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Recommended Citation
Abraham I. Goldner, The Ear, the Law, and the Otologist, 18 DePaul L. Rev. 514 (1969)
Available at: https://via.library.depaul.edu/law-review/vol18/iss2/11

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THE EAR, THE LAW, AND THE OTOLOGIST

ABRAHAM I. GOLDNER*

There are three principal areas where the otologist comes in contact with the law. These will be discussed under the headings of:

I. Otological Evaluation of Head Injuries.
II. Noise: Hearing and People.
III. Rating of Hearing Disability, Measurement of Hearing: Methods, Paradox and Challenge.

Each of these could easily fill a tome, but as difficult at it may be, I have decided to present all three in a simple and useful style, drawing upon a unique and long experience with the effects of trauma and noise upon the ear, complemented by a more unusual background of additional experience in the broad fields of disability evaluation and occupational disease prevention. Though this presentation is particularly designed for a legal audience, it should be of interest to students of other disciplines. There is ample supplementary material in medical and legal texts, medical journals, and even in the lay press. My purpose is not solely to inform the reader, but also to stimulate interest and concern. If at times I seem to have become a protagonist, I truly confess to being partisan to the cause of preventing any degree of hearing impairment from excessive occupational noise and to the elimination of what has come to be known as the fourth pollutant—excessive community noise, with its undoubted impact upon comfortable living and unpredictable effects upon health in general.

OTOLOGICAL EVALUATION OF HEAD INJURIES

The head area is most frequently injured in auto accidents, and is also a major cause of disability in occupational and other types of

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514
Cross Section of Ear. (A) Note that ear is contiguous to the brain. (B) The cochlea (nerve of hearing) and vestibular (balance) form the VIII (auditory) cranial nerve. The facial (VII) in close proximity. The cochlea (sense organ of hearing) (D) and the labyrinth (C) are suspended in fluid in part of the basal skull. They are susceptible to damage from shock waves transmitted by a blow on the head. (E) Note that bleeding may come from the ear drum or ear canal. (F) Illustrates rich connecting nerve supply from nerves of the neck to the inner ear.

civilian injuries. The cochlea, the sense organ of hearing, and the labyrinth, the sense organ of balancing and position, are suspended in a fluid medium in a part of the temporal bone which in turn is part of the basal skull area. A paper-thin bony layer separates the middle ear from the overlying brain. The acoustic nerve arises from the cochlea and joins with the vestibular nerve from the labyrinth to form the

of Ophthalmology and Otolaryngology. Dr. Goldner has written numerous articles appearing in medical journals.

1 See generally Goldner, Inner Ear Evaluation of Head Injuries, presented at symposium, National Ass'n of Claimants' Compensation Attorneys, New York City, July 1, 1957; Goldner, Scope of Otolaryngology in Occupational Trauma and Disease, 55 Arch. Otolaryng. 641 (1952).
auditory or eighth cranial nerve. The seventh cranial nerve or facial nerve has an intimate relationship with the middle and inner ear structures and auditory nerve. The auditory nerve in the brain has connections with various way stations and tracts within the brain, and the connections of the vestibular part of the nerve with the eye muscles form the basis for the objective evaluation of vertigo. Dislocation or disruption of the chain of tiny bones in the middle ear which have a major function in hearing has been noted with increasing frequency in association with head trauma. The connections of the nerve supply and the terminal blood supply of the inner ear with nerves in the neck account for frequent incident of ear complaints and vertigo in association with neck injuries.

Injury to the inner ear in head trauma has been extensively documented. Because the cochlea and the labyrinth are suspended in fluid they are extremely vulnerable even to relatively minor head blows. A striking example of the high degree of disability that can be produced by what might be considered a trivial accident is illustrated by the injury of John Glenn. Following a minor bathtub accident, he had to abandon his astronaut and flying career.

OTOLOGICAL SYMPTOMS IN HEAD INJURY

It is relatively simple to determine the need for otological consultation when the head injury is associated with bleeding from an ear, ear discharge, disturbing ear sounds, ear pain, or deafness. However, it is not generally recognized that the evaluation of dizziness requires the informed assessment of the function of the eighth cranial or auditory nerve, the cochlea and labyrinth of the inner ear, and the connections without and within the brain of the auditory and vestibular branches of the auditory nerve which arise from these areas. This is, of course, the function of an otologist, preferably one who is equipped by additional training and armamentarium to perform a complete examination. This latter sub-speciality is also known as neuro-otology.

Dizziness, vertigo, ataxia or various forms of this complaint are, of course, the most common complaints in head injuries. When such

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2 Grove, Otologic Observations in Trauma of the Head, 8 Arch. Otolaryng. 249 (1928).
3 Inside the Inner Ear, Time, April 10, 1964, at 68.
4 See generally supra note 1.
complaint is found in a nonlitigant its veracity is not questioned. However, such a complaint in a litigant, following an injury improperly classified as trivial, and without loss of consciousness, positive skull X-rays, extensive medical treatment, or related lost time from work is usually greeted with skepticism. The neurological examination is generally reported as negative, frequently containing the statement or its equivalent, "cranial nerves intact." However, unless a proper neuro-otological examination has been performed, it cannot be validly stated that the auditory or eighth cranial nerve is intact. This examination frequently offers what has been termed demonstrative evidence, tending to corroborate the complaint of vertigo when all other tests and examinations are reported as negative.

