cases will be in court sooner or later. A competent expert witness with a valid point to make can create a poor impression without some understanding of courtroom demeanor, procedures, and strategy.

Appendix A contains tables of typical noise levels for workplaces, machines, tools, vehicles, firearms, and the like. Appendix B gives a tabular summary of state and federal hearing loss compensation regulations (circa 2000). Appendix C lists all the abbreviations used in the book.

This is not a book about NIHL per se. Very little of the basic science of NIHL is discussed, except to the extent that these data are necessary to understand NIHL as a clinical (and specifically medical-legal) problem. In addition, other ear disorders are prominently discussed, and the assessment and allocation methods proposed are not unique to NIHL. In particular, it would be illogical to devise methods for hearing handicap assessment and compensation that would be suitable for one ear disorder and not for others. Readers interested in additional in-depth study of NIHL are urged to consult the books and papers cited in the appropriate chapters. Nonauditory effects of noise (annoyance, sleep disturbance, physiological changes) are discussed only briefly.

This is not a book on forensic otology. Such an undertaking would require much more extensive treatment of vestibular disorders, facial nerve disorders, and medical malpractice than attempted here. Rather, the focus is on hearing loss (and tinnitus, its frequent companion), with these other otologic topics discussed only to the extent that they are relevant to hearing loss. Although many inner ear disorders affect both hearing and balance, vestibular dysfunction is not extensively treated in this book for several reasons. First, most hearing loss claims involve NIHL, in which vestibular damage is rarely at issue. Second, vestibular function testing is complex, controversial, and of questionable value in estimating handicap and disability. Third, and most important, what is known about hearing loss is more than enough for this book.

We hope this book will be useful as both a didactic text and a reference. Relevant literature has been selectively and critically reviewed. Topics of potential medical-legal importance have been discussed in more detail and with more documentation than those that are primarily of didactic interest. Recent publications have been chosen over older ones, accessible publications over those that are obscure or abstruse, and (in some areas) review articles over primary publications. In some cases, these policies may promote clarity and the reader's convenience at the expense of fair acknowledgment of original research contributions, but we have tried to accurately describe the history of the field: When was a particular fact known widely? (This is often important in medical-legal cases.) In reviewing the state of knowledge, we have attempted to distinguish certainty (or at least consensus) from controversy. Multiple case studies are worked through in Chapters 13 and 14 to show the reader how to solve actual problems in practice.

Many legally important topics have been addressed by more or less authoritative governmental and professional groups, including the Occupational Safety and Health Administration, the American National Standards Institute, the American Academy of Otolaryngology-Head and Neck Surgery, the American College of Occupational and Environmental Medicine, the National Institutes of Health, and many others. The pronouncements of these groups are liberally referenced and discussed in various chapters, both because they may