Assessment and Treatment of Tinnitus Patients Using a “Masking Approach”

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Abstract
Audiology clinics are increasingly being asked to provide tinnitus treatment services to patients who are severely distressed by tinnitus. It is unclear what levels of tinnitus care are available at different audiology clinics across the nation. Some clinics have staff who are experienced with the tinnitus masking technique or with tinnitus retraining therapy (TRT), whereas other clinics may limit their care to the provision of hearing aids. This article is an attempt to provide some basic information for those clinicians who would like to provide at least a minimum level of care for their tinnitus patients using the tinnitus masking approach. The most important requirement is a commitment by the clinician to assemble some basic resources and to structure the clinical schedule so that adequate time is available for historical review, evaluation, trial and selection of devices, and tinnitus counseling. A minimum set of measurements is recommended for inclusion in the tinnitus evaluation process. This informal review summarizes a variety of clinical observations culled from years of direct patient care experience. A tinnitus questionnaire is provided to help clinicians review potentially relevant issues.

Key Words: hearing disorders, tinnitus

Abbreviations: ENT = ear, nose, and throat; MML = minimum masking level; TRT = tinnitus retraining therapy

Sumario
Las clínicas audiológicas están recibiendo un número creciente de solicitudes para brindar servicios de tratamiento para el acúfenos en pacientes severamente perturbados por esta condición. No está claro qué niveles de atención para el acúfenos están disponibles en las diferentes clínicas audiológicas en toda la nación. Algunas clínicas tienen personal con experiencia en las técnicas de enmascaramiento del acúfenos o con terapia de re-entrenamiento para el acúfenos (TRT = Tinnitus retraining therapy), aunque otras clínicas limitan su intervención a la prescripción de auxiliares auditivos. Este artículo es un intento de aportar alguna información básica al clínico que desea proveer al menos un mínimo nivel de atención a sus pacientes con acúfenos utilizando el enfoque de enmascaramiento del acúfenos. El requisito más importante es el compromiso del clínico de organizar ciertos recursos básicos y de estructurar el horario clínico para lograr tiempo suficiente para la historia clínica, la evaluación, las pruebas y la selección de los dispositivos, así como para la consejería sobre el acúfenos. Se recomienda un número mínimo de mediciones para incluir al paciente en el proceso de evaluación del acúfenos. Esta revisión informal resume una variedad de observaciones clínicas extraídas de años de experiencia en el manejo directo de pacientes. Se ofrece un cuestionario sobre acúfenos para ayudar al clínico a revisar los elementos potencialmente relevantes.

Palabras Clave: trastornos auditivos, acúfenos (tinnitus)

Abreviaturas: ENT = oídos, nariz, garganta; MML = nivel de enmascaramiento mínimo; TRT = terapia de re-entrenamiento para el acúfenos

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Because of its location in Portland, Oregon, the Veterans Affairs Audiology Clinic probably receives more than the average number of requests for tinnitus assessment and fitting of tinnitus masking devices or "tinnitus instruments" (combination hearing aids/maskers). The location of the Oregon Health & Science University Tinnitus Clinic and the headquarters of the American Tinnitus Association create a regional interest in tinnitus, which may be unmatched across the nation. Through public relations, educational efforts, and the pioneering work of Drs. Jack Vernon and Mary Meikle, Portland is one of the international centers of tinnitus research and tinnitus treatment activity.

Tinnitus masking is a method that has been described extensively in the literature for over 25 years, primarily by Dr. Vernon and his colleagues. The method has been widely used and is often considered a mainstay of tinnitus treatment. Vernon and Meikle (2000) have reviewed the clinical studies that have reported the efficacy of treatment with tinnitus masking. Success rates reported by these studies have ranged considerably, and there have been no clear standards with regard to methodology of treatment or the assessment of treatment outcomes. Further, there are no controlled, randomized clinical studies that have documented the efficacy of tinnitus masking (Dobie, 1999).