Tinnitus is the term applied to a variety of sounds perceived by the patient in the ears or head. Most often described as a hissing, whistling, or bell-like sound, it may be constant or intermittent. It is more apparent in quiet surroundings and may provide the only clue to significant involvement of the inner ear and corroborative evidence of the more serious complaint of vertigo. It is frequently present, but often ignored by physicians, and overlooked by patients as being part of the concussion experience.

Although deafness per se is a relatively rare complaint following head trauma, significant degrees of hearing impairment, demonstrated by appropriate examination, are present in a large portion of head injuries, with or without loss of consciousness, fracture, or bleeding from the ears. It may be unilateral or bilateral and at times involve the ear opposite to what appears to have been the major side of head trauma. A failure to understand or comprehend is characteristic of the most common type of hearing involvement and this too often is equated with the confusion of the head injury, or what is worse, a lack of cooperation in a litigant. On the other hand, profound deafness is even more rare; if it occurs, hysteria or other forms of inorganic deafness must be ruled out. The most common type of hearing loss is a so-called cochlear, nerve, or neurosensory type of hearing loss. At times a severe conductive deafness may be produced by a traumatic disruption of the ossicular chain. However, this diagnosis must be confirmed by surgery. Depending upon whether or not the middle ear has been damaged, varying degrees of conductive or mixed deafness may ensue.

Frequently the most important aspect of the demonstration of a deviation from normal lies in its value of disclosing damage to the
inner ear, and associated mechanisms of balancing. Thus only a small dip in the 4,000 frequency, nondisabling as to hearing, can be useful as part of the objective assessment of vertigo.

Bleeding from an ear, while a dramatic symptom, may be misleading. If the source of the bleeding is accurately identified as coming from the middle ear, then even in the absence of positive skull X-rays it is customary to view such patients as having a basal skull fracture. However, it frequently arises from skin lacerations in the ear or ear canal area and may be of little significance.

Purulent ear discharge never occurs as an immediate finding in head injury but rather may manifest a late complication of middle ear trauma, or pre-existent middle ear disease. Injury to the middle ear may open potential channels of infection, leading to meningitis or brain abscess, even years after the injury.

Clear ear discharge in association with head injury denotes leakage of cerebral spinal fluid and is indicative of skull fractures.

Perforations of the ear drum frequently occur with head trauma. Usually bleeding is produced but may be masked by extensive bleeding from other areas around the ear. Most frequently it heals completely and, characteristically, may occasion no auditory disability. Unless the ear drum has been examined by an otologist, perforations or injury are frequently overlooked.

Aggravation or modification of prior deafness or ear disease is not uncommon. The allocation of responsibility is not simple, particularly in the absence of exact details of the prior condition. One must guard against the not uncommon tendency to associate unsuspected ear disease or hearing loss with a head trauma.

Facial palsy and disturbances of taste and smell are frequent complications of head trauma. The facial nerve may be injured in any of those areas of the ear through which it runs, leading to various degrees of facial paralysis or, depending upon the site of injury, disturbances of taste. Disturbance of smell and associated disturbance of taste are not infrequent, but are often unsuspected. The most common cause is the fracture of the fragile thin plate of bone through which the fibers of the olfactory nerve pass to the sense organ of smell located in the superior part of the nose. The disability is serious for, in addition to the inability to enjoy food flavors, there is the hazard of being unable to recognize deadly gas fumes.

Otalgia describes the variety of pain syndromes originating in the
ear area. It is frequently associated with head trauma, or via reflexes, to the so-called whiplash type of injuries.

EXAMINATION AND DIAGNOSIS

A comprehensive and detailed history with particular emphasis upon the nature of the trauma is basic. Details of treatment, X-rays, and other relevant laboratory data, as well as any details of prior injuries or conditions should be made available or procured.

The examination of the ear, nose, and throat areas is a standard part of any specialized otological examination and usually, except for scars or definite injury to the areas examined, is negative.

The examination of hearing is most important and is a basic part of the neuro-otological examination. It can be properly done only by a qualified otologist with an adequate armamentarium and background. It is desirable that the physician, whenever possible, perform this part of the examination, although certain portions of the examination may be delegated to a trained office assistant or to an audiologist (a nonmedical aide with specialized training in the testing of hearing impairment). In the presence of a significant deviation from normal, however, it is important that the physician personally supervise or corroborate the findings insomuch as the interpretation of the result cannot be separated from the whole person being tested.

Audiometry, using a properly calibrated instrument, is basic. Additional comments regarding audiometry will be found in a later section on measurement of hearing. It frequently will demonstrate significant impairments not demonstrable by other means.

The tuning fork is a basic tool used by neurologists to test vibration sense. It is also quite useful to the otologist, but when it is not supplemented by audiometry or other necessary specialized tests, it can lead to inaccurate diagnosis. Just as with a whisper or coin-click, a normal response may be consistent with severe hearing loss in one ear or a hearing loss of approximately twenty-five per cent to thirty per cent in both ears.

Other useful tests include speech audiometry, Bekessy audiometry, recruitment testing, and the Sisi test. These tests usually require more sophisticated equipment and more specialized training.

