Allocation Among Causes of Hearing Loss: The Concept, Its Pros and Cons

A commentary

By David M. Lipscomb, PhD

A claim for hearing impairment compensation can be subjected to an allocation procedure, an attempt to separate the suspected causes of the hearing deficit. An example is shown that forms the basis for reviewing the controversy surrounding allocation.

Litigation and resolution of hearing impairment claims have been major driving forces behind efforts to separate the etiologies of hearing loss. This article reviews the current rationale and procedures for determining allocation. While allocation is certainly a noble goal, the author believes that there is far too much evidence to refute a mathematically based calculation for such a procedure.

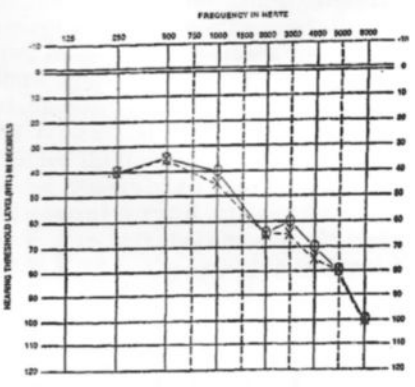

Fig. 1. *Hearing test results of a 65-year-old industrial hearing impaired compensation claimant. Note: bone-conduction testing was recorded, but was not included on this figure.*

The Claim

A 65-year-old man filed a hearing impairment claim against his employer of 37 years. He alleged that high noise in his workplace was responsible for the sensory (sensorineural) hearing impairment shown in Fig. 1. Noise exposure for this worker was 95-100 dBA on a regular basis throughout his work life. The claimant's medical, recreational and family history was unremarkable. It was determined that the primary influences on his hearing sensitivity were a combination of noise overexposure and aging.

Allocation: The "Pro" Side of the Argument

For years, claims reviewers, judges and juries have sought a way to allocate hearing impairment due to multiple causes, typically in the absence of pre-claim hearing test data. It is often stated that occupational noise exposure is not the only culprit. In hearing conservation programs, noise exposure questionnaires include non-occupational noise exposure information, as well as possible drug toxicity, illnesses and family history for hearing impairment. However, documentation of non-occupational noise exposure and other etiological causes is sketchy at best. The fact remains that determining the mixes of hearing impairment causation has frequently been left to courts and juries to allocate. As expected, the results have been inconsistent.

Multiple causation hearing impairments occur often. Hearing impairment due to some combination of noise exposure and advancing age is most common. Therefore, the concept of "allocating" between etiologies has become a quest. As might be expected, with the high stakes posed by alteration of hearing impairment consideration and compensation, controversy has been a constant companion to the movement. Proponents of allocation between etiologies have cited two principle bases:

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1) For clinical purposes, there is value in being able to determine the relative contribution of multiple etiological factors, and

2) The hearing impairment claims process would be advanced by the development of a means whereby the relative contributions of causes of hearing impairment can be separated and prioritized.

Some form of allocation has been utilized for decades. A "clinical feel" was employed to offer some idea of the parts played by two or more deleterious influences upon hearing. The educated guess yielded some "data free" estimate to how much hearing impairment is due to various causes. Some evaluators simply felt that one etiology prevailed and, therefore, the hearing impairment under consideration should be assigned to what was assumed to be the primary causative factor.

Still other reviewers attempted to allocate hearing impairments by studying noise exposure. With the use of *damage-risk criteria* (DRC), attempts were made to determine whether a claimant's hearing was consistent with the expected noise-related impairment. Noise exposures are not always known for a given worker or group of workers. Further, the wide variation in susceptibility to noise-induced hearing impairment between individuals affects the accuracy of the noise exposure analysis technique.

Lack of formalization in allocation attempts created problems when their introduction into the litigation process began. The "clinical feel" and "single prevailing etiology" approaches were challenged in cross-examination. Assumptions upon which a noise-exposure analysis was based were subject to attack. During the past decade, a formalized allocation method has been developed, advocated and advanced by Dobie.[1] Noting the high variability occasioned by the subjective attempts at allocation, Dobie postulated a mathematically based method for calculating relative contributions of noise exposure and age. The method is predicated upon two assumptions:

1) The AMA percentage of handicap formula offers a consistent, accepted basis for consideration of handicap;

2) Standardized references[3,4] provide estimates of *noise-induced threshold shifts* (NIPTS) and reference population data for age-related hearing levels.

Steps for the Determining Allocation: An Example

Allocation was applied to the claim example (Fig. 1) and appears in Table 1. Information for the illustrative case was gleaned from claim files for which an otological evaluation was conducted by a physician. Table 1 was constructed by the physician, and it serves as a worksheet for allocation calculations:

► *Step 1:* AMA percentage hearing handicap[2] is calculated (top half of Table 1). Recall that the handicap index is produced based solely upon pure tone audiometric test results. No consideration is given to any speech reception function.

