Assessment of Patients for Treatment with Tinnitus Retraining Therapy

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Abstract

Clinical management for patients complaining of severe tinnitus has improved dramatically in the last 25 years. During that period of time, various methods of treatment have been introduced and are being used with varying degrees of success. One method that has received considerable attention is tinnitus retraining therapy (TRT). This method is being practiced by hundreds of clinicians worldwide, and retrospective clinical data indicate that TRT has been effective for the majority of patients. This article provides a guide for clinicians to evaluate their patients for treatment with TRT. Included in this guide is the expanded version of the TRT initial interview and specific instructions for the clinician administering the interview.

Key Words: hearing disorders, tinnitus

Abbreviations: 2AFC = two-alternative forced choice; LDL = loudness discomfort level; MML = minimum masking level; TRT = tinnitus retraining therapy

Sumario

El manejo clínico de los pacientes que sufren de un acúfeno severo ha mejorado dramáticamente en los últimos 25 años. Durante ese período de tiempo, varios métodos de tratamiento han sido introducidos y se utilizan en la actualidad con grados variables de éxito. Un método que ha recibido considerable atención es la terapia de re-entrenamiento para el acúfeno (TRT = tinnitus retraining therapy). Cientos de clínicos practican este método y retrospectivamente, la información clínica indica que el TRT ha sido efectivo en la mayoría de los pacientes. Este artículo aporta una guía para el clínico que permita evaluar sus pacientes para la terapia con TRT. La versión expandida del interrogatorio inicial para TRT se incluye en esta guía, así como instrucciones específicas para el clínico que aplica dicho interrogatorio.

Palabras Clave: trastornos auditivos, acúfeno (tinnitus)

Abreviaturas: 2AFC = Escogencia forzada de dos alternativas; LDL = nivel molesto de sonoridad; MML = nivel de enmascaramiento mínimo; TRT = terapia de re-entrenamiento para el acúfeno

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Tinnitus is the perception of a sound when there is no sound source outside the head. Tinnitus can thus be considered an auditory phantom perception (Jastreboff, 1990). Prevalence estimates of tinnitus vary, but most estimates generally agree with the American Tinnitus Association report that approximately 40 to 50 million individuals in the United States experience tinnitus (Davis and Refaie, 2000). Of these, approximately 10 to 12 million seek some form of professional help for the condition and 2.5 million are debilitated by their tinnitus. The prevalence of tinnitus is expected only to increase in the coming years (Vernon, 1998).

Although effective methods of tinnitus treatment have been developed and are available in some cities, millions of people in this country who are afflicted by tinnitus do not have ready access to such treatment. Furthermore, when they seek help from their medical practitioner, they are often told that "nothing can be done" and to "learn to live with it" (Jastreboff and Hazell, 1993; Vernon, 1998). This kind of negative information is erroneous and can lead to an exacerbation of the tinnitus condition if the patient concludes that there is no hope for relief.

Tinnitus Retraining Therapy

One method of tinnitus treatment that has received worldwide recognition during the last decade is tinnitus retraining therapy (TRT) (Jastreboff and Hazell, 1993; Jastreboff et al, 1996; Jastreboff, 2000). The conceptual basis of TRT was first described in 1990 as a method of tinnitus treatment based on a neurophysiologic model of tinnitus (Jastreboff, 1990). The model has subsequently been described in a series of articles (e.g., Jastreboff, 2000; Jastreboff and Jastreboff, 2001b). The neurophysiologic model expands tinnitus beyond the auditory nervous system as a problem that involves the limbic and the autonomic nervous systems.

The Neurophysiologic Model

According to the neurophysiologic model, the treatment of tinnitus should focus mainly on the limbic and autonomic nervous systems; only secondary attention is given to the tinnitus sensation itself (Jastreboff and Jastreboff, 2001b). The central auditory nervous system processes environmental sounds by identifying, sorting, and routing their associated neural signals. Some of the sounds activate emotions (limbic system) and/or cause behavioral reactions (autonomic nervous system). Such sounds carry an emotional meaning for the listener owing to previous association of the sounds with emotional responses. The rules of learning and conditioning that apply to external sounds also apply to the tinnitus signal. If a person's tinnitus becomes associated with an emotional response, any future perception of the tinnitus is likely to activate the same response. The emotional response further increases the likelihood of paying attention to the tinnitus, leading to a "vicious circle."

The central auditory nervous system receives and processes an almost constant stream of incoming acoustic information. The brain must determine, in real time, which of the environmental sounds (if any) will receive the listener's attention. Neural signals that are associated with pertinent auditory information are transmitted to the auditory cortex, whereas less important signals are terminated prior to reaching consciousness. This routing of signals is controlled by patterns of memory that recall consequences that are associated with each of the stimuli. Signals that are normally blocked from reaching consciousness have undergone habituation. Subconscious pattern recognition of habituated signals functions to identify the signals as unimportant and consequently unnecessary for receiving conscious attention. Novel stimuli, or stimuli recognized as important (e.g., threatening), will bypass this blocking mechanism to activate other brain centers.

The neurophysiologic model thus considers problematic tinnitus to be caused by an aberrant auditory signal that has been conditioned to cause activation of the limbic and/or autonomic nervous systems. The aberrant signal must undergo specific conditioning procedures to be processed differently as a meaningless, unimportant signal. The ultimate goal of TRT is to "retrain" the brain to habituate to the tinnitus signal.

Rationale for TRT

The rationale for treatment with TRT is based entirely on the conceptual basis of the neurophysiologic model. The goal of therapy is to induce habituation to the patient's tinnitus, and this goal is addressed using two strategies. The first is to remove any negative thoughts or fears that may be associated with the tinnitus perception. This is accomplished through directive counseling, which consists of a structured program of patient education. The counseling information conveyed to the patient is designed

to mitigate the fears and concerns associated with tinnitus. The second strategy is to remove the tinnitus from conscious perception, which can be accomplished only if the first strategy is successful. The removal of tinnitus from conscious perception is attempted by means of sound therapy. Sound therapy uses constant low levels of background sound to reduce the "detectability" of tinnitus at subconscious levels. This reduced detectability must be maintained for 1 to 2 years to achieve retraining of the tinnitus signal processing mechanism. When both of these strategies are successful, the tinnitus signal will be habituated from negative reactions (limbic and autonomic nervous systems) and from conscious perception (cortical association areas).

Based on current prevalence estimates (Davis and Refaie, 2000), for approximately 80 percent of individuals who experience chronic tinnitus, these nonauditory systems are not involved in the tinnitus experience. These individuals are apparently able to habituate to their tinnitus without clinical intervention. Such natural habituation normally occurs to any constant background sound that would be considered inconsequential to normal functioning. The other 20 percent of individuals who have chronic tinnitus do not habituate naturally to their tinnitus, and clinical intervention would be warranted in these cases.

History of TRT

The first center to offer tinnitus treatment based on the neurophysiologic model was created in 1990 by Pawel Jastreboff. The University of Maryland Tinnitus and Hyperacusis Center recently celebrated its 10th anniversary, at which time they had treated over 1800 patients with TRT (Gold et al, 2000). In 1999, Pawel and Margaret Jastreboff moved to Emory University School of Medicine in Atlanta, Georgia, where they created another center to treat tinnitus and hyperacusis patients.

Formal TRT training is provided at instructional courses and workshops offered by the Jastreboffs and by Dr. Jonathan Hazell. Twelve 3-day instructional courses have been offered in the United States by the Jastreboffs. The first four were conducted at the University of Maryland and the last eight at Emory University. The Jastreboffs have also conducted 37 TRT workshops internationally. Dr. Hazell has offered these courses annually in London. Attendance at one of these courses is currently the only means for clinicians to receive training to perform TRT. Since 1996, over 250 health professionals in the United States and over 600 internationally have been trained, and TRT is now used in approximately 100 centers.

Purpose

TRT has been thoroughly described in numerous articles, book chapters, and proceedings. This article is unique in that it can serve as a systematic guide for audiologists to conduct the clinical evaluation component of TRT. A second document is in preparation to describe clinical intervention techniques using TRT. Thus, even without formal TRT training, resources are available for audiologists to learn the basic concepts of TRT, which can be applied to assist their patients who complain of tinnitus. An understanding and adoption of these principles by tinnitus patients should be helpful in providing them with basic guidance so that they can make positive progress on their own or with further help from their audiologist. The information will further educate patients as to the availability of formal treatment with TRT from a clinician who has received the TRT training and who is experienced in administering the technique.