Dobie (2002b) has pointed out the difficulties in constructing an adequate randomized clinical trial of tinnitus treatment, be it a psychological or an acoustic form of therapy. He suggests that the next best option to randomized clinical trials is to conduct nonrandomized comparisons that use "consensus methods of predicting prognosis and of measuring success" (p. 4). Dobie astutely raised the issue of the current lack of a "staging system" that would place tinnitus patients in different prognostic categories because some patients may be more difficult to treat than others. Meikle and Greist (2002) have addressed the issue that there is no consensus regarding the evaluation of tinnitus treatment outcomes. They have advocated the development of a "core set" of variables that can be used for the evaluation of treatment effects and to facilitate valid comparisons at different treatment sites or perhaps between different treatment methods. These kinds of consensus tools do not yet exist, and Dobie suggested the interim use of established tinnitus questionnaires to compare the effectiveness of different treatments.

Although the current trend toward "evidence-based clinical medicine" would require verification of treatment efficacy, at present, we must rely mostly on the experience of clinicians to attest to the effectiveness of any particular technique. Since 1980, the first author has personally evaluated thousands of military veteran patients who have complained of tinnitus of varying levels of loudness and annoyance. He has provided tinnitus assessment and treatment for many of those patients using the basic methodology of tinnitus masking. This article provides a brief summary of what has been learned from those years of experience. Although the patients have all been veterans, the problems veterans experience owing directly to tinnitus may frequently be generalized to the civilian population. It should also be mentioned that this article focuses on treatment of patients for tinnitus only and does not address loudness intolerance (hyperacusis) issues.

GENERAL OBSERVATIONS ABOUT CLINICAL TINNITUS MANAGEMENT

Anyone who has spent substantial time working with tinnitus patients should be aware that intelligent attempts to identify the psychoacoustic correlative attributes of tinnitus may reveal it to be somewhat "mercurial" and occasionally "ethereal" in nature. In many cases, tinnitus measurement is not unlike the bubble in wallpaper, which appears to be appropriately "bleed" through after very brief duration stimulation (Penner et al, 1981). Although reliable tinnitus judgments may be made by patients within a particular test session, tinnitus measurements may vary considerably over time, owing to either measurement variability or changing qualitative characteristics of the tinnitus from one test session to another. This variability may not only be in perceived pitch, which is highly variable (Penner, 1983; Burns, 1984), but annoyance ratings and subjective loudness judgments may also vary considerably over time. If one can safely assume that, in a given case, tinnitus is not one discrete frequency (e.g., 1108 Hz), it is not too surprising that attempts at tinnitus measurement may vary if the neural signal that comprises tinnitus contains a complex mix of frequencies of varying magnitude, ranging, for example, from 3200 to 4400 Hz.

A number of essential factors must be considered in the clinical management of tinnitus
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using the tinnitus masking approach. These include obtaining a useful history, gauging the extent of difficulty a patient is having, attempting to expeditiously measure and then mask tinnitus, making decisions regarding appropriate treatment options, and selecting effective types of amplification/masking devices and counseling. All of these factors require a considerable degree of experience and sound clinical judgment, which comes only with adequate audiologic training and cumulative experience in direct patient care. Unfortunately, very few audiology programs provide students with a systemized, comprehensive, and consistent approach to evaluating tinnitus and making recommendations for treatment. Rather than fault audiology programs, it is probably because the area of tinnitus treatment is fraught with controversy and conflicting information.

Clinical tinnitus management has been evolving over time employing a variety of useful counseling techniques and using sound stimulation to provide tinnitus sufferers with therapeutic benefit. It is not unusual, however, to find audiology clinics that have never dispensed sound-generating devices that are designed to promote tinnitus relief (i.e., ear-level noise generators, tinnitus instruments, or tabletop sound machines). The following information is offered to those audiologists or ear, nose, and throat (ENT) physicians who wish to consider at least a rudimentary tinnitus assessment and treatment program in an attempt to help some of the patients who are referred to their clinic with this distressing symptom. Additionally, some unanswered questions and unresolved issues regarding tinnitus assessment and treatment will be introduced, purely to generate thought on questions, which should be important for all providers of tinnitus treatment.

MINIMUM ESSENTIAL COMPONENTS OF TINNITUS MANAGEMENT

The fast pace of many audiology clinics often does not permit lengthy time slots for tinnitus management appointments, which might be fiscally justifiable in some private sector tinnitus clinics. Adequate tinnitus treatment service can, however, be provided at most audiology clinics if the motivation and management support are present.