The recognition of exaggeration or malingering is an integral part of any examination where financial gain is involved. It is more properly
classified as inorganic deafness which can include the relatively rare condition of outright malingering to the more common conditions of simple exaggeration to classical hysteria, naivete, ignorance, or problems in language. It is absolutely mandatory that in profound deafness, either bilateral or unilateral, that this condition be considered as a distinct possibility and either confirmed or eliminated. The experienced otologist begins to suspect this condition on the basis of the history, interview, tuning fork responses, and gross testing. With proper equipment the Stenger test can be performed for unilateral deafness claims and frequently it can give an exact estimate of any possible underlying significant organic deafness. The recognition of bilateral severe inorganic hearing loss is more difficult. Sophisticated and not generally available tests, such as Galvanic Skin Response Audiometry, delayed speech testing, and Bekessy audiometry are useful tools for the detection of bilateral inorganic hearing deafness. However, such tests are not as satisfactory as the Stenger test for unilateral inorganic deafness. An awareness of the possibility of such exaggeration or inorganic deafness is probably as important as the performance of the various tests described. The skillful and experienced examiner can frequently, on the basis of the entire pattern of response, make a rough estimate of the underlying permanent hearing loss, if any.

The labyrinthine examination is the last, but certainly not the least important, of the evaluation procedures. As the hearing tests evaluated the function of the hearing apparatus from the middle internal ear to the brain, the labyrinthine test evaluates the function of the labyrinth, the vestibular portion of the auditory nerve and the intracranial mechanisms responsible for position sense and the maintenance of equilibrium. Insomuch as there are overlapping functions, the neuro-otologist observes the function of the other cranial nerves and the function of gait and station. Although there are a variety of labyrinthine tests, an extensive experience of thousands of cases in which the minimal ice water caloric test was performed has demonstrated that it is a useful tool. Findings, such as hyper-irritability or hypo-irritability of each labyrinth, inequality of response, or failure to respond to even massive quantities of ice water are significant findings. These are objective findings and, while not as satisfactory as audiometry, often help explain what otherwise would have been classified as subjective, as mentioned previously concerning the troublesome complaint of vertigo or dizziness.
The opinion results from the integration of the completed evaluation. As much as we would like to believe that, given the same set of facts and findings, two doctors must of necessity come to the same conclusions as to diagnosis, treatment, disability, and causal relationship, this is not necessarily so. Certainly, background and experience, particularly in litigation and disability evaluation, are important factors. At the very least we can insist that all the facts be completely considered and that the examination be as complete as possible. This is particularly true in litigation where the history and findings are obscured by the nature of the litigation process itself. In summary, it is hoped that this part of the presentation will make you aware of the role of otology in head injuries, and will particularly help you in evaluating that large group of claimants with complaints of dizziness following a head injury which would appear trivial without corroborative items such as positive X-rays, extensive medical treatment, or considerable lost work time.

NOISE: HEARING AND PEOPLE

It was originally intended, on the basis of extensive experience and concern with the medical, legal, and sociological aspects, to limit this portion to deafness arising from excessive occupational noise. However, in recent years we have been bombarded with a vast variety of disturbing noise. The sonic boom hovers over us with the impending doom of a jovian thunderclap. An aroused citizenry, unfortunately too often aroused from sleep, barely able to make themselves heard over the din, clamors for relief. Just as the worker suffering from occupational deafness may be deprived of his common law rights to a safe working place free from harmful noise, and the liability for work connected deafness may be whittled down by labor laws, the ordinary citizen seeking the undeniable right of acoustic privacy is pitted against the Goliath of big business, big government, and what too often is described as progress. Therefore it seems to me that some comments on excessive community noise are in order.

The source and character of disturbing community noise should be so apparent as not to require documentation. It requires no medical documentation to prove that proximity to a noisy airport does not increase the value of residential property. Most of our knowledge as to

5 Hazard of Noise, Modern Medicine, July 29, 1968, at 21.
Typical overall sound levels

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Maximum level for blast from 12-gauge shotgun

- Multiflame jet airliner

- Elevated train

- Pneumatic chipper (5 ft.)

- Discotheque (full volume)

- Trumpet auto horn (3 ft.)

- Power lawn mower

- Woodworking shop

- Inside a DC-6 airplane

- Inside a bus

- Inside a car in city traffic

- Average traffic noise (100 ft.)

- Conversational speech (3 ft.)

- Average residence

- Noisy business office

- Noisy kitchen

- Average traffic noise (100 ft.)

- Average residence

- Quiet business office

- Minimum levels for residential areas in Chicago at night

- Average residence

The Decible “Trap”—An annoying noise does not require a decible meter. Noise without people is just sound. To cause deafness sound must not only be above 80 db in intensity, but proximity, length of exposure, character of sound, environment, and susceptibility must be considered.
the physiological effects of noise have originated in studies of industrial deafness. While there are overlapping areas, despite a great deal of misinformation in the press, the actual medical problems are not similar. It is more difficult to measure the undoubted effects of excessive noise upon general health. It has been suggested that it can well be a factor in cardiovascular disease, ulcers, and emotional disorders, as the ear in its efforts to ward off, or as it reacts to excessive noise, initiates reflexes that interfere with the blood supply to essential organs. However this is almost impossible to measure and therefore to prove. As to hearing loss, the actual intensity of the offending noise can be misleading, since in order for a noise to be harmful to hearing, there are many other factors to be considered, such as proximity, conditions of exposure, and length of exposure. Thus while you may read of the effects upon hearing of "rock and roll" music and a glimpse at intensity levels of noise in our cities may lead you to think that we are in imminent danger of mass deafness, it just is not so! Nevertheless, on an individual basis it can damage hearing significantly and its deleterious effect upon the enjoyment of living and property values certainly should not be too difficult to prove.

