Classification and epidemiology of tinnitus

Andrew J. Heller, MD

Department of Otolaryngology/Head and Neck Surgery, Virginia Commonwealth University, Medical College of Virginia Hospitals, PO Box 980146, Richmond, VA 23298, USA

The history of attempts to treat and classify tinnitus date back to ancient Egypt. The Ebers papyrus includes great detail regarding the “treatment for a bewitched ear.” Infusions of medicine into the ear were common at this time (2500 BC), and one consisting of “balanites oil 1 portion, frankincense 1 portion, and sekhof 1 portion” is widely believed to be the earliest described treatment for tinnitus [1]. Assyrian clay tablets believed to be from the seventh century BC also described tinnitus, differentiating it into three types, each with its own specific treatment: (1) singing, (2) whispering, and (3) speaking. Descriptions of tinnitus continued throughout the ages with examples found in Roman, Byzantine, Medieval, and Renaissance literature. What is clear from these early descriptions of tinnitus is each society’s concern with the widespread prevalence and desire to classify and better treat this often devastating condition.

Today’s medical society has continued this quest. Tinnitus affects up to 30% of the adult population, with 6% of these individuals reporting incapacitating symptoms [2]. Although a universal classification system for tinnitus has not yet been realized, there are several factors that can be identified to assist in further differentiating the etiology in some patients. A standardized classification system for tinnitus is a vital component of the common language that must be developed to better define the etiology and treatment for patients.

Epidemiology

Prevalence

In 1978, the Medical Research Council’s Institute of Hearing Research performed the National Study of Hearing throughout certain parts of England. This was clearly the first large-scale investigation into the prevalence
of tinnitus, with over 19,000 respondents to the questionnaire. This study found that 16% to 19% of people over the age of 17 had experienced spontaneous tinnitus lasting more than 5 minutes [3]. Of these individuals, at least 8% experienced tinnitus as a moderate to severe annoyance or causing interference with sleep. Only 0.5% reported that tinnitus has severely hampered their ability to lead a normal life [4].

Other studies have been conducted in England, demonstrating a 9.7% prevalence of prolonged spontaneous tinnitus [5], and in Sweden, with 14.2% of adults reporting that they experience tinnitus “often” or “always” [6]. Five Italian cities were recently investigated, and 14.5% of the population reported prolonged spontaneous tinnitus [7].

In the United States, much of what is known about the prevalence of tinnitus comes from government agencies and their health surveys. Most recently, in 1996 the National Center for Health Statistics administered a survey regarding chronic illness. When all ages were considered, the prevalence of tinnitus was 3%. This was further evaluated to show a prevalence of 1% under the age of 45 and 9% over the age of 65 [8]. These numbers translate to roughly 36 million Americans with tinnitus.

A more localized investigation of the population in Beaver Dam, WI, found an 8.2% prevalence of tinnitus in 1993. Five years later, the same population was again examined to determine the risk of developing tinnitus in the at-risk population. The incidence of tinnitus was found to be 5.7% [9].

Demographics

Factors possibly affecting the prevalence of tinnitus include age, gender, race, socioeconomic status, hearing loss, and noise exposure. The National Center for Health Statistics examined several of these variables in their 1996 survey [8]. Another group of researchers at the Worker’s Compensation Board in Canada has also sought to better define the influence of these demographic factors on tinnitus [10]. The findings of these two studies are presented later.

Prevalence of tinnitus clearly increases with age, and this does not seem to be influenced by noise exposure. As an example, the prevalence of tinnitus is 4.7% in the 20- to 29-year-old age group and 12.1% in the 60 to 69 year olds. The data reported for each of the variables discussed next refers to the over-65 population.

Men seem to report a higher prevalence of tinnitus than women, although this is not a large difference (6.6% in men versus 5.6% in women, according to the Canadian study). This may be related to higher hearing thresholds in the male population, as this report also demonstrated. The United States study showed a more significant difference between men and women with 12% of men over age 65 reporting tinnitus, compared with 7% of women.

The National Center for Health Statistics also compared Caucasian and African–American populations, with the prevalence of tinnitus being higher
in Caucasians (9% versus 5.5%) [8]. There was also a slight difference in prevalence when groups were separated by family income level. In households making more than $35,000 per year, 7.6% reported tinnitus, whereas 12.8% of families with incomes less than $10,000 reported tinnitus.