► *Step 2*: Allocation calculations involve several procedures:

a) Age-related permanent threshold shift (ARPTS) for each ear is determined by referring to one of the standard references (ISO-1999[3] or ANSI S.3-44[4]). The examining physician chose data base (D-base) "B" as his reference. The tabled four-frequency average of mean age-related threshold levels was 17 dB;

b) Expected NIPTS is obtained by entering the reference tables for the period of exposure and sound pressure level. For this example, 40-year exposure duration was used and hearing thresholds for the 95 dBA and 100 dBA levels were averaged together to yield a 15 dB average.

c) Add ARPTS and NIPTS to arrive at the relative contributions of noise exposure and aging (17 + 15 = 32).

d) Percentage of *age allocation* is found by dividing ARPTS by 32. The proportion attributable to age was 53%. The noise allocation (in %) is found similarly by dividing NIPTS by 32, obtaining a value of 47%.

e) To determine the relative contributions of age and noise, handicap value for each ear and for binaural percentage are multiplied by the proportion for age and noise that were obtained in Step d.

Outcome: The relative contribution of the total 38.1% binaural hearing handicap is 20.2% relative to age, 17.9% for noise exposure.

Proponents for the above method for allocation point to the "standardized" reference population data bases (usually data base "B"[3,4]) and hearing impairment expectations from noise exposure of a certain sound level between 85-100 dBA for noise exposure durations ranging between 10-40 years (Annex "E"[3] or Annex "F"[4]).

The allocation method is attractive because: 1) Something like it has been necessary for decades; 2) The method is predicated on "standard" reference materials, and 3) It is straightforward to perform the calculations.

Subject Name: XXXXXXX Date of Birth: 00/00/29 Age: 65
Hearing test used (date): 0/0/95 Noise exposure level: 95-100 dB
Years exposed to noise: 37 Note: Median tabled data used

Step 1: Determine % handicap (AAO)

Hearing test frequency	Right ear	Left ear	Binaural
500 Hz	35	35	--
1000	40	45	--
2000	65	65	--
3000	60	65	--
Total	200	210	--
Total/4	50.0	52.5	--
Low fence factor	-25	-25	--
Fence adjusted avg.	25	27.5	--
	x1.5	x1.5	--
(x)% hearing impairment	37.5%	41.3%	--
Binaural	--	--	38.1

Step 2: Allocate between NIHL and presbycusis

Hearing test frequency	Right ear	Left ear	Binaural
PTA	50.0 dB	52.5 dB	
a) ARPTS (D-base "B")	17.0 dB	17.0 dB	
b) NIPTS for 95 & 100 dBA	15.0 dB	15.0 dB	
c) ARPTS + NIPTS	32.0 dB	32.0 dB	
d) % Age allocation (a/c):			53%
% Noise allocation (b/c):			47%
e) % Due to age (x x d)	20.0%	22.0%	20.2%
% Due to OHL (x - e)	17.5%	19.3%	17.9%

Table 1. *Worksheet for the allocation of hearing between noise-induced and age-related hearing loss.*

Allocation: The "Con" Side of the Argument

The supporting arguments for allocation may appear difficult to refute. However, a number of cautions and criticisms have been raised by opponents, including this author:

► *Inadequate scientific basis*: There is very little information concerning the technical, theoretical and practical basis for making distinctions among various causative factors of hearing defects.

Recall that the guiding principle for the framers of the AMA handicap calculation was to install *only* those features for which there was clear supportive data.

▶ *The Dobie[1] allocation method failed its first litigation test*: Intense litigation activity in the State of Washington concerned the *scientifically valid applicability* of allocation. Doubtless, other state jurisdictions will be involved in similar conflicts that were recently experienced in Washington State. A panel of Washington State judges rejected proposals for allocating between etiologies citing the following reasons[5]:

1) In the proposed method[1], group data were used as the basis for individual comparisons. The judges ruled that the statistical assumptions used in the application of the allocation method were flawed;

2) Allocation is not supported by histological, audiological and theoretical evidence. The assumption that hearing impairment related to noise exposure and to aging is additive (possibly synergistically interactive) is part of the allocation method. It was deemed by the judges, however, that it is impossible to fairly and accurately separate between a combination of interactive effects by mathematically deriving relative contributions of two or more causes.

3) The application of reference group data found in ISO-1999[3] and ANSI S3-44-1996[4] to a single individual violates the stated fundamental principle of making comparisons between sub-sets. For one reasons, the high degree of variability (wide confidence limits) found in the reference group data interjects the probability of appreciable error. The judges commented on the prohibition found in ISO-1999 which disallowed individual comparison to group data. The judges agreed that it was inappropriate to make such comparisons and also noted that a subtle change in ANSI S3-44 stating that such comparisons could be made "for statistical purposes" was made "with a wink and a nod."