Excessive occupational noise, on the other hand, has been extensively documented. Laboratory demonstrations and a vast number of case reports have established excessive occupational noise as one of the leading causes of hearing impairment. Perhaps, it is partially the fear of astronomical costs that have led to the adoption of guidelines for determination of hearing disability and other regulations that are contradictory to sound legal, medical, and preventive medicine principles.

It would be cumbersome to enumerate all the processes which carry a noise hazard. The operations vary among large industries such as boiler factories, steel mills, stamping mills, shipyards, and newspaper and printing plants. But any industrial process that involves the fabrication of metal, use of pneumatic tools or noisy machinery of any kind may carry with it a definite noise hazard to hearing. The military is a good example of an occupation containing many areas of serious noise hazards, as is illustrated by the numerous studies conducted on military personnel.

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6 Noise, University of Michigan Training Course, February 5-8, 1952.
7 For discussion of the effect of occupational noise, see Goldner, Occupational Deafness, 42 Arch. Otolaryng. 407 (1945); Goldner, Deafness in Shipyard Workers, 57 Arch. Otolaryng. 287 (1953); Noise, id.
In general it has been considered that noise of an intensity from 80 to 90 decibels, depending upon proximity, nature of noise, environment, length and type of exposure, and even individual susceptibility may produce significant hearing loss. The intensity is measured in an instrument known as the decibelmeter which also measures intensity of sound in different cycles, as it is believed that sound of certain cycles is potentially more harmful. However, it is difficult for the solitary measurement to reproduce all the varying types of sound, under different conditions, to which any worker may be exposed during his entire industrial life. Therefore, it is most important that when such measurements are produced in connection with a claim for industrial hearing loss that the measurements actually represent the level and character of sound to which the claimant’s ears were exposed. In the absence of such information, the inability to communicate except at loud levels, or at its worst only by sign language, would point to an industrial process with a probable noise hazard. It is unfortunate that the early involvement is insidious and insomuch as these workers are accustomed to carry on conversation at loud levels, the handicap is not recognized until they leave or retire from this type of activity, and then too often erroneously attributed to the natural attrition of age.

Tinnitus, a sensation of sound in the ears, is a frequent complaint. Fortunately it is more characteristic of early exposure with a tendency to become less bothersome and even disappear with continuing exposure and involvement of hearing. Occasionally an individual worker may have to change his occupation. The complaint of tinnitus is subjective and cannot be absolutely verified. On an individual basis, depending upon the genesis of the complaint and other indefinable features having to do with claims evaluation plus the classical pattern of an inner ear involvement, one can state with a reasonable degree of certainty that the complaint is genuine. If so, this condition can be quite annoying and disabling for tinnitus continues to be a therapeutic challenge to otology.

The diagnosis of occupational deafness should be quite simple. In its classical form it consists of a bilateral, fairly symmetrical, so called inner ear, nerve, neurosensory or cochlear type of hearing loss. Except in the rarer severe forms, fortunately confined to relatively few occupations, it is not generally recognized by the patient as a hearing impairment. At the most common level of involvement, the greatest impairment is for comprehension and understanding of words and sentences, and the patient or his family too often attributes this type of...
situation to attention failure or defects in the quality of the delivered sentence.

Involvement of one ear exclusively is very rare and is usually confined to those workers who have sudden accidental exposure of sound to one ear in loud intensities and under such conditions that will make only one ear susceptible to injury.

The differential diagnosis of occupational deafness must be tempered by the simple fact that there are many conditions which can produce a similar clinical pattern, and, in the absence of a history or other essential data, cannot be diagnosed as occupational deafness simply on the basis of the examination alone. By the same token it cannot be excluded in the absence of information as to hearing status before the onset of the suspect exposure, or by an absolute demonstration by accurate measurements of sound, that the process is incapable of producing a hearing loss. In addition, the employer may examine large groups of workers doing similar work, but his reluctance to do so may be understandable.

Occupational hearing loss may coexist or be superimposed upon other forms of deafness. Certain conditions, such as chronic middle ear disease, may make an ear more susceptible, just as other conditions such as otosclerosis may make an ear less susceptible. However, no condition confers an absolute immunity to damage from excessive noise.

Long exposure to excessive industrial noise does not produce any visible changes of the external ear or ear drum. Studies of large groups of such workers indicate that they possess the same incidence of deviated septum and large tonsils and sinus infections. It is rare, if at all, that such conditions can produce any but a temporary effect upon the hearing pattern.

The pre-employment audiogram, while important in any type of occupation, is especially so in those with an actual or potential noise hazard. When accompanied by a competent ear examination its value is enhanced, just as it is diminished without such examination. Because of variations in technique and testing of work environment, and its self-serving nature as an employer's defense against liability, the uncorroborated audiogram must be evaluated on an individual basis. If used as it should be, for selection of workers and the overall collection of medical information, it is a highly useful procedure and can shed light upon the etiology of current or subsequent hearing loss.

To summarize, in the preceding section I have endeavored to introduce you to the problems of noise as it affects the individual in the community and at work. As in the preceding section, by necessity and choice, I have skimmed lightly over the technical medical aspects, buttressed by the knowledge that those of you who are faced with a legal problem involving these issues have available more than adequate sources of supplementary information, and can easily call upon the informed otologist for guidance.