Outcomes of Treatment with TRT

The companion article (Henry et al, 2002) includes a review of outcomes data reported about the clinical efficacy of TRT. Only a short summary is therefore provided in the present article. Dobie (1999) reviewed randomized clinical trials that have been conducted to assess the efficacy of treatments for tinnitus. These studies included many drug trials and nondrug treatments. Surprisingly, there were no randomized clinical trials to report for TRT. Dobie has updated his review, and, to date, there are still no published results for randomized clinical trials to evaluate TRT (Dobie, 2002). There are, however, several prospective uncontrolled studies in the literature, as reviewed in the companion article (Henry et al, 2002). Outcomes data have been reported from a number of clinics indicating that treatment with TRT significantly benefited 70 to 85 percent of their patients. These data would be considered "evidence by consensus," but, clearly, efficacy studies are needed. Such studies would ideally be randomized clinical trials to evaluate the comparative efficacy of TRT as well as its long-term efficacy.

The Audiologist as a TRT Practitioner

When good care is available, the majority of patients with problematic tinnitus can be treated with some measure of success. Most ear specialists, however, have not acquired a high level of expertise to treat tinnitus. Limited services are the norm for tinnitus patients because tinnitus treatment methodology has not been standardized, and relatively few professionals have received adequate training. Most otolaryngologists, otologists, and audiologists routinely encounter tinnitus sufferers in their clinical practices. Although these hearing-health professionals have received extensive education and training to diagnose and treat the majority of auditory disorders, clinical management of tinnitus has not been a major component of most training programs.

The practicing audiologist may hold the best position professionally to serve as a treatment specialist for tinnitus, and TRT certainly lends itself to being practiced by an audiologist. The individual audiologist must be motivated, however, to learn the program well to be effective. The present article, as a supplement to the TRT instructional courses, is directed primarily to audiologists to provide them with the basic skills needed to evaluate their patients for treatment with TRT.

In the TRT training seminars, the concept of a multidisciplinary team is taught as the ideal to properly treat tinnitus patients (Jastreboff and Jastreboff, 1999b). The formation of multidisciplinary teams should be the objective for future tinnitus management. In the meantime, audiologists can singularly perform all aspects of tinnitus management, except to rule out medically or psychologically treatable causes of tinnitus distress.

Referral of the Tinnitus Patient

In all cases, tinnitus patients should be referred to an otolaryngologist or otologist to receive a complete ear examination. The physician should be competent in conducting such an examination specifically for tinnitus. A knowledgeable physician can rule out surgically correctable tinnitus etiology and evaluate for other potential causes of tinnitus, such as drug interactions, that would be understood best by a physician (Perry and Gantz, 2000).

Audiologists must use their professional judgment to assess whether a tinnitus patient should be referred to a counselor for a psychological or psychiatric evaluation. It has been proposed that an inordinate number of tinnitus patients seem to have a psychological overlay that is potentially the cause of their tinnitus being so distressing (Schechter et al, 1992). According to most estimates, approximately 80 percent of individuals with chronic tinnitus do not require clinical intervention; they seem to have naturally habituated to their tinnitus. It is not yet understood which factors cause these persons to be generally unaffected by their tinnitus, whereas the remaining 20 percent experience some degree of distress. Research is greatly needed to determine the factors that cause tinnitus distress with regard to understanding the psychological profile of these patients and assessing the "acoustic" characteristics of their tinnitus perception.

ASSESSMENT OF PATIENTS FOR TREATMENT WITH TRT

The administration of TRT involves three basic areas for tinnitus management: assessment, directive counseling, and sound therapy. Each of these areas works in conjunction with the other, and the skilled TRT practitioner will coordinate the three to maximize the effectiveness of treatment. The specific procedures for assessing the tinnitus patient for treatment with TRT are described below. A follow-up article will more formally describe the rationale for TRT, the key concepts relating to treatment with TRT, and directive counseling and sound therapy as the components of treatment.

Initial Appointment

A proper evaluation of the patient for treatment with TRT will require administration of the TRT initial interview (Appendix), a standard audiologic assessment, and specialized audiometric tests. It may be advantageous to conduct the audiologic evaluation first so that test results will be available during the interview. The audiologic evaluation will require approximately 2 hours, and the initial interview will generally require 30 to 60 minutes. A 3-hour appointment is therefore suggested for the complete assessment.

To Treat or Not to Treat

At the initial visit, the basic concepts of the TRT program should be explained, that is, the purpose and goals of treatment, how many vis-

its are involved, requirements for the ear-level devices, costs, etc. This information should be conveyed to the patient following administration of the TRT initial interview to obtain unbiased answers during the interview. During the concluding discussion, the audiologist and the patient will decide whether TRT is the best course of action. Patients must realize the full extent of their commitment to participate in the program and be willing to make that commitment. Otherwise, it would be a wasted effort for both patient and clinician to proceed further.

In some cases, once the TRT initial interview has been completed, the decision reached with the patient will be that full treatment is not necessary. Such patients would be placed into category 0, as defined by the TRT category system (Jastreboff and Jastreboff, 2001b). Category 0 patients, as described below, are minimally bothered by their tinnitus and receive a recommendation of counseling as their only needed treatment. Through the process of conducting the initial assessment, some counseling is performed, which may be enough to resolve most of the patient's concerns. The audiologist can offer to provide additional counseling, but, at this point, the patient may be reasonably satisfied that further services are not necessary. If it is clear that the patient wants and needs treatment, the audiologist must then complete the evaluation and make earmold impressions to prepare for the first treatment appointment, which involves dispensing ear-level devices and performing initial TRT counseling.

TRT Initial Interview

The TRT initial interview form was developed to facilitate the intake of information from new patients seeking treatment with TRT. The form serves as a guide for clinicians to obtain all information relevant to making treatment decisions and as a baseline for monitoring the effects of treatment. To achieve simplicity and expediency of administration, the entire content of the form is contained on a single page (Jastreboff and Jastreboff, 1999a). This compression of contents has necessitated the use of an abbreviated (or telegraphic) format to cue the clinician concerning the various questions. Without a complete scripting of the items on the form, the interviewer must clearly understand the purpose behind each item and know how to properly sequence the questions. Lacking these requisite skills, a clinician cannot use the form to its full potential. Through consultation with the form's developers (P. and M. Jastreboff), the TRT initial interview has been revised to include fully scripted questions and supplementary notes to the interviewer. The expanded version of the initial interview is provided in the Appendix.

Addressing the Misconception That Tinnitus Causes Hearing Loss

It is important for clinicians to be aware that many patients with tinnitus make the assumption that their tinnitus interferes with their ability to hear clearly. This kind of thinking was demonstrated dramatically by a group of 173 military veterans who completed tinnitus questionnaires prior to entering tinnitus treatment as part of a randomized clinical trial (Zaugg et al, 2002). The questionnaires included the Tinnitus Handicap Inventory (THI) (Newman et al, 1996, 1998) and the Tinnitus Severity Index (TSI) (Meikle et al, 1995a). As examples, 89 percent of the veterans selected "yes" or "sometimes" in response to the THI question "Does the loudness of your tinnitus make it difficult for you to hear people?" When asked on the TSI "Do you feel that tinnitus makes it more difficult to hear clearly?" 89.5 percent of the group responded "often" or "sometimes." Many of these patients further believed that their primary problem with tinnitus was its effect on their hearing. It is therefore critical for TRT clinicians to assist patients in distinguishing between effects caused by their tinnitus from effects caused by their hearing loss. In all probability, these patients are inappropriately attributing their hearing problems to their tinnitus. The TRT initial interview functions well as a tool for sorting out the two problems of hearing loss and tinnitus, as well as for determining if the patient has a problem with loudness tolerance.

Description of TRT Patient Categories

Upon completing the TRT initial interview with a patient, the clinician must determine the patient's "TRT category," which can be 0, 1, 2, 3, or 4 (Jastreboff, 1999; Jastreboff and Jastreboff, 2000, 2001b). Accurate categorization requires the clinician to clearly understand and differentiate the patient's subjective difficulties with tinnitus, hearing loss, and loudness tolerance. The initial interview is designed to facilitate the acquisition of this information from the patient. Using the interview, each of these three issues (tinnitus, hearing loss, and loudness tolerance) should be discussed to the exclusion

of the other two, enabling the clinician to assess the relative impact of each on the patient's life. A proper diagnosis (i.e., proper TRT categorization) is critical to most effectively perform TRT. In the process of being interviewed, patients also become empowered to make informed decisions about their needs for treatment.