4) The author of studies which provided much of the group data upon which ISO-1999[3] was predicated—the late Dr. Aram Glorig—claimed inappropriate use of his data. The widely ranging confidence limits deny any application of these data to individuals.

▶ *Physiological damage and audiometric indicators*: Auditory physiological processes in response to damaging influences are indescribably complex. In the most simple of examples, one etiology can damage a group of cochlear sensory hair cells while another etiology can damage a different group of cells and, at a cellular level, this combined damage is "additive" (but not additive in the thresholds determined by hearing testing). A more complex dilemma occurs when one asks, Which etiological process is the culprit when one of the etiologies injures or weakens (but does not permanently destroy) sensory hair cells and the next causative influence "finishes the cell(s) off?" This situation also pertains not only with regard to sensory elements in the cochlea, but to neural ones as well. For example, basal ganglia and first-order nerve fibers are seen to decay secondary to the loss of sensory hair cells. It is simply not yet possible to accurately assess which causative factor carries the blame. Allocating between noise-related injury and age-related effects attempts comparisons between early-in-life (noise exposure) and later life (age-related) influences, trying to blend them together in the "now." Related facts to the above include:

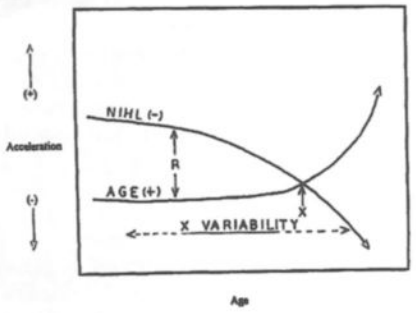

Fig. 2. *A greatly simplified illustration of etiological crossover. Crossover occurs when two influences, such as noise-related hearing impairment and presbycusis progress at different rates. The plus (+) indicates positive acceleration of aging while the minus (-) indicates deceleration over time.* R *is the relative influence of effects at a given age,* x *equals the crossover point and "x variability" represents the range of age periods in which crossover might occur.*

• *The pure tone audiogram as a poor indicator of cochlear sensory cell destruction*: Studies in the U.S. and Europe indicate "low" or "no" correlation between sensory cell damage and the pure tone audiogram.[e.g., 6,7] Data from these projects casts doubt as to whether pure tone audiometric test results are a valid indicator of the location, extent and nature of cochlear sensory cell and neural element damage.[8,9] In brief, it appears the pure tone audiogram does not consistently and accurately reflect the condition of the sensory units of the cochlea.

• *Weaknesses in the foundation for allocation*: The observed lack of correlation between hearing test data and sensory cell condition makes impossible the separation between effects of etiologies. One of the two "linchpins" upon which allocation is predicated (i.e., pure tone allocation results) is not valid with regard to the very information desired for use. The other "linchpin" for this procedure is the AMA formula for calculating percentage hearing handicap, itself subject to serious doubts as a valid handicap discriptor. There is no evidence that the AMA procedure was ever intended for use in etiological allocation.

• *Fallacious reasoning regarding "additivity"*: By assuming the "additivity" of two or more injurious influences on hearing ability, the assumption is made that if X% of sensory cell damage results in Y hearing impairment on the pure tone audiogram, then another X% of cell destruction by a second etiology would double the audiometrically measured hearing impairment. That assumption, while central to the concept of "additivity," is unproven and, therefore, cannot be available for use in allocation.

• *The timing factor*: The "time course" of audiometrically determined hearing impairment as a function of etiology cannot be ignored. In fact, it introduces perhaps the most complex features to be considered. Progressive noise-induced hearing loss (NIHL) is "negatively accelerating" with continued noise exposure. Presbyacusis is "positively accelerating" with age.[10] Then, at some period in a given individual's life, is "crossover" (Fig. 2).

It is not known how, at various periods in a person's life one can make a distinction between the positively and negatively accelerating influences. Further, the slope of progression varies between individuals with age, genetics and other factors. Therefore, crossover probably occurs at different times for different individuals. At some time, the accelerating etiology (e.g., age) becomes the greater influence on hearing. The difficulty is that the only certain means of recognizing when crossover occurs is through long-term serial hearing testing as part of a comprehensive occupational hearing conservation program.

• *Potential for incorrect applications of the Allocation Method*: The most accurate means whereby it is possible to identify influences upon a person's hearing is to moni-

tor that hearing over a period of years. If, for example, there is strong evidence that noise exposure is eliminated, then a gradual, continuing high frequency impairment is appropriately laid to the aging process. However, without serial audiometry, it is not possible to observe accurately the interactive effects of noise and age.