RATING OF HEARING DISABILITY, MEASUREMENT OF HEARING: METHODS, PARADOX AND CHALLENGE

In the last analysis it is disability, whether it is called damages, costs, loss of earnings, or impairment of function, which concerns the attorney. While his approach to purely medical aspects of a problem is, at best, that of an informed layman, in the area of disability he stands on an equal footing. Many of the procedures and concepts represent the end results of economic pressures, and compromise between protagonist and antagonist; and the lawyer either as a legislator or as a representative of interested parties, or as an administrator or judge, has played an important part in the theory and mechanics of disability in general and otological disability in particular. It will be shown that the methods and attitudes toward disability are not limited to the individual claimant but, like a pebble thrown in a pool, have an impact upon disease prevention, judicial and public attitudes, and even upon physicians. Unlike a disease, the subject does not lend itself to an orderly presentation with separated sections dealing with pathology, physiology, symptoms, diagnosis, or treatment. However, I will try to present this complicated and vital subject in the following order:

1. Sources or Authority—How or where does the otologist base his opinion as to disability or extent of hearing impairment?

2. General Concepts, Definitions of Disability, and Rating of Hearing Loss—What does the doctor mean by disability? Are the doctors and the lawyers talking about the same thing? Where hearing has been valued in relationship to other parts of the body, how does it compare?

3. Measurement of Hearing—What is meant by hearing loss? Why is there so much confusion and lack of standardization?

Goldner, Defects and Inequities of Hearing Loss Determination, presented at NAACA symposium, New York City, Dec. 12, 1959; see also Goldner, id.
4. Recommendations—What methods or procedures are most equitable and conform to precedents?

SOURCE OR AUTHORITY

Unlike the average orthopedist, neurologist, or even occasional general practitioner, the average otologist has little opportunity to either concern himself or be involved in questions of disability. Thus his opinions as to temporary or partial, permanent or total disability, the origins and implication of disability ratings, and other concerns are apt to reflect a general rather than informed attitude. Otological textbooks do not concern themselves with general principles of disability and if any part of the text is concerned with disability, it generally would be confined to a discussion of methods of calculating hearing disability on the basis of audiometric findings.

Until relatively recently even the methodology of determining percentage hearing loss was a hodgepodge of highly individualized procedures which did not have the merit of sponsorship of some official medical body.

Even today, expressing hearing disability in terms of the relationship of the distance of an observer using conversational voice to the patient at a distance of fifteen feet can be found in many jurisdictions and on many application forms for government work or service. It is not a procedure which is recommended by any official medical body.

In 1947, a special committee of the American Medical Association recommended that a weighted scale be applied to the frequencies of 500 to 4,000 of an approved audiometer as perceived by a patient. This system known as the AMA Method of 1947 is widely used. Though rarely used today, a system known as the Fletcher Method which utilized all seven frequencies enjoyed widespread usage simultaneously. In some jurisdictions, in its original form, and subsequently in a modified form, the Fletcher Method of computing disability was legally mandated in compensable injuries or disease of the ears.

In 1959, a subcommittee on noise of the Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology recommended a method for measuring and calculating binaural hearing impairment. This method has come to be known as the AAOO Method, and it utilizes only the 500, 1,000, and 2,000 frequencies in an attempt to calculate hearing disability.

In 1961, a group of consultants, consisting of several otologists and others, were assigned the task of promulgating a guide to the evaluation of permanent impairment of ear, nose, throat, and related structures by the Committee on Medical Rating of Physical Impairment of the American Medical Association. This subcommittee adopted the recommendations referred to above as the AAOO Method as a means of calculating hearing impairment. Other comments as to disability were published and will be referred to in the following section. I believe it is accurate to say that there is considerable disagreement as to the medical merits of the AAOO Method and the equity of its genesis. It is widely used and as time goes on it will be more universally utilized as a means of calculating hearing disability. Unfortunately, to the uninformed, the unconcerned, and the uncritical, the recommendations are accepted as having the force and validity of a legal statute. Indeed, it is a mandated procedure in many jurisdictions. But it is not similar to law, and essentially it is the medical opinion of a few individuals and by no means does it have the unqualified approval of a majority of informed individuals, despite the indirect endorsement by the AMA. Thus the otologist must be prepared to "defend" and explain his appraisal of disability and the method of determining hearing impairment, just as the attorney, fortified by adequate research, will be expected to challenge or support this most essential part of the medical opinion.

GENERAL CONCEPTS, DEFINITIONS OF DISABILITY, AND RATING OF HEARING IMPAIRMENT

For the most part, procedures, philosophy, and effects of disability determinations have evolved around workmen's compensation laws. The major impact of disability methodology, even today, is upon the rating of disability arising from occupational accident or disease. As the control of occupational hearing impairment does not lend itself to prohibition of harmful noise, nor regulation by codes, such as do phosphorous or lead or dust disease, then the factor of cost to industry becomes an important factor in stimulating the adoption of measures


12 COMMITTEE ON CONSERVATION OF HEARING OF AMER. ACAD. OPHEL. OTOLARYNG., GUIDE FOR CONSERVATION OF HEARING IN NOISE, (rev. ed. 1964); see also supra notes 9, 10, and 11.
to prevent occupational deafness. The effects of recommendations for disability evaluation spread from workmen's compensation, to veterans disability evaluation, social security, medical diagnosis, and to other types of civilian injuries. In compensation procedures, whether state or federal, the degree of disability of a limb, finger, toe, eye and ear has no relationship to earning capacity, and even if the claimant has not lost one penny in wages, compensation is due for significant functional deviation of a member.\textsuperscript{18}

The Committee on Medical Rating of Physical Impairment, and its consultants, have set down detailed principles and instructions as to "permanent impairment of the ear, nose, and throat structures."\textsuperscript{14} It is doubtful that many otologists have given even a passing glance to this article. But the attorney should study it carefully. Essentially, the committee attempts to separate impairment from disability. It relates disability to overall ability of everyday life activities. It enjoins the physician from considering the social or economic effects of permanent impairment. What is "minor disability" is ignored. As to hearing, the basis of the recommendations, the so-called AAOO Method was the ability to hear everyday speech under everyday conditions. It excludes from consideration a significant degree of actual hearing impairment, as will be demonstrated, and makes no provision for those many instances where the arithmetic result does not coincide with the actual hearing loss.