Category 0 would describe patients who have a minimal problem with their tinnitus, and the problem does not warrant full treatment with TRT. Such patients would be considered a "counseling only" group. Following their evaluation, they should be given basic counseling regarding TRT principles. These patients will often be satisfied with the information they receive during the initial assessment.

Category 1 specifies patients whose tinnitus has a significant negative impact on their life. Their tinnitus bothers them to the degree that at least one major life activity is affected (e.g., sleep, work, concentration). For these patients, ear-level sound generators will be recommended.

Category 2 patients have a subjective problem with hearing loss in addition to their tinnitus. Their tinnitus condition, however, is sufficiently problematic as to warrant full treatment with TRT. These patients are fitted with hearing aids, but the primary purpose of the hearing aids is to enrich their sound environment to facilitate long-term habituation to their tinnitus.

Category 3 patients have reduced tolerance to sound, termed "hyperacusis." For TRT, hyperacusis is technically identified when patients are tested for loudness discomfort levels (LDLs) at audiometric frequencies and the average of the LDLs falls below 100 dB HL (see below for further description of hyperacusis and methodology to obtain LDLs). To be placed into category 3, these patients must also report sound tolerance difficulties during the initial interview. Clinical data indicate that about 40 percent of patients attending a tinnitus clinic have some degree of hyperacusis (Coles, 1996; Jastreboff and Jastreboff, 2000). These patients are fit with ear-level sound generators, but the sound generators are adjusted according to a specific desensitization protocol.

Category 4 patients have a problem that is defined as a prolonged exacerbation of the intensity of their tinnitus (or hyperacusis) as a result of exposure to sound. Such exacerbation has also been referred to as the "kindling" or "winding up" effect (Jastreboff, 1999, 2000), as explained below. For these patients, exposure to some sounds will cause their tinnitus to become louder, and the tinnitus stays louder at least until the following morning. These patients are fit with ear-level sound generators, and the sound adjustment protocol is specific to this category.

The term kindling was derived from the phenomenon of epileptogenic changes that resulted from mild, periodic electrical stimulation to certain parts of the brain (Garnes and Pinel, 2001). Repeated electrical or chemical stimulation of limbic structures was observed to gradually increase the extent and duration of the electrical response, eventually inducing a generalized seizure (Westbrook, 2000). It was later shown that audiogenic seizures could be evoked by systematic exposure of animals to loud sound (Feng and Faingold, 2002).

Winding up is a concept borrowed from the pain field. The sensations of chronic pain and tinnitus have often been mentioned as having many underlying similarities (Tonndorf, 1995). Winding up denotes an increase in the pain sensation owing to prolonged exposure to a stimulus that causes low-level pain. (The same stimulus presented for a short time has no effect.) Painful stimuli are detected by nociceptors, consisting of mostly free nerve endings that are embedded in peripheral tissues. On receiving a painful stimulus, both a fast sharp pain and a slow dull pain ensue. The slow or "second" pain is transmitted by unmyelinated C nerve fibers. Winding up is caused by instances of severe and persistent injury that cause C fibers to fire repetitively (Basbaum and Jessell, 2000). This results in a gradual increase in the response of central pain-mediating neurons. The changes in synaptic transmission that are elicited by these central neurons are long term—similar to the long-term storage of memory in the hippocampus.

Administering the TRT Initial Interview

Instructions

The form begins with general instructions that are read to the patient. These instructions explain the basic differences between tinnitus, sound tolerance, and hearing loss. As explained above, it is particularly important for clinicians to be sensitized to patients who consider their hearing problems to be the result of tinnitus interfering with sound (usually speech) perception. It is often the case that, even with such explicit instructions, patients will continue to answer the questions about the negative effects of tinnitus with respect to their hearing problems. The clinician must continue to probe and reinstruct concerning this issue.

Items 1 to 4

These questions help to identify the perceptual characteristics that constitute a patient's tinnitus. The questions are not useful for determining the patient's TRT category, but they are important for the clinician to understand the nature of the patient's tinnitus symptoms. Patients need to know that their clinician has an awareness of the source of their distress, and they may even find some solace in knowing that their highly personal symptoms are not uncommon. It is not an objective of TRT to alter patients' tinnitus in any way; however, it has been reported that some TRT patients experience a reduction of their tinnitus intensity following treatment or a complete elimination of the percept (Sheldrake et al, 1996). These descriptive responses therefore can be useful to evaluate for changes in the patient's tinnitus characteristics that might result from treatment.

Item 5

Determining the onset and duration of a patient's tinnitus is helpful in establishing the underlying etiology. Intake data from 784 tinnitus clinic patients, however, revealed that almost half of the patients were unable to identify a precipitating event that would correspond with their tinnitus onset (Meikle and Griest, 1989). The tinnitus etiology for these patients would therefore be unknown, and these data, if generalizable, would suggest unknown tinnitus etiology for about half of all individuals who seek intervention for their tinnitus. Although treatment with TRT is not influenced by tinnitus etiology, it has been suggested that determining the natural history of a patient's tinnitus is important for counseling purposes (Davis and Refaie, 2000). An interesting question would be whether tinnitus of unknown origin is more problematic for patients than when their tinnitus has a known cause.

Item 5 is also important to assist in predicting whether the tinnitus condition is temporary or permanent. Patients who report tinnitus duration of only a few weeks or months may be especially concerned about the implications of their new symptom. Such short-term tinnitus is more likely to be labile, thus raising the hope of spontaneous resolution (Meikle, 1991). With increased duration, the likelihood that the tinnitus is permanent also increases. Chronic tinnitus of 3 to 6 months or longer can be considered a permanent condition, assuming that the tinnitus is not caused by temporary dysfunction of the auditory system (Davis and Refaie, 2000).

Item 6

Many patients experience tinnitus that consists of multiple sounds, as reported by 43 percent of a large clinical population (Meikle and Walsh, 1984). For TRT, it is important that the "most bothersome" tinnitus be identified. This question will be straightforward for patients who hear only one sound, but many patients will have to select from multiple sounds the one they consider most annoying. That sound will be the referent for the tinnitus matching procedure and, more importantly, for setting the levels of the sound generators for patients in categories 1, 3, and 4.

Item 7

This question seems straightforward, but patients sometimes have difficulty understanding its purpose. All patients answering this question will be bothered by their tinnitus to some extent. The question is intended to determine if, during the previous month, there were any days when their tinnitus bothered them more than usual. If so, the associated question asks how often these "bad days" tend to occur—on a weekly or monthly basis. For patients who habituate to their tinnitus as a result of treatment, it would be expected that such improvement would be correlated with fewer "bad days" over time.

Item 8

This question is fairly complex, but it is the key question for identifying category 4 patients, who are the most difficult to treat with TRT (Jastreboff, 1998, 1999). It must be determined whether exposure to any sounds causes the patient's tinnitus level and/or hyperacusis to become intensified at least until the next morning. This "prolongation of exacerbation" effect is thought to be caused by a mechanism comparable to either "kindling" or "winding up" (described above).

A specific variation of treatment is warranted for category 4 patients, and their prognosis is more guarded than for the other TRT categories. It is important to note that patients experiencing significant misophonia (i.e., a strong

dislike of sound—see description below under "Item 20"), a condition that is relatively easy to treat, could exhibit behavior similar to that of category 4 patients. It is therefore necessary to differentiate between these two conditions during the line of questioning.

Item 9

This item consists of a series of questions that are intended ultimately to determine if patients are overprotecting their ears through the use of earplugs or earmuffs. Overprotection can lead to a heightened sense of awareness to tinnitus—the opposite of habituation—and can contribute to reduced sensitivity to sound (Hazell, 1999). This was recently demonstrated by a study in which pre- and post-treatment LDLs were measured in individuals who wore earplugs for 2 weeks and in individuals who wore ear-level sound generators for 2 weeks (Formby et al, 2002). For the group that wore earplugs, the post-treatment LDLs became lower—an effect that would be considered consistent with enhancement of auditory sensitivity (or "gain"). The group that wore sound generators experienced increased LDLs, indicating diminished auditory gain. Other clinical groups have demonstrated that LDLs can be increased (to more normal levels of loudness sensitivity) as a result of desensitization procedures using increased exposure to sound (usually wearable sound generators) (Hazell and Sheldrake, 1992; Vernon and Press, 1998; Gold et al, 1999; McKinney et al, 1999; Wolk and Seefeld, 1999; Formby and Gold, 2002).