No single audiogram or limited number of hearing tests over a relatively brief period of a person's life can give sufficient information for separation between noise injury and age-related impairment.

It is dangerous if an attractive method is touted to do what seems to be impossible. Unfortunately, misapplications of the procedure can, and will, occur.

Returning to the claim at the beginning of this article, the allocation conducted by the examining physician and shown in Table 1 was based upon the last hearing evaluation conducted for the claimant. There was, however, a hearing test conducted on the claimant 20 years earlier in the same physician's office. The man's hearing in the earlier hearing evaluation was nearly identical to the one upon which allocation was calculated. The only difference is the 20 year greater age. Allocation showed a nearly equal "split" between age and noise effects (Table 1). The physician had allocated a hefty proportion of the 65-year-old man's hearing to age, thus severely reducing the calculated AMA percentage of hearing handicap. The claimant's hearing was unchanged for two decades. Although he still worked in noise, apparently his NIHL had reached asymptote. In the allocation calculation, the claimant was essentially "punished" by the procedure for simply becoming older. This example, one of several this author has reviewed, demonstrates the gross errors possible in attempting allocation. Careless and inaccurate use of allocation has the potential for unfair and inaccurate weighting of the relative influences upon hearing.

The adage "You can't make a silk purse out of a sow's ear" is classic wisdom which applies to the proposed allocation procedure. One simply cannot use limited hearing test data representing a brief portion of a person's life and expect to divide it accurately between complex contributors to hearing impairment.

• *Direct adjustment*: The effect of allocation between etiological influences is mono-directional. In the litigation and occupational injury claims arena, allocation *only* serves to reduce the calculated AMA percentage of hearing impairment. There are obvious questions as to whether a fair and equitable allocation method can ever be generated. As presently constituted, allocation mediates against all claimants.

Summary

Allocation is a noble goal. Professionals who evaluate hearing impairments either clinically or in the context of litigation welcome a reliable, valid, fair and equitable means whereby determination can be made between the contributions of negative influences upon hearing. A method for allocation between etiologies is needed. Movement toward the development of a method should be encouraged. However, an appropriate data base is needed. A sensible approach that is scientifically valid and reliable must be developed. Without these qualities, time and effort are being wasted in needless controversy. Opponents reject the argument that "allocation is needed, so let's hurry up and do it." That is like the imperative, "Let's do something—even if it's wrong!"

Juries have wrestled with questions regarding multiple influences for as long as there have been courts. Only when there is clear and uncontroverted evidence is it appropriate to apply the allocation principle. The data base does not yet exist upon which any currently proposed method can be predicated.

The controversy raises ethical questions. As presently proposed, mathematically calculated allocation between etiologies violates the need for strong scientific evidence as a foundation. Further, fairness is not guaranteed when the effect of allocation is to reduce the overall AMA percentage handicap figures for claimants. Any approach that unilaterally decreases handicap values without having scientific validity should be disallowed. It is unfair, unethical, immoral and is regarded in some venues (e.g., the State of Washington) to be illegal.

The caution must be offered that whatever is done—although it is not necessarily etched in stone—will be very difficult to undo. It is requisite to develop allocation methodology correctly in the first place.

Conclusion

Where do we go from here? Some readers will conclude that "We are right back where we started decades ago!" To a degree, that point has merit. However, the severity of impact resulting in rejection of the Dobie[1] allocation proposal is not as great as it would have been years ago. Never before have so many claimants had serial audiometric test results spanning, in many cases, decades.

Granted, it is not very labor intensive to complete an allocation calculation such as that shown in Table 1. Yet, members of the hearing health community who are dedicated to proper and fair adjucation of hearing impairment claims must endeavor to utilize all of the tools available. Proper distribution of causation is usually a time-consuming and rather arduous undertaking. It includes the use of serial audiometric testing, coupled with an assessment of relative exposures to occupational and non-occupational noise to develop a rational, fair and defensible division of causation between various candidates. There is far too much evidence to refute a mathematically based calculation such as that discussed herein.

Litigation and the resolution of hearing impairment claims has been the driving force behind the efforts to develop an allocation method. Employers contend that any hearing impairment compensation due to an employee should be predicated only on injury that can be attributed to occupational noise exposure. The plight of defendants is worthy of consideration and relief, but at unfair cost to claimants? A balance must be struck. The allocation method or protocol is yet to be developed that meets that goal.

From literature comes classic wisdom that applies to the controversy reviewed herein:

"It is a capital mistake to theorize before one first has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."

—*Sherlock Holmes* (as created by Arthur Conan Doyle in *A Scandal in Bohemia*) ◆

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