A doctor cannot hold himself aloof from the social, economic and medical effects of a rating procedure. The finding of zero disability, even if accompanied by an explanation that the findings are not normal, can have a shattering impact upon the overall problem of disability, when part of the substantiating medical evidence of the disability is the admitted impairment classified as being "zero disability."

A comprehensive study by Meyer Fox\textsuperscript{15} illustrates the lack of uniformity in utilization of methods for calculating hearing disability in the 50 states. The military, the Veterans Administration, and other bodies of jurisdiction set their own standards. Understandably the otologist in court will utilize any one of the methods. This underlines the problem and makes it mandatory that he understand the background and methodology of the opinion.

\textsuperscript{13} \textit{Supra} note 8.
\textsuperscript{14} \textit{Supra} note 11.
The so-called six months rule is an example of a legal statute, which places the victim of occupational deafness in a limbo where, theoretically protected by compensation law, he is barred from seeking relief under well-established principles of common law. He is unable to complete a claim for occupational deafness, no matter how severe, until he separates himself not only from the alleged noisy exposure but also from the alleged noisy employment for a period of six months. This allegedly was based upon medical reasons; however the medical reasons were never authenticated and even those who propounded such reasons previously no longer contend that they are valid. However, in some jurisdictions, like New York, it is woven into the fabric of the law and moving a mountain is a relatively simple procedure as compared to changing a law. No other occupational disease or disability carries with it such a restriction; and a concept that by law encourages the maintenance of a health hazard until such time as maximum damage has been done violates every canon of occupational disease prevention and legal precedent.

The rating, or more simply the determination of the value of hearing impairment, has an interesting background, and although the special committee referred to previously states that it is not the function of the physician to concern himself with this area, in fact, it makes many recommendations which clearly assign a value to a disability. As an example, a detailed chart is presented where binaural hearing impairment (about which you will learn more later) is related to the whole man impairment. It is recommended that a binaural impairment of 98.9 per cent to 100 per cent is equivalent to 35 per cent of the whole man. Those of you who have had occasion to come in contact with a man of normal hearing suddenly deprived of his total hearing would probably not agree with this concept that the man is only 35 per cent disabled from pursuing a gainful occupation. If a person completely deafened at birth is able to achieve a gainful place for himself in society, or if a patient severely handicapped in hearing is able to rehabilitate himself adequately, this is not a measure of the disability but rather a tribute to the individual.

Even the law has relegated hearing impairment to a position of relative unimportance. For instance, the loss of a thumb in New York State is rated as the equivalent of 75 weeks of disability, whereas the complete loss of hearing of one ear is rated as 60 weeks. The complete loss of useful hearing in both ears is rated as 150 weeks or merely 30 weeks greater than the combined total of each ear separately.
pare this to the total disability as legally afforded by statute when useful loss of function of two extremities, or the combination of an eye and an extremity, or two eyes, are suffered. These inequitable procedures do have an effect in arriving at otological disability. They probably have come about due to a combination of political convenience, economic factors, and ineffectual or uninspired representation, medical or otherwise, and the general attitude which greets the hearing handicapped as compared to the genuine sympathy and concern afforded, for instance, to the blind or to the amputee.

In the preceding pages, I have endeavored to acquaint you with general principles so that, at the very least, you can judge for yourself the authenticity or the background of an expression of disability. Perhaps as members of the legal profession who do have a significant role in definitions of disability, it will not only inform you but stimulate necessary reforms and changes in procedure and law.

MEASUREMENT OF HEARING

One would hope and expect that in the measurement of hearing, there should be uniformity in method, wide acceptance of the procedures, agreement as to the extent of impairment, and at the very least a correlation of the finding with the clinical complaint of hearing loss. Unfortunately, the opposite frequently results. It is hoped that some of the reasons for this will become clearer as the presentation proceeds.

Hearing in its broadest sense implies the perception of all types of sounds, from the rustling of leaves to the roar of traffic. Naturally, the most important function is the translation of conversational sounds into meaningful speech patterns. Sound travels in waves of specific frequencies measured as cycles or vibrations per second, and the intensity of the sound, either at its source or as perceived by an observer, is measured in decibels. While the human can perceive sounds of a frequency range from an approximate low of 32 cycles per second to an average maximum of 18,000 cycles per second, the range of 125 cycles per second to 8,000 has been considered the most useful, and within this range the frequencies from 250 to 6,000 make up speech sounds with the most important function centered in the 500 to 4,000 frequencies. The ability to hear pure tones as these frequency sounds are called is easily measured on an audiometer; and usually the frequencies from 125 per second to 8,000 per second in octave steps are measured. The response is recorded in decibels which is not a term of absolute
value as an inch or a pound, but a term of relative value. One decibel is approximately equal to that intensity of sound barely perceived by a normal individual. However, impairment grows logarithmically, meaning that the difference of five decibels between ten and fifteen decibels is much less significant than a difference of five decibels between an impairment of 70 and 75 decibels.