Coles [11] has shown that groups with tinnitus have much worse hearing than comparable nontinnitus groups. The Canadian study found tinnitus prevalence increased with severity of hearing loss, regardless of the frequency affected by the hearing loss. In subjects with unilateral tinnitus, there was a higher prevalence on the side with greater hearing loss. Various studies over the years have demonstrated that either the right or left side is more likely to exhibit tinnitus. The classic report is that tinnitus is 1.5 times more likely to occur in the left ear [12]. The difference between right and left sides no longer remains clear, however, because some studies have found the right to be more affected, and others have shown no difference from right to left [10].

Children and tinnitus

A 1972 study of over 2000 school-age children, found 13% of their population reported experiencing tinnitus [13]. When the population was confined to children who failed hearing screenings, as many as 59% reported tinnitus. A decade later, Nodar and LeZak [14] reported the prevalence of tinnitus was even higher in hearing impaired children, but interestingly, only 3% complained of this symptom spontaneously. Graham [15] found tinnitus in 64% of children with hearing loss, and determined that for 30% of them, it was “very disturbing” to the child.

The increased incidence of otitis media in the pediatric population may play a role in the reported high prevalence of tinnitus in children. The prevalence of tinnitus in children with secretory otitis media has been reported to be as high as 43.9%, compared with only 29.5% of children with hearing loss. Given the possibility that tinnitus leads to difficulties in concentration and behavioral problems, such as irritation, nervousness, and learning disabilities, the timely treatment of otitis media may be critical to avoid developmental pathology [16].

Classification

Common descriptive terms are vital to physician communication, disease description, and identification of etiology with subsequent treatment planning. Elaborate classification systems have been proposed for tinnitus, and these will be discussed later. It is often the simplest classifications, such as those discerning between two variables, however, which help quickly to narrow the differential diagnosis and succinctly describe the disease process to fellow clinicians. These more general, simple classification schemes are discussed first.
In the simplest terms, one can differentiate between subjective and objective tinnitus. Subjective tinnitus is heard only by the patient, whereas objective tinnitus can be heard by both the patient and the examiner. This is an important distinction, because objective tinnitus usually has an identifiable acoustic source. This type of tinnitus has also been called vibratory or extrinsic tinnitus or pseudotinnitus, and requires auscultation of the ear and surrounding vessels as part of the physical examination. Subjective tinnitus is more commonly idiopathic (subjective idiopathic tinnitus). Other names used for subjective tinnitus in the past include “tinnitus aurium” and “nonauditory tinnitus.”

Another important distinction is that between pulsatile and nonpulsatile tinnitus. This is determined by the patient’s description of the quality of the sound he or she perceives. Nonpulsatile tinnitus should be differentiated further into mild and severe types [17]. Mild tinnitus is audible by the patients occasionally or only when in a quiet place and usually is not troublesome. Severe tinnitus is a very disturbing symptom, which often degrades the quality of the patient’s life.

Pulsatile tinnitus may be classified further as either vascular or nonvascular in etiology. Nonvascular causes are usually related to myoclonus of the palatal musculature, stapedius muscle, or tensor tympani. Vascular etiologies can be differentiated further into venous and arterial classifications. Arterial causes include atherosclerotic carotid artery disease, arteriovenous fistulas and malformations, aberrant arterial anatomy, and hypertension. A common cause of venous pulsatile tinnitus is benign intracranial hypertension, whereas other possibilities include jugular bulb anomalies and hydrocephalus [18].

Classification systems

When physicians ask their patients to describe their tinnitus, they are faced with a myriad of replies ranging from detailed descriptions of loudness, pitch, and duration to analogous statements like, “it sounds like crickets in my ear.” Patients also define their tinnitus by the level of annoyance or disability. The most frustrating statement for the clinician may be, “I can’t describe it,” which frequently is the case. Many attempts have been made over the years to simplify the description of tinnitus with a universal classification system. Many of these were outlined by Shulman [19] in 1991, but few have gained widespread acceptance. In particular, the schemes of Goodhill [20], Nodar [21], Shulman [19], and a more recent revision by Nodar [22] all have qualities worthy of further discussion.

The Goodhill classification system is broken into three sections: (1) head noises versus aural noises, (2) vibratory versus nonvibratory tinnitus, and (3) composition and ability to cope with tinnitus [20]. One attractive feature of this system is the dichotomous nature of the descriptive terms; the physician needed only choose between two options in each descriptive
category. The system did not gain widespread acceptance, however, likely because of its lengthy nature and difficulty in remembering the many choices for classification.