The interviewer first determines if the patient is using hearing protection specifically to prevent their tinnitus from becoming louder. It is important not to suggest this potential effect to patients who may be naive to the concept. Such a suggestion would be an example of "negative counseling" that could lead to a worsened condition. Patients are overprotecting their ears if they use hearing protection for any reason other than to prevent damage to their ears when exposed to loud sound. There are two factors that can lead to overprotection. First, patients may be fearful about their already distressing tinnitus becoming louder; thus, their attitude about hearing protection is to err on the side of caution. Second, patients with reduced loudness sensitivity may think that physical discomfort owing to sound indicates that the sound is at a damaging level. Either of these factors can be the incentive to wear ear protection that is not needed for protective purposes. If patients do wear ear protection for less-than-damaging levels, its use can escalate if their tolerance to sound decreases as a consequence of the overprotection.

Item 10

Other forms of tinnitus treatment can include a variety of alternative methods, or treatment can be self-administered (e.g., use of herbs, sound conditioning devices, etc.). Such additional treatments may facilitate or confound treatment with TRT; thus, it is important for clinicians to obtain this information so as to counsel accordingly.

Item 11

Patients will usually be able to identify a primary reason why they feel the need to receive treatment for their tinnitus. The clinician must identify this major distressing factor to properly focus the counseling for greatest relevance to the condition. For this question, no response choices are provided; patients are asked to report this information without suggestions from the clinician. It will sometimes be the case that patients will, directly or indirectly, specify hearing difficulties as their primary concern. If this occurs, the clinician must then assist the patient in determining why the tinnitus itself is a problem. This can be the point at which the patient finally realizes that tinnitus and hearing loss are two separate issues. The tinnitus may seem less of a concern with this realization.

The patient's response to this question will serve as a key benchmark for later assessments of treatment efficacy. The patient's initial response may indicate the primary problem that will need to be addressed throughout treatment. Often, however, the patient's primary problem will shift to other issues over time.

Item 12

This item presents a list of life activities that are most likely to be negatively affected by tinnitus. The list will identify for most patients some issues that they had not previously considered. The clinician must state the issues individually and allow time for a thoughtful response to each. The responses concisely summarize why the tinnitus is a problem, and this information will serve as a baseline against which to assess the efficacy of treatment.

Items 13 and 14

These questions are particularly relevant to the overall purpose of TRT, which is to facilitate habituation to a patient's tinnitus. Tinnitus habituation is addressed by TRT essentially at two levels: habituation of perception and habituation of reaction (Jastreboff, 1996; Jastreboff et al, 1996; Jastreboff and Hazell, 1998). Question 13 obtains a baseline measure against which to determine the degree to which habituation of perception occurs during treatment, whereas question 14 similarly addresses habituation of reaction.

For question 13, patients are asked to estimate the percentage of their waking hours over the previous month that they were aware of their tinnitus. This percentage of time will indicate the need to habituate to the perception of tinnitus. Question 14 asks the percentage of time patients were annoyed (or distressed or irritated) by their tinnitus. This percentage indicates generally the degree to which patients are reacting emotionally to their tinnitus. With successful treatment, patients will habituate to both perception and reaction to their tinnitus, which would be indicated by these percentage estimates shifting to zero or close to zero.

Items 15 to 17

Questions 15, 16, and 17 involve the use of visual analog scales to obtain ratings from patients of, respectively, the loudness of their tinnitus, the annoyance caused by their tinnitus, and the overall life impact of their tinnitus. These rankings serve as further key benchmarks to assess treatment efficacy by comparing the numbers reported by patients between their baseline and follow-up appointments.

Item 18

The TRT initial interview covers most issues that would be associated with a patient's clinical tinnitus condition. Item 18 gives patients the opportunity to express any further comments about their tinnitus.

Item 19

This item initiates the sound tolerance section of the TRT initial interview and comprises the key question that will determine whether any further questioning will occur in this section. The patient must therefore understand clearly the intent of the question, which is to determine if he/she finds some everyday sounds to be uncomfortably loud when other individuals do not experience such discomfort. The question therefore does not pertain to loud sounds, such as power tools and guns, that would be uncomfortably loud to most people.

Item 20

It is vital for the clinician to understand the various conditions that can be involved when the patient has decreased sound tolerance (Jastreboff and Jastreboff, 2000). When sound causes pain or physical discomfort, hyperacusis is indicated. Phonophobia is the fear of sound and is not associated with pain or physical discomfort. Recently, the condition of "misophonia" has also become a consideration when assessing sound tolerance. Misophonia literally means the "dislike of sound" and involves no emotional component (Jastreboff and Jastreboff, 2001a, 2001c). Phonophobia is a specific case of misophonia when fear is involved. With these issues in mind, the clinician uses item 20 as a tool to determine which of these three conditions might apply to the patient's complaint of loudness intolerance.

Items 21 to 30

This series of items is specific to issues of sound tolerance, and these questions mirror items 7 through 18 in the tinnitus section of the TRT initial interview. Items 21 to 30 are questions that determine specifically how reduced sound tolerance negatively affects a patient's life. While asking these questions, the clinician must be constantly vigilant that the patient's responses might reflect the problem with tinnitus and not with loudness sensitivity. The information obtained is quite detailed, which is useful for tailoring treatment to address the specific concerns.

Item 22 addresses the kindling effect in relation to reduced sound tolerance. This phenomenon, also caused by winding up, was addressed with respect to tinnitus in item 8. Item 22 contains a series of questions designed to determine if a patient's reduced sound tolerance is exacerbated by exposure to sound and if such exacerbation lasts at least until the next morning. If the effect lasts until the next day, the patient is assigned to a specific subcategory of TRT category 4 (Table 1) and is treated accordingly.

Table 1 Criteria for Assigning Tinnitus Retraining Therapy Patient Categories

Patient Category	*Criteria*
0	1. Hearing difficulties irrelevant 2. **Tinnitus a minimal problem**
1	1. No significant problem with hearing loss 2. **Tinnitus a significant problem**
2	1. **Hearing loss a significant problem** 2. **Tinnitus a significant problem**
3	1. Hearing difficulties irrelevant 2. Tinnitus irrelevant 3. **Sound tolerance a significant problem**
4—Tinnitus	1. Hearing difficulties irrelevant 2. **Tinnitus a significant problem** 3. **Prolonged tinnitus exacerbation caused by sound**
4—Hyperacusis	1. Hearing difficulties irrelevant 2. Tinnitus irrelevant 3. **Sound tolerance a significant problem** 4. **Prolonged sound-tolerance exacerbation caused by sound**

Boldface indicates most critical criteria.

Items 31 to 33

These three items comprise a new section in the TRT initial interview that is essential for identifying TRT category 2 patients. The questions are intended simply to determine if patients feel that they experience significant hearing difficulties. At stake is whether the patient will be fitted with sound generators or with hearing aids. The patient's audiometric test results are not reliable for making this assessment. Reduced hearing sensitivity must be corroborated by the patient's subjective report to make a placement into category 2.

Items 34 to 36

The last three items of the interview use visual analog scales of 0 to 10 to facilitate side-by-side comparisons of patients' relative difficulties with tinnitus, sound tolerance, and hearing loss. If there is any uncertainty as to TRT category placement, these last items should assist in the final decision making. The responses to these items will be particularly useful at follow-up visits to determine if and how these difficulties change over time with respect to each other. For example, the patient may enter treatment with hyperacusis as the greatest problem. During treatment, the patient may report that hyperacusis is not as much of a problem and that tinnitus or hearing loss has become the greater problem. Treatment would therefore be modified to reflect the patient's changing concerns.

Audiometric Assessment

Routine audiologic testing is recommended for all patients (Jastreboff and Jastreboff, 2000). The basic audiogram and LDLs (methodology described below) are the primary measures that will influence the course of treatment with TRT. The remaining tests are necessary to make a proper assessment of the auditory system with respect to hearing function, loudness tolerance, and tinnitus. The tinnitus measurements will not influence the course of treatment, but they are important for several reasons. First, as explained below, they are important for individualized counseling purposes. Second, tinnitus measures will be necessary if patients pursue any legal course of action related to their tinnitus. Third, if outcomes data are compared between clinics, it is important to make sure that the study populations are similar.