The measurement of hearing prior to the development of the audiometer consisted in recording the distance in feet that a patient would respond to conversation in relationship to a presumed normal of 15 feet. One still sees this method on physical examination forms. Its undeniable virtue lies in the fact that the completely deafened or the profoundly deafened were equitably classified. Its limitations, however, lie in the inability to recognize as much as a 30 per cent defect in hearing except perhaps by the most skillful of observers and the difficulty of standardizing levels of voice stimulation. Also, if utilized by the untrained observer, a profound hearing loss in one ear could be overlooked insomuch as simply occluding the opposite ear by a finger does not effectively exclude that ear from recognizing sound or conversation effectively.

In the hope of creating a simple standard procedure, the measurement of pure tones by audiometers was seized upon as the solution. Today with qualifications in very small print, generally ignored, hearing disability is defined as a percentage derived by mathematical formulae applied to a limited number of pure tones depending upon the method either utilized or mandated. What compounds the problem is that even the audiometer, as used by different examiners, may differ in standardization. At present most audiometers in otologists' offices are probably standardized with values recom-

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One of many types of audiogram charts. Note ISO-1964 and ASA 1951 scales and correction factors above. Note frequency range from 125 to 8000, most usual range of testing. Note the narrow unshaded area, the restricted portion of the sound spectrum upon which AAOO hearing disability calibration is based. The shaded area, "the zone of silence," in many instances is even greater. The hatched area shows the increased area utilized by AMA 1947 method of computing hearing disability but still a limited part of sound spectrum.

mended by the American Standards Association. However in most Speech and Hearing Centers, and with some otologists who have recently acquired audiometers, the standardization is apt to be that recommended more recently by the International Standards Association. The former is conveniently listed as ASA and the latter as ISO. Eventually all audiometers will be ISO standardized but until that time you must recognize this as a factor in comparing two opinions, and if there be any difference because of variations in audiometers, be certain that the recommended corrections are applied to the derived pure tone values. Beginning with the method of Fletcher, utilizing 80 per cent of the average of impairment of seven frequencies from 128 to 8,000 as a measure of hearing loss, and terminating in the so-called AAOO Method which utilizes only the three frequencies from 500 to 2,000, there have been many different procedures based on perception of pure tones. The AAOO Method, as has been pointed out, is the most recent method recommended by the AMA, and I have already commented upon the nature and weight of this endorsement.

The other method which is often utilized is the so-called AMA Method of 1947. Under compensation procedures in New York State, the AMA Method of 1947 is required for traumatic hearing loss claims, and the AAOO Method, for occupational hearing loss claims. For military claims and claims involving governmental employees, the AAOO Method is also required, but for other workers with the same condition, under federal jurisdiction, the AMA Method of 1947 is utilized. This practice of utilizing two separate methods of computation of hearing loss disability is common in many jurisdictions. Some jurisdictions permit examiners to utilize methods other than the AMA of 1947 or the AAOO. Apart from the overriding consideration as to which method gives the most accurate estimate of hearing disability, it is incumbent upon attorneys and others to recognize and understand these differences so that at the very least such tests can be understood.

There are limitations in any method which attempts to rate hearing disability exclusively on the basis of pure tone perception. The most obvious but fortunately rare examples are conditions in the brain which preclude the proper translation of sound signals into comprehensible speech patterns, a form of receptive aphasia. In these people the perception of pure tones may be absolutely normal. More common are the many instances where, because of difficulties in comprehension,
the actual ability to hear and understand conversation is materially
greater than a percentage arrived at by applying a formula to pure
tone perception. More simply this leads to situations where a claimant
is advised that he has "normal hearing" or even better than normal
when in fact there is a subjective and objective hearing impairment.
Very frequently patients may have what amounts to loss of useful
hearing for conversation, and the calculated hearing disability may be
as little as 50 per cent.

The exclusion from consideration of deviation from normal of pure
tone perception is characteristic of the AMA Method of 1947 and even
more characteristic of the AAOO Method. The original Fletcher Method
had the virtue of considering significant any deviation from normal of
the seven frequencies usually tested (i.e., 125 to 8,000 cps).

The AMA Method of 1947 applies a weighted scale of values to the
frequencies of 500 cps to 4,000 cps. Values below ten decibels on an
ASA standardized audiometer do not carry any weight. These recom-
mendations were made on ASA standardized audiometer findings, and
it is doubtful that they would have been made for ISO standardized
findings which give an average value of twelve to fifteen decibels more
for the same degree of loss.

The AAOO Method applies a so-called "low fence" and eliminates
from consideration intensities with an average of 15 decibels in the
frequencies 500 cps to 2,000 cps for ASA standardized audiometers.18
For ISO findings the "blackout" is even more severe, averaging be-
tween 25 and 30 decibels loss from normal. The use of an averaging
technique for the three frequencies can lead to an elimination from
consideration of almost a total loss of the highly useful 2,000 fre-
quency.

The AAOO Method also eliminates completely any frequency above
2,000 cps.19 This excludes from consideration frequencies which are
necessary for comprehension of speech patterns. In effect a claimant
with a 22.5 per cent hearing loss could be found to have normal hearing
under the AAOO Method, while application of the AMA Method of
1947 to the same audiometric findings would corroborate this loss, and
furthermore be consistent with the complaint and other findings.