Nodar’s [21] 1978 suggestion for classification was based on the importance of six factors related to tinnitus: (1) description, (2) presence, (3) continuous or pulsatile, (4) single or multiple, (5) level, and (6) annoyance. The variables described were similar to those of Goodhill’s system, but the terms were a little simpler and more user-friendly. Again, widespread acceptance was not achieved, and as is discussed later, another revision would be forthcoming.

A classification scheme first described by Shulman [23] in the early 1980s divided tinnitus into two main categories: otologic and neurotologic. This determination is based on the cochlear-vestibular findings during the neurotologic examination, with hopes of establishing an objective measure of a subjective complaint. Otologic classification is assigned based on the history and physical examination. Patients in this category include those with disease of the external or middle ear, cerumen impaction, abnormal mobility of the tympanic membrane or ossicular chain, and abnormal contractions of the middle ear musculature. The neurotologic classification is based on a complete cochlear-vestibular evaluation, which includes history and physical examination, audiologic testing, vestibular evaluation, and radiologic studies. Cochlear evaluation consists of pure-tone audiometry, auditory brainstem response, speech audiometry, tone-decay testing, tympanometry, acoustic reflexes, reflex decay testing, and recruitment testing. Vestibular testing consists of complete electronystagmography. The neurotologic tinnitus classification encompasses most patients previously noted to have subjective idiopathic tinnitus.

The otologic-neurotologic classification further allows the physician to differentiate tinnitus into one or more of several clinical types. These can occur singly or in combination and include auditory, nonauditory, subclinical, middle ear, cochlear, vestibular, cervical, central, contralateral, and neural [24]. Although some believe this type of systematic, objective description of tinnitus may be vital to discuss etiology and treatment, many have found this classification scheme to be too cumbersome and difficult to put into practice.

In 1996, Nodar [22] published a new version of his classification scheme for tinnitus. The goal was to keep the system simple, but also to make it inclusive. Two mnemonics were derived to help classify tinnitus: ABC for aurium (one ear), binaural (both ears), or cerebri (centered in the head); and C-CLAP for cause, composition (patient’s description [ie, buzz, roar, and so forth]), loudness (subjective scale or loudness matching on the audiometer), annoyance (subjective scale), and pitch (high versus low or pitch matching on the audiometer). The authors suggested that every patient with tinnitus could be classified using this system, which can then be expanded further to examine for other factors.
Classification according to tinnitus analysis

In cases of severe tinnitus, further analysis can allow better classification of the symptoms and help to direct treatment. This evaluation includes (1) pitch matching, (2) loudness matching, (3) minimum masking level, and (4) residual inhibition [17]. This testing allows for description of a patient’s tinnitus with regard to its exact pitch, intensity, ability to mask the tinnitus at the lowest possible intensity, and the presence of residual inhibition of the tinnitus after the administration of the minimal masking level plus 10 dB.

The results of a tinnitus analysis provide extremely useful information. For example, repeated loudness matching with reproducible results suggests that the tinnitus is an objective, rather than subjective, finding. Although the success of minimal masking level determination does not necessarily predict successful masking, it does show the patient that control is possible, and directs future trials of masking. Also, if the minimal masking level is lower than or equal to the loudness matching, it is unlikely that maskers are effective [25].

Classification systems in clinical practice

The classification schemes outlined previously all have at their origin components of a thorough patient history. Although there has been no widespread acceptance of one single classification plan, it is apparent by observing the overlap between these systems that the following questions must be asked to help define a patient’s tinnitus: (1) Where is the sound heard?, (2) What does it sound like?, (3) How loud is the sound?, (4) Is it a high pitch or a low pitch?, and (5) How does the sound affect one’s life? To these questions one must add the components of any neurotologic history, including hearing, balance, and vision testing, and a complete medical review of systems. A complete neurotologic examination is also critical. Development of a tinnitus-specific questionnaire for patients to complete before examination may be a worthwhile endeavor for any physician treating these patients.

Audiologic evaluation is the next obvious step and should include tests for speech discrimination, rollover, reflex testing, and reflex-decay evaluation. Auditory brainstem response testing and MRI of the internal auditory canals may also be necessary in cases of unilateral tinnitus to rule out retrocochlear pathology. When symptoms are deemed to be severe, tinnitus analysis with pitch and loudness matching, minimum masking level determination, and residual inhibition testing can be obtained. By synthesizing the information gained, the clinician can now proceed with appropriate treatment planning.