Audiometric evaluation for treatment with TRT should include the following tests (in the approximate order of testing):

1. Pure-tone thresholds in the conventional (0.25–8 kHz) and high (to 12 kHz) frequencies
2. Speech recognition thresholds
3. Tinnitus loudness and pitch matching
4. LDLs to speech, white noise, and pure tones (0.5, 1, 2, 3, 4, 6, and 8 kHz)
5. Word recognition scores
6. Distortion-product otoacoustic emissions
7. Minimum masking level (MML)
8. Immittance testing (extreme care must be taken if obtaining acoustic reflexes; reflex and reflex decay testing are generally not advised)

When conducting audiometric testing, it is critical for the clinician to be aware that many tinnitus patients are also hypersensitive to sound. Hyperacusis, according to the definition provided above, has been reported to occur in about 40 percent of tinnitus patients (Coles, 1996; Jastreboff, 2000). Other researchers have defined hyperacusis as "the collapse of loudness tolerance so that almost all sounds produce loudness discomfort" (Vernon and Press, 1998). Vernon and Press have been cited as reporting hyperacusis prevalence of only 0.3 percent based on a survey conducted among the membership of the American Tinnitus Association. This prevalence rate of 0.3 percent is incorrect, as explained in the companion article (Henry et al, 2002). Most reports of incidence rates for hyperacusis are in the range of 25 to 45 percent, as indicated by a number of clinical groups who provided such reports at a recent international tinnitus conference (Gold et al, 1999; Hazell, 1999; Hesse et al, 1999; Jastreboff et al, 1999; McKinney et al, 1999).

Regardless of how hyperacusis is defined, loudness sensitivity is a problem for many tinnitus patients in that it can impact testing and treatment methodologies. Therefore, LDLs must be determined to assess the upper limit of the auditory dynamic range for each patient. Determining LDLs early in the assessment process can ensure that patients are not exposed to any sound during testing that exceeds their LDLs.

The order in which audiometric tests are conducted must take into account not only the requirement to not exceed patients' LDLs but also the concern of inducing "residual inhibition" in patients. Residual inhibition is defined clinically as the reduction or elimination of a patient's tinnitus following exposure to 1 minute of broadband noise presented at 10 dB above the level of noise that just masks the tinnitus (Vernon and Meikle, 1988). Residual inhibition occurs in about 90 percent of patients who are tested for this effect (Henry and Meikle, 2000; Vernon and Meikle, 2000). In broader terms, residual inhibition may occur at any time with tinnitus patients following exposure to certain types of sound. Audiometric testing exposes patients to many types of sounds, any of which can potentially induce residual inhibition. If residual inhibition were to occur, the patient's tinnitus perception would change, which could alter the tinnitus matching results. It is therefore important to obtain the tinnitus matching measures prior to the presentation of any suprathreshold sounds.

Tinnitus Loudness and Pitch Matching

Tinnitus loudness and pitch matching is conducted to define the frequency and sound pressure level of a tone that comes closest to approximating a patient's tinnitus sensation. It is a subjective procedure in which the clinician presents tones to the patient in a systematic fashion to obtain the closest "match" between the tinnitus and one of the tones.

With TRT, the results of loudness and pitch matching are useful primarily as a counseling tool and do not have any bearing on how treatment is conducted (Jastreboff, 2000). When tinnitus patients arrive in the clinic, they often have fears and anxieties about the implications of their tinnitus owing to their lack of knowledge about the condition. An important aspect of TRT counseling is therefore to "demystify" patients' negative concepts that are associated with their tinnitus (Jastreboff, 2000). This is accomplished through a specified educational protocol, part of which includes an explanation to patients about their tinnitus tone matches. The tinnitus matching data provide quantification of the patient's subjective perception of tinnitus. By simply attaching meaningful numbers to the phantom auditory sensation, a degree of relief can be provided to the patient. Also, the loudness match at the perceived tinnitus pitch is usually only a few decibels above the patient's threshold at the pitch match frequency (Henry et al, 1999). By showing the patient where the tinnitus perception falls on the audiogram, this information conveys to the patient that the tinnitus signal is very faint in relation to common environmental sounds.

Procedures for obtaining tinnitus loudness and pitch matches vary from clinic to clinic. Vernon and Meikle (1981), however, have described detailed tinnitus matching procedures that were used for many years in their clinic. Using their method, patients make subjective loudness matches, at a series of frequencies, between their tinnitus and external tones. Patients direct the examiner to raise or lower the level of each tone until it is equally matched for loudness with their tinnitus. Pitch matches are made after loudness matching, using the two-alternative forced choice (2AFC) method. With the 2AFC method, patients select, between pairs of tones that were already matched in loudness to their tinnitus, which tone is closest in pitch to their tinnitus. The best pitch match is designated the "tinnitus frequency."

For these tinnitus matching procedures to be conducted as described, specialized tinnitus testing instrumentation is necessary. A number of companies have produced such specialized equipment in the past (e.g., Danavox, Starkey, Norwest), but these devices have been out of production for years. Some tinnitus researchers use audio bench equipment (tone generators, attenuators, amplifiers, filters, etc.) that can be patched together to perform tinnitus matching. At this time we are not aware of any commercial instrumentation that is dedicated for this purpose and that is reasonably priced for the typical clinic. Some audiologists have become adept at using commercial audiometers to conduct tinnitus matching, in spite of the limitations involved. For example, audiometers will not present test frequencies in 1000 Hz steps and will not normally allow output step sizes of 1 dB. Audiometers are also not designed to facilitate the 2AFC procedure (i.e., presentation of alternating tones of different frequencies and different output levels) for making pitch choices between different tones. With some creativity and practice, however, an audiometer can be adapted to perform essentially the same series of measurements within the constraints of the audiometer's functional specifications.

During loudness matching, it is important not to present any tones that exceed the loudness of the patient's tinnitus by any substantial amount. Such caution is important for two reasons, as mentioned at the beginning of this section. First, there is the possibility of inducing residual inhibition, that is, causing the patient's tinnitus to be reduced in level as a result of the sound stimulation. The occurrence of residual inhibition would result in the patient attempting to match external tones to a labile tinnitus, which would invalidate the test results. Second, the level of a tone could exceed the patient's LDL. However, the LDLs should be obtained after tinnitus matching because of the possibility of inducing residual inhibition by presenting the higher-level tones during LDL testing.

Tinnitus loudness and pitch matching procedures are typically done in one ear only. The patient is asked to identify the ear with the louder, or more predominant, tinnitus, and that ear is identified as the "tinnitus ear." The matching tones are presented to the contralateral ear, termed the "stimulus ear." It must be clearly explained to the patient that the task is to match the tone in the stimulus ear to the tinnitus in the tinnitus ear.

As described by Vernon and Meikle (1981), the pitch matching protocol involves three separate, interleaved procedures: threshold testing, loudness matching, and pitch matching. Testing starts by presenting a 1000 Hz tone to the stimulus ear, and the patient is instructed to respond when he/she hears the tone. Hearing thresholds are obtained using an adaptation of the modified Hughson-Westlake ascending-descending audiometric test technique (Carhart and Jerger, 1959). The threshold is first bracketed using an up 5, down 10 dB procedure. When the examiner is comfortable that the threshold has been bracketed to within 5 dB, an up 1, down 2 dB procedure is used. Ideally, two responses should be obtained at a given level for that level to be accepted as the auditory sensitivity threshold. However, for clinical expediency, the audiologist must use judgment to identify the 1 dB threshold without undue repetition of testing. Obtaining the threshold with 1 dB resolution is important to identify the sensation level of the loudness match at the same frequency. The threshold also serves as a guide for where to start loudness matching at the same frequency.

After the threshold is determined at a given frequency, a tinnitus loudness match search is done at the same frequency by presenting the tone above threshold for 2 to 3 seconds and asking the patient to report whether the tinnitus is louder or softer than the tone. Generally, pure-tone levels are increased in no greater than 5 dB increments until the patient reports that the loudness of the pure tone exceeds the loudness of the tinnitus. The tone is then presented at a 5 dB lower level and adjusted up or down in 1 dB steps until the patient reports a loudness match.

Tinnitus loudness matching is performed at suprathreshold levels. These tones are therefore always presented somewhere within the auditory dynamic range of the patient. The dynamic range at each test frequency is dictated by the threshold and the LDL at that frequency, and the LDL is unknown at the tinnitus loudness matching stage of the audiometric evaluation. For the patient with a typical sloping high-frequency hearing loss, the dynamic range will be broader in the lower frequencies and narrower in the higher frequencies. When doing tinnitus loudness matching at a given frequency, the dynamic range should be taken into consideration when increasing the level of the tone. The cardinal rule is to try not to exceed the loudness of the tinnitus by any substantial amount, as stated above. On the other hand, the testing should be done as

rapidly and efficiently as possible. Using small step sizes at each frequency tested can be an inefficient use of the testing time. In general, the following guidelines should be used to increase testing efficiency. At the starting frequency, even if the threshold is within normal limits, the level should be increased in 5 dB steps until a loudness match is obtained or exceeded. The initial loudness match should be used as a guide for the level at which to start presenting tones at the second test frequency. Typically, the starting level should be about 10 dB below the previous frequency's loudness match, followed by 5 dB step increases. When the hearing sensitivity starts to slope down on the audiogram, more caution should be exercised because of the increase in loudness recruitment. At frequencies at which there is reduced hearing sensitivity (i.e., > 30 dB HL), the first loudness match tone should be presented at 5 dB above threshold. Further step sizes will range between 1 and 5 dB, and the steps are selected by the audiologist, who should be sensitive to the possibility of exceeding the LDL at each frequency.