The downgrading of the 4,000 frequency has more serious implica-

18 Supra notes 10 and 11.
19 Supra note 15.
tions than its undoubted importance in overall hearing. This frequency is the earliest frequency involved in excessive noise. It is a sensitive index of drug toxicity, particularly streptomycin and similar drugs. It has been shown to be involved with other drugs such as aspirin, quinine, carbon monoxide, and lead. Even a minimal involvement may be in-

ASA STANDARDIZATION: O-right ear X-left ear

Common audiometric finding following head trauma. Complaint of noise in ears (tinnitus), being inattentive, and dizziness. X-ray of skull negative. Neurological examination negative. The minimal caloric test of balancing function showed a diminished reaction of the right labyrinth.

COMPARISON OF AAOO AND AMA 1947 METHODS:

<table>
<thead>
<tr>
<th>Right Ear</th>
<th>Left Ear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero %</td>
<td>AAOO</td>
</tr>
<tr>
<td>22.2%</td>
<td>AMA 1947</td>
</tr>
</tbody>
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EFFECT OF BINAURAL COMPUTATION AMA 1947—

New York State Compensation Values:

Loss of hearing one ear—60 weeks.
Loss of hearing both ears—150 weeks.
Each ear separated—right 13.2, left 1.2, total 14.4 weeks.
Binaural per cent—4.6%, equivalent to 6.9 weeks.
Net loss—7.5 weeks.
dicative of a brain tumor, or help corroborate a complaint of tinnitus or vertigo in conjunction with other findings. No amount of explanation can offset a finding of zero disability which would be forthcoming even if the patient or claimant has loss of every frequency beyond 2,000 cps. The AMA Method of 1947 at least includes the 4,000 cps, although it excludes a loss of less than ten decibels on the ASA scale, or more in ISO which could be significant.

The term binaural loss of hearing as applied to the percentage of hearing loss of both ears when each have an impairment is misleading and can lead to considerable inequity. Although it implies the overall effectiveness of two functioning ears, in effect it is a special formula which had its origin in laboratory experiments under ideal listening conditions, which corroborates basically the obvious premise that it is useful to have a good ear, when one has a deaf ear, as it is useful to have a good eye or a good limb in the presence of a severe functional impairment of the other. In hearing loss, however, this observation has been converted into a mathematical formula which, in effect, reduces the entitlement of a sufferer from severe unilateral deafness. The practice of weighing the possession of a good member against a severely impaired member fortunately is limited only to the ear. In other systems if anything, the involvement of two members more often than not enhances the disability. In New York State, for traumatic hearing loss under compensation procedures, the procedure has been changed so that the so-called binaural hearing is actually the true hearing ability of both ears, and is obtained by a simple averaging of the two values. This more accurate and more equitable method is also used in many other jurisdictions. The defect is applicable to both the AMA of 1947 and the AAOO Methods, and even to the older Fletcher Method.

Presbyacusia is the term applied to deafness which is loosely attributable to age. By the laity, and until recently even by the medical profession, it was assumed that as people grew older they grew more deaf. Research has shown that this increase in deafness is not a factor of age but represents rather an increased incidence of hearing loss from definite causes in the older age groups, as is true of many diseases. If the term is used, it should be reserved to the relatively rare instances of deafness in older people, generally of an advanced age with other evidences of true senescence. No allowances are made for presbyacusia in the AMA Method of 1947, or directly in the AAOO Method.
RECOMMENDATIONS

It should be apparent by now that there are many pitfalls for the unwary and uninformed in the interpretation of opinions regarding otologic disability and the measurement of hearing.

When comparing opinions and findings as to hearing loss, it is important that the standardization of the audiometer be noted. If the standardization is different, then a correction must be applied to the findings. With this reservation in mind the actual audiometric findings should be listed and compared. Variation in findings are common, due to errors in technique, equipment failures, the presence of temporary conditions which influence hearing, and varying degrees of conscious or unconscious exaggeration.

Having reconciled any differences in audiometric findings, it is then most important to determine which method of computing hearing loss has been used, and hopefully, on the basis of the preceding, either challenge or accept the validity of the findings.

Until such time as a truly representative meeting is held to formulate more equitable methods of calculating hearing disability on the basis of ISO standardized audiometric findings, actual impairments for speech, and taking into account the importance of deviations from normal of certain frequencies, I recommend the utilization of the AMA Method of 1947. The binaural computation should be modified to the extent that the loss of hearing of both ears be obtained by simple averaging of the loss of each ear. However, even this method has defects as have been enumerated, and the completed opinion should take these defects into account when the calculated result is at variance with the symptoms or the findings.

As to hearing aids, no comments have been made inasmuch as the AAOO Method properly makes no allowances for any benefit accrued by the use of such an appliance, in that it does not approach to any real degree natural or normal hearing.

SUMMARY

In the preceding pages, I have endeavored to share with the attorney some of my experience in dealing with the otological effects of head trauma, the effect of noise upon workers and people in general, and the principles of occupational disease prevention and disability evaluation.
It is, perhaps, fortunate that space did not permit description of highly technical hearing tests, such as SRT (speech reception threshold), Discrimination, SISI test, Bekessy Audiometry, and Delayed Speech Testing. If this article should help you to understand related problems as you meet them in your work, I have succeeded. At least it should point you in the direction of expert guidance should it be needed. I will be more than amply compensated if it stimulates you, the reader, and eventually helps in resolving some of the paradoxes and meeting some of the challenges which have been described.