The information gained can also be sorted into a universally recognized classification system, such as that described by Nodar [22] in 1996. His ABC–C-CLAP system, described previously, provides a more objective and uniform scheme for description of the tinnitus patient. All physicians will know what information is expected and how to relay that information. As a communications tool, this is invaluable. For patient care, there is no
substitute for a thorough history and physical examination, with appropriate diagnostic testing.

Tinnitus and disability

As outcomes studies become more important in evaluation of the effects of disease processes and their treatments, there has been increasing demand for an instrument to measure the handicap associated with tinnitus. There are many degrees of tinnitus, with some patients noting an occasional high-pitched tone in the ear, whereas others are constantly plagued by a loud noise that inhibits their concentration and prevents adequate sleep. In a study of over 1800 patients with tinnitus, Meikle et al [26] found that over half of patients rated their tinnitus severity greater than 5 on a 10-point scale. Loudness, type, quality, and pitch had no correlation with degree of severity. When sleep disturbance was present, the tinnitus was believed to be more severe. The exact variables that make tinnitus more disabling in some rather than others have not been clearly identified.

The Tinnitus Handicap Inventory (THI) was developed in 1996 and consists of a self-report measure that has been validated for use in quantifying the impact of tinnitus on daily living (Appendix) [27]. The questionnaire consists of 25 questions in three subscale categories: (1) functional, (2) emotional, and (3) catastrophic. Answers are in the form of “yes, sometimes, or no,” with corresponding scores of 4 points, 2 points, or 0 points. A higher score corresponds to a greater handicap.

A grading system has been suggested, based on the THI [28]. With a score of 0 to 16, the handicap is considered slight, being heard only in quiet environments and easily masked. In contrast, a score of 78 to 100 is considered catastrophic, with all tinnitus symptoms above the severe level. These patients must have a medical consultation and associated psychologic problems are commonly present. The complete grading system is as follows: grade 1—slight (THI 0 to 16); grade 2—mild (THI 18 to 36); grade 3—moderate (THI 38 to 56); grade 4—severe (THI 58 to 76); and grade 5—catastrophic (THI 78 to 100). Use of this scale to monitor patient impairment before, during, and after treatment for tinnitus can be a valuable tool for monitoring progress.

There are other self-report questionnaires available. The only other form that has been validated and shown to have good inter-test reliability with the THI is the Tinnitus Questionnaire [29]. The THI, however, is more practical from an administrative perspective and is used more frequently.

Summary

One third of all adults report experiencing tinnitus at some time in their lives. Ten percent to 15% have prolonged tinnitus requiring medical
evaluation. Classification of tinnitus requires a thorough history and physical examination, supplemented by appropriate diagnostic tests. Tinnitus can be categorized according to its qualities (as described by the patient and matched on the audiometer) and its clinical type (as suggested by probable etiology). Audiologic testing, tinnitus analysis, and occasional radiologic studies assist with classification and direction of treatment planning. The THI is another method of classification that can facilitate the precise monitoring of a patient’s progress. By using these tools and standardizing the language, tinnitus studies around the world can become more comparable and patients can be better monitored for treatment response.

Appendix. The Tinnitus Handicap Inventory

The purpose of the scale is to identify the problems your tinnitus may be causing you. Check “Yes,” “Sometimes,” or “No” for each question.

<table>
<thead>
<tr>
<th>Item</th>
<th>YES</th>
<th>SOMETIMES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F13</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix. The Tinnitus Handicap Inventory

The purpose of the scale is to identify the problems your tinnitus may be causing you. Check “Yes,” “Sometimes,” or “No” for each question.
E14. Because of your tinnitus do you find that you are often irritable?  
F15. Because of your tinnitus, is it difficult for you to read?  
E16. Does your tinnitus make you upset?  
E17. Do you feel that your tinnitus problem has placed stress on your relationships with members of your family and friends?  
F18. Do you find it difficult to focus your attention away from your tinnitus and on other things?  
C19. Do you feel you have no control over your tinnitus?  
F20. Because of your tinnitus, do you feel tired?  
E21. Because of your tinnitus, do you feel often depressed?  
E22. Does your tinnitus make you feel anxious?  
C23. Do you feel you can no longer cope with your tinnitus?  
F24. Does your tinnitus get worse when you are under stress?  
E25. Does your tinnitus make you feel insecure?  

Items are classified as pertaining to the functional (F) subscale, emotional (E) subscale, or the catastrophic (C) subscale. Answers of “yes” are scored 4 points, “sometimes” 2 points, and “no” receives 0 points.


References