After tinnitus loudness matching is completed at 1 kHz, the threshold and loudness-matching procedures are repeated at 2 kHz. Tinnitus pitch matching is then done using the 2AFC method. Pairs of tones (starting with 1 and 2 kHz) are presented alternately in the same ear. Each tone is presented at the same sound level previously established as matching the loudness of the tinnitus at the respective test frequencies. Each tone in a pair is presented for a period of 3 to 4 seconds, and the intertone interval is 0.5 to 1 second. For each pair of tones presented, patients report which of the two tones sounds closest to their tinnitus pitch. Because most patients have higher-frequency tinnitus than either 1 or 2 kHz, they usually choose the higher-frequency tone (2 kHz). The test frequency then moves up to 3 kHz, and, following a threshold and loudness match at 3 kHz, the second pair of tones for 2AFC pitch matching is 2 and 3 kHz. Pairs of tones continue to increase in frequency in this way (ideally in 1 kHz steps) until the patient chooses the lower-frequency tone from the tone pair. When the lower-frequency tone is selected, the final step is to evaluate for "octave confusion."

Octave confusion is a common mistake that patients make when they match the pitch of their tinnitus (Graham and Newby, 1962; Vernon et al, 1980). Following a pitch match, if a tone one octave higher is presented, the patient will often report that the one octave higher tone is actually closer in pitch than the tone that was previously identified as the pitch match. The octave confusion test can, of course, only be done if a one octave higher test frequency is available and if the patient can hear the tone and produce a loudness match. If these conditions are met, the threshold and loudness match are first obtained at the upper frequency. Then the lower-frequency tone is presented in alternation with the higher tone (i.e., 2AFC) to determine the correct octave frequency of the pitch match.

Tinnitus pitch matching can involve either the low- or high-frequency limits of the testing equipment. When the first pair of tones (1 and 2 kHz) is presented in the 2AFC procedure, patients with unusually low-frequency tinnitus may choose 1 kHz as closest to the tinnitus frequency. In such a case, their tinnitus loudness is then matched at 0.5 kHz to enable a tone at that frequency to be presented in alternation (2AFC) with the 1 kHz tone. Testing equipment limitations will restrict testing to the lowest test frequency (usually 0.125 or 0.25 kHz). In practice, this limitation does not normally affect the pitch measurements because tinnitus below 1 kHz is relatively rare (Meikle and Walsh, 1984; Meikle et al, 1995b). Patients with exceptionally high-frequency tinnitus will consistently choose the higher of the two frequencies for all 2AFC tone pairs up to 8 kHz. When that occurs, a loudness match is then done at 9 kHz, followed by tone-pair presentation of 8 and 9 kHz for 2AFC pitch matching. Further extension to higher frequencies is possible (with special equipment) if the patient continues to choose the highest frequency. A tinnitus pitch match above 12 kHz is also rare but does occasionally occur.

Tinnitus Matching to Narrow-Band Noise

Following the tonal pitch match, narrow-band noise is presented, centered at the pitch match frequency. With special equipment, the narrowest band is selected first, and patients are asked if the noise sounds more like their tinnitus than the previous tone that served as their pitch match. If the noise does not sound more like their tinnitus, then the tone is selected as the final pitch match. If patients say the noise sounds more like their tinnitus, then the noise band is sequentially widened until it starts to sound less like their tinnitus. At this stage of testing, a trial-and-error approach is used to obtain a final noise-band match.

If special equipment is not available for this purpose, the narrow-band noise presented from

an audiometer can be used. With an audiometer, narrow-band noise centered at the pitch match frequency should be compared to a tone at the final pitch match frequency.

Minimum Masking Level

The MML is the minimum level to which broadband noise must be raised to render an individual's tinnitus inaudible. Determining the MML is a common measurement made in tinnitus clinics and has been reported to be a measure that correlates with treatment efficacy (Jastreboff et al, 1994). That is, as patients reported improvement with their tinnitus problem, the MMLs were generally observed to decrease.

Use of the term "masking" to describe the effect of sound on tinnitus is currently an issue of considerable debate. Many studies have demonstrated that the psychoacoustic principles relating to the masking of one external sound by another do not apply to the effect that external sound has to reduce the perception of tinnitus. These studies and the basic concepts involved have been reviewed in detail elsewhere (Henry and Meikle, 2000; Vernon and Meikle, 2000; Jastreboff and Jastreboff, 2001b). The reduction of tinnitus perception may be more appropriately termed "suppression," as suggested by Jastreboff and Jastreboff (2001b). With that caveat in mind, the conventional terminology will be maintained for this article.

To establish the MML, broadband noise is first presented monaurally to attempt to mask the tinnitus in each ear separately and then binaurally to mask the tinnitus completely. For monaural testing, the audiologist must determine the threshold of white noise in the respective ear. Once the threshold is determined, the level of the noise is raised in 5 dB steps until the patient reports that the noise completely masks the tinnitus in the stimulated ear. The monaural procedure is then repeated in the contralateral ear.

To obtain the binaural MML, the level of noise presented to each ear will be relative to the noise threshold obtained in each ear, respectively. The noise is first presented at a level 5 dB above the respective thresholds. For example, if the threshold in the left ear is 0 dB SPL and the threshold in the right ear is 10 dB SPL, the initial binaural presentation will be 5 dB SPL in the left ear and 15 dB SPL in the right ear. The audiologist maintains the same relative levels in each ear as the patient directs the audiologist to make the noise louder or softer to find the masking level. The patient is directed to choose the level that "just masks" the tinnitus.

Loudness Discomfort Levels

The LDL is the level of a sound that a patient reports as the threshold of discomfort for that sound. LDLs can be obtained at a series of audiometric frequencies, and the LDL at a particular frequency establishes the upper limit of the auditory dynamic range for that frequency (Skinner, 1988). The dynamic range is the decibel range between the hearing threshold and the LDL, which reflects the range of sound pressure level that can be tolerated comfortably. Measuring LDLs at audiometric frequencies is important to assist in determining the patient's TRT category, which determines the specific treatment that the patient will receive.

For TRT, LDLs are measured at octave frequencies between 0.5 and 8 kHz (0.5, 1, 2, 4, and 8 kHz), as well as the interoctave frequencies 3 and 6 kHz. Patients are directed to listen to the tones and to report when they would "not want to listen to the tone for more than a few seconds." Each tone is presented for 1 to 2 seconds. One ear is completed at all frequencies, followed by the other ear, and the test frequencies are ordered from lowest to highest for each ear tested.

It is extremely important to never exceed the patient's LDL at any frequency tested. Thus, the initial presentation level at any test frequency must be well below the LDL. Efficiency of testing must also be considered, however; thus, the start level at each frequency should be as high as possible to conserve testing time. The initial frequency used for LDL testing is 0.5 kHz, and the first tone is presented at a level that would be estimated as the most comfortable level for the patient at that frequency; usually, a starting level of 50 dB HL is appropriate for the lower frequencies. The level is then raised in 5 dB steps until the patient reports the threshold of discomfort as per the verbal instructions above. At each frequency tested, the previous LDL can be used as a guide for the initial presentation level. A good rule of thumb is to start testing at any frequency at least 20 dB below the previous frequency's LDL. For example, if the first LDL at 0.5 kHz is determined to be 100 dB HL, testing at 1 kHz should start at 70 to 80 dB HL. On the other hand, if the first LDL at 0.5 kHz is reported at 70 dB HL, testing at 1 kHz should

start at about 50 dB HL. This testing requires good judgment on the audiologist's part to avoid patient discomfort, especially considering the effects of recruitment at frequencies at which hearing sensitivity is compromised.

It has been observed that patients are often inconsistent when providing repeated LDLs within a test session (Beattie and Sheffler, 1981; Hawkins et al, 1987; Byrne and Dirks, 1996). It is therefore necessary to measure each LDL twice within a session. This is done by first obtaining the LDLs in each ear, as described above, and then by repeating the entire set of measurements. All LDLs are recorded, but only the second set of measurements is considered the final test results.

Although LDLs at audiometric frequencies are not normally obtained by audiologists, LDLs are essential to quantify a tinnitus patient's sensitivity to sound (Jastreboff and Jastreboff, 2000). It has been reported by Jastreboff, and others who use TRT, that about 40 percent of their tinnitus patients have some degree of hyperacusis (Coles, 1996; Jastreboff, 2000). Hyperacusis is treatable, and even curable, and these measurements are critical to quantify the problem and to document improvement with therapy. For patients receiving treatment for hyperacusis, it is not uncommon to observe their LDLs gradually approach 100 dB HL over a period of 1 to 2 years (Gold et al, 1999; Formby and Gold, 2002).

Assigning Patients to TRT Categories

Following the assessment and interview, patients are assigned to one of the five TRT categories that were described above. Table 1 summarizes the criteria for assigning patient categories. There are essentially four questions that must be answered when assigning a category: Does the patient have a significant subjective problem with (1) tinnitus? (2) hearing? (3) sound tolerance? and (4) Is the patient's tinnitus (or hyperacusis) exacerbated for a prolonged period by exposure to certain types of sounds?

Patients with minimally bothersome tinnitus do not normally justify full TRT treatment with ear-level devices. For these category 0 patients, an assessment and some basic education are usually all that are necessary for them to be satisfied that they do not require further rehabilitative efforts. These patients may benefit from treatment, but the cost will probably outweigh the benefit. Patients who sign up for TRT must be convinced of the value of pursuing a long-term program that can be time consuming and expensive. To possess this level of motivation, the tinnitus must have a significant detrimental effect on their lives.

As discussed above, it has been our experience that many individuals with hearing loss and tinnitus will attribute their hearing difficulties to their tinnitus (Zaugg et al, 2002). These individuals have the conscious perception of tinnitus and experience hearing difficulties in certain situations. It thus might make sense that they would conclude that tinnitus is the cause and hearing problems are the effect. When evaluated, these patients are usually discovered to have a typical high-frequency hearing loss that would make it difficult to hear in noisy situations. The loss may or may not be to such an extent as to warrant amplification. If amplification is indicated, however, the fitting of hearing aids can be beneficial to their minimal tinnitus problem. Category 0 patients, whether requiring amplification or not, should be counseled about the beneficial effects of sound therapy.

Category 1 and 2 patients have a problem with their tinnitus to such a degree that a full 1- to 2-year program of treatment is warranted. The clinician must be astute in assessing the true degree of tinnitus difficulty that is experienced by the patient. This assessment is made through the process of administering the TRT initial interview. Interview administration contains an important didactic component that requires the clinician to clearly explain the intent of each question. The accuracy of a patient's answers will be largely dependent on this skill of the examiner. Both the patient and the clinician must be convinced that treatment is needed.

Category 2 patients have the further concern of hearing difficulties. The clinician must assess the differential effects of hearing loss and tinnitus, and both must be a significant problem to the patient for placement into category 2. The audiogram may suggest that amplification would be beneficial, but category 2 placement is mainly determined by patients' subjective feelings about their hearing problems. Category 2 patients will be fitted with amplification, usually in the form of a combination device—hearing aid plus sound generator. It is important that both the patient and the clinician understand that the primary purpose of amplification is to provide sound therapy for facilitating habituation to tinnitus. Thus, any improvement in hearing function is considered a secondary objective.

Category 3 patients will have hyperacusis as a primary complaint. Technically, hyperacusis in the context of TRT is diagnosed on the basis

of reduced LDLs, as defined above (Coles, 1996; Jastreboff, 2000). However, patients' subjective impressions of loudness tolerance problems may or may not be consistent with their LDLs, and the combined data must be considered. Making an accurate assessment of this problem will again require skill on the part of the examiner. The TRT initial interview contains an entire section about sound tolerance (items 19 to 30), which will generally be sufficient to assess the extent of the problem. If the patient has a significant problem with hyperacusis, he/she should be assigned to category 3 and treated accordingly.

Category 4 is reserved for patients who not only have a problem with tinnitus but the further problem of extended tinnitus exacerbation as a consequence of exposure to certain sounds. The TRT initial interview uses item 8 to address this issue, and the patient's answers to this block of questions will provide the critical information to determine if category 4 placement is appropriate. Item 8 is specific to tinnitus exacerbation, but there is also the potential for patients to experience exacerbation of sound tolerance problems as a result of exposure to certain sounds. Prolonged exacerbation with respect to hyperacusis is addressed in item 22, which contains a block of questions that are similar to item 8. Category 4 patients comprise a small percentage of tinnitus and hyperacusis patients, but it is important to determine if prolonged exacerbation is an issue for the patients so that they can receive proper treatment for the condition.

DISCUSSION

There are many purported methodologies for the treatment of tinnitus. Such methods span the range of traditional and alternative specialties, and it may appear that all specialists have their own particular procedure for treating tinnitus with a "high success rate." In general, each of these various forms of treatment may be effective for some individuals, but they are not effective for the majority of tinnitus sufferers. In fact, a person's tinnitus problem may be exacerbated by certain types of treatment. Tinnitus patients will often ask about various forms of therapy that they have heard about, read about, or seen on a Web site. The patient needs to be properly counseled regarding the reality of the claims that are made and the potential of making their condition worse in some instances.

TRT offers a practical approach to treating individuals with severe intrusive tinnitus and can be practiced by any motivated audiologist who receives the proper training. The intent of this article is to provide audiologists with a guide to evaluate their tinnitus patients to receive treatment with TRT. This material should, however, only be considered supplemental to what has already been written about TRT and to what is presented in the TRT instructional courses. For those clinicians who have not received formal TRT training, the present document can still be useful as a guide for evaluating tinnitus patients. The specifics of this assessment protocol, however, will be most applicable to subsequent rehabilitative efforts using the principles of TRT.

Although efforts are made to ensure that TRT practitioners conduct TRT according to the specified protocol, some clinicians make their own modifications to the program and essentially present their own version of TRT. Because of the specificity of the protocol, TRT should be practiced with minimal variation, ensuring that every patient receives the same standard of treatment.

CONCLUSION

There are a number of aspects of TRT that are, in general, very positive for the tinnitus patient. TRT is a program that has been clearly described from the outset. It has been used for over 12 years by the originators of the program and has undergone improvements over this time as a result of the thousands of patients who have been treated. The program incorporates basic physiologic and psychological principles—many of which are intuitively obvious—and yet no one had previously integrated these particular principles into a cohesive tinnitus treatment protocol.

This document, along with the companion article (Henry et al, 2002) and the forthcoming follow-up article, is an attempt to present the key components of TRT that are essential to providing treatment with this method. With study and experience in applying the principles, a clinician can become well versed in TRT and serve as an effective resource for individuals suffering from tinnitus.

Acknowledgment. Funding for this study was provided by the Veterans Affairs Rehabilitation Research and Development (RR&D) Service (C891-RA) and the RR&D National Center for Rehabilitative Auditory Research (RCTR 597-0160). Portions of this material were presented at the VIIth International Tinnitus Seminar, Fremantle, Australia, March 5–9, 2002.

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APPENDIX

Tinnitus Retraining Therapy Initial Interview

Name: _____ Date: _____

Before I ask these questions, I need to explain that we are evaluating three different things: (1) tinnitus, (2) sound tolerance, and (3) hearing. Each question is specific to tinnitus, sound tolerance, *or* hearing. Tinnitus *refers to any kind of sound in your head—ringing, hissing, and so on.* Sound tolerance *refers to how you react to different sounds in your environment.* Hearing *refers to your ability to detect sounds in your environment or to your ability to understand the speech of others. Before we go on, is it clear how these differ?*

The questions about your tinnitus generally refer to the last month. *Answer these questions thinking about your tinnitus* over the last month. *I also need to tell you that some of these questions may seem repetitive or redundant to you. However, I need all of the answers to come directly from you, even if I may already know the answer. This is because we must be consistent with each patient to minimize any possibility of bias. Also, please know that there are* no wrong answers.

Tinnitus

The first series of questions is specific to your tinnitus. Please think only about your tinnitus when you answer these questions.

1. Where is the location of your tinnitus?
   ☐ Head ☐ Right ear ☐ Left ear ☐ Both ears
2. Is your tinnitus louder on one side of your head than the other?
   ☐ Right > Left ☐ Left > Right ☐ Equal
3. Is your tinnitus a constant sound or an intermittent sound?
   ☐ Constant ☐ Intermittent
4. Does your tinnitus fluctuate in volume? (i.e., does the volume change on its own?)
   ☐ No ☐ Yes
   (IF YES) How often does it fluctuate? _____ times per _____
   (Interviewer: If female respondent, ask if fluctuation in tinnitus volume is related to menstrual cycle.)
5. Please describe the onset of your tinnitus:
   ☐ Gradual ☐ Sudden
   When did it start? _____
6. What does your most bothersome tinnitus sound like? _____
7. Do you have days when your tinnitus is more bothersome than on other days?
   ☐ No ☐ Yes
   (IF YES) How often do you have these "bad days?" ____days per week/month
8. Does any kind of sound have an impact on your tinnitus? That is, does sound make your tinnitus louder, softer, or is there no effect?
   ☐ No effect ☐ Softer ☐ Louder
   (IF "LOUDER" OR "SOFTER")
   What kind of a sound has an impact on your tinnitus? _____
   How long does this last? _____
   Is it still louder until at least the next morning after you've slept? Yes/No
   (IF EFFECT LASTS AT LEAST UNTIL NEXT MORNING) Please give an example of the kind of sound that would cause this to happen. _____
9. Do you use ear protection (earplugs or earmuffs)?
   ☐ No ☐ Yes

(IF YES) When do you use ear protection? _____

Interviewer: Determine if patient uses ear protection specifically because of tinnitus; this would usually be to prevent the tinnitus from getting louder, which should not be suggested to the patient because of "negative counseling."

IF EAR PROTECTION IS USED FOR TINNITUS:

What percentage of the time do you use earplugs or muffs for your tinnitus? ____%

Do you use your earplugs or muffs for your tinnitus when it's fairly quiet? Yes/No

(Interviewer: Does patient overprotect ears because of tinnitus?) Yes/No

10. Are you currently receiving any other treatment specifically for your tinnitus?

    ☐ No ☐ Yes

    (If YES) What? _____

    (Interviewer: This can be professional or self-administered "alternative" therapies, e.g., herbs, vitamins, tapes.)

11. What is the major reason your tinnitus is a problem? _____

12. I'm going to describe certain activities that may be a part of your life. Please tell me if the tinnitus prevents you from conducting these activities or if your tinnitus negatively affects these activities in any way.

	Prevented	Affected	No Effect
a. Concentration?	☐	☐	☐
b. Sleep?	☐	☐	☐
c. Quiet resting activities (reading, relaxing, etc.)?	☐	☐	☐
d. Work?	☐	☐	☐
e. Going to restaurants?	☐	☐	☐
f. Participating in or observing sports events?	☐	☐	☐
g. Social activities?	☐	☐	☐
h. Anything else? _____	☐	☐	☐

People can be aware of their tinnitus some of the time and not aware of it at other times.

13. What percentage of your total awake time, over the last month, have you been aware of your tinnitus? Please give an average percentage over the last month. ____%

14. What percentage of your total awake time, over the last month, were you annoyed/distressed/irritated by your tinnitus? Please give an average percentage over the last month. ____%

    (Interviewer: Double-check that patient responded appropriately to questions 13 and 14, i.e., to total awake time for each condition of awareness and annoyance.)

    I'm now going to ask you to rank your tinnitus, on a scale of 0 to 10, with regard to severity, annoyance, and effect on your life. Please do not include hearing difficulties when you answer these questions.

15. How strong, or loud, was your tinnitus, on average, over the last month? "0" would be "no tinnitus"; "10" would be "as loud as you can imagine."

    0 1 2 3 4 5 6 7 8 9 10

16. How much has tinnitus annoyed you, on average, over the last month? "0" would be "not annoying at all"; "10" would be "as annoying as you can imagine."

    0 1 2 3 4 5 6 7 8 9 10

17. How much did tinnitus affect or impact your life, on average, over the last month? "0" would be "not at all"; "10" would be "as much as you can imagine."

    0 1 2 3 4 5 6 7 8 9 10

18. Do you have any other comments about your tinnitus?

Sound Tolerance

The next series of questions is only about your ability to tolerate sound. Please think only about your sound tolerance when you answer these questions.

19. Do you have a decreased tolerance to sound? That is, are sounds bothersome or unpleasant to you when they seem normal to other people (family and friends) around you? Yes/No (IF NO, GO TO QUESTION 31)

    _____

    (Examples: television, children screaming, dishes clattering, dishwasher in operation, etc.)

20. (IF YES) Do sounds cause you pain or physical discomfort? Yes/No _____

21. Do you have days when your sound tolerance is more of a problem than on other days?

    ☐ No ☐ Yes

    (IF YES) How often do you have these "bad days?" ____ days per _____

22. Does any kind of sound have an impact on your ability to tolerate sound? That is, does exposure to sound make your sound tolerance better, worse, or is there no effect?

    ☐ No effect ☐ Better ☐ Worse

    (IF "WORSE" OR "BETTER") What kind of a sound has any kind of impact on your sound tolerance? _____

    How long does this last? _____

    Does the effect last at least until the next morning after you've slept? Yes/No

    (IF EFFECT LASTS AT LEAST UNTIL NEXT MORNING) Please give an example of the kind of sound that would cause this to happen. _____

23. (Interviewer: Refer to question 9. If patient does not use hearing protection, go to question 24. If patient does use hearing protection, determine if such use is specifically because of sound tolerance.)

    Do you use earplugs or earmuffs specifically because of sound tolerance?

    ☐ No ☐ Yes

    (IF YES) What percentage of the time do you use ear protection because of sound tolerance? _____%

    (IF YES) Do you use your earplugs when it's fairly quiet because of sound tolerance? Yes/No

    Interviewer: Does patient overprotect ears because of sound tolerance? Yes/No

24. Are you currently receiving any other treatment specifically for your sound tolerance?

    ☐ No ☐ Yes

    (IF YES) What treatment? _____

25. What is the major reason your sound tolerance is a problem? _____

26. I'm going to describe certain activities that may be a part of your life. Please tell me if the sound tolerance prevents you from conducting these activities or if your sound tolerance negatively affects these activities in any way.

	Prevented	Affected	No Effect
a. Concerts?	☐	☐	☐
b. Shopping?	☐	☐	☐
c. Movies?	☐	☐	☐
d. Work?	☐	☐	☐
e. Going to restaurants?	☐	☐	☐
f. Driving?	☐	☐	☐
g. Participating in or observing sports events?	☐	☐	☐
h. Attending church?	☐	☐	☐
i. Housekeeping activities?	☐	☐	☐

j. Child care?	☐	☐	☐
k. Social activities?	☐	☐	☐
l. Anything else? _____	☐	☐	☐

I'm now going to ask you to rank your sound tolerance, on a scale of 0 to 10, with regard to severity, annoyance, and effect on your life.

27. How severe was your sound tolerance, on average, over the last month? "0" would mean "you can tolerate all sounds"; "10" would mean "you cannot tolerate any sounds."

0 1 2 3 4 5 6 7 8 9 10

28. How much has your problem with sound tolerance annoyed you, on average, over the last month? "0" would be "not annoying at all"; "10" would be "as annoying as you can imagine."

0 1 2 3 4 5 6 7 8 9 10

29. How much did sound tolerance affect your life, on average, over the last month? "0" would be "not at all"; "10" would be "as much as you can imagine."

0 1 2 3 4 5 6 7 8 9 10

30. Do you have any other comments about your sound tolerance?

Hearing

I now have just a few questions about your hearing ability.

31. Do you think you have a hearing problem?

☐ No ☐ Yes

32. Have you ever worn hearing aids?

☐ No ☐ Yes

33. Have you ever had hearing aids recommended to you?

☐ No ☐ Yes

(IF YES) From whom: a professional? Family? Friend? _____

Ranking Problems

On a scale of 0 to 10, I would like you to rank the importance of tinnitus, sound tolerance, and hearing with regard to how much they are a problem for you, on average, over the last month. "0" would be "no problem at all"; "10" would be "as much as you can imagine."

34. How much of a problem is tinnitus? "0" would be "no problem at all"; "10" would be "as much as you can imagine."

0 1 2 3 4 5 6 7 8 9 10

35. How much of a problem is sound tolerance? "0" would be "no problem at all"; "10" would be "as much as you can imagine."

0 1 2 3 4 5 6 7 8 9 10

36. How much of a problem is hearing? "0" would be "no problem at all"; "10" would be "as much as you can imagine."

0 1 2 3 4 5 6 7 8 9 10

Interviewer:

(A) Indicate patient tinnitus retraining therapy category:

_____

(B) Recommendation: _____

(C) Patient decision: _____

(D) Next visit: _____