The minimal basic components of an assessment for tinnitus treatment should include (1) a comprehensive audiologic and tinnitus-specific history; (2) audiologic evaluation and site of lesion testing; (3) ENT medical examination and medical clearance; (4) tinnitus measurements, including loudness and pitch matching, minimum masking levels (MMLs), and tests for residual inhibition; (5) hearing aid–related measurements (most comfortable level, uncomfortable loudness level, soundfield testing, real-ear testing); (6) trial use of ear-level devices (hearing aids, tinnitus instruments, or tinnitus maskers); (7) evaluation of utility of compact discs, sound conditioners, or other augmentative sound-generating devices; and (8) provision of tinnitus education/counseling materials. One might ask why soundfield or real-ear testing should be part of a tinnitus evaluation. If the recommendation for tinnitus treatment is a hearing aid, one needs to assess the conformity or effectiveness of the selection.

Taking the History

A comprehensive and logically well-ordered case history is particularly important in the evaluation of tinnitus because the etiology may be more evident in the questions answered rather than in the tests administered. As Dobie (2002a) has pointed out, the patient’s history is the primary source of data. The case history is particularly important in tinnitus-related medicolegal issues, for which it is an integral part of assessing the consistency and plausibility of the patient’s report.

The Appendix offers a sample of a case history questionnaire that is designed to aid the clinician in obtaining important information related to the etiology of a patient’s tinnitus and to assess needs for treatment. In addition to these types of case history questionnaires, there are several useful tinnitus assessment instruments such as the Tinnitus Handicap Inventory (Newman et al, 1996), Tinnitus Handicap Questionnaire (Kuk et al, 1990), and Tinnitus Severity Index (Meikle et al, 1995). These instruments can be used to assess the patient’s perception of the degree of handicap or difficulty caused by tinnitus and may be used to monitor changes with treatment or simply to document the pattern of tinnitus perception over time.

When taking a history, it is important to always assess the use of medications that might contribute to the tinnitus symptom. The complaint of tinnitus in conjunction with significant sensorineural hearing loss might lead to the conclusion that the tinnitus is a natural byproduct of the residual integrity of the sensorineural mechanism. It is important not to
make this assumption, which might cause the examiner to overlook factors such as high daily intake of caffeine, quinine, or aspirin. These potential sources of tinnitus etiology or tinnitus exacerbation must be ruled out in every case. Previous use of antibiotics and any chemotherapeutic agents should also be explored for possible associations with the onset of the symptom.

One will want to know when the tinnitus began and whether there has been a progression, a diminution, or a pattern over time. Many veterans will state that they remember the date and circumstance that their tinnitus, as well as their hearing loss, began. Others simply remember that the tinnitus had begun sometime prior to their exit from the military, after an assortment of noise exposure incidents or assignments in noise hazard environments. The veteran population is distinctive in the high number of patients with sudden hearing loss secondary to explosions or gunfire. Encountering patients with histories of blast trauma or other military noise (aircraft, engines, machinery) exposure reveals a common picture of permanent hearing loss with chronic residual tinnitus. It is not uncommon to find noise trauma victims in the civilian sector as well, with similar reports of noise trauma, threshold shift, and permanent tinnitus.

Patients who have a history of military noise exposure should always be questioned about occupational and recreational noise exposure. Rather than ask if patients have been around any noise in their lifetime, it is useful to have a list of noisy environments as appears in the questionnaire in the Appendix so that a patient does not leave out important noise history information. When asked about noise, some patients do not offer much information, only later to realize after probed by specific example that they operated a tractor, used chainsaws, and worked on a noisy assembly line for many years.

For patients with tinnitus worsening in later life, the picture is more muddled. It is always difficult to sort out those changes of inner ear function that result from aging or some type of significant intracochlear event from changes owing to early- or midlife noise exposure. This has been one of the challenges for the Department of Veterans Affairs in establishing the validity of disability claims for veterans who seek compensation benefits for their tinnitus many years after the reported initiation of the symptom. Without serial audiometric monitoring and adequate historical documentation, the chronology of both the hearing loss and the tinnitus is problematic.

Every time patients are seen in the clinic, they should be asked to rate both the loudness and annoyance level of their tinnitus. These ratings provide some insight as to the tinnitus perception over time and any variability, which may need to be considered for treatment recommendations or for assessing treatment outcomes. The scales used for this purpose, as with any subjective rating scale, may be highly variable. These scales do, however, provide a valuable reference for clinicians as to how patients judge their tinnitus at the time of the interview. This rating approach may be useful as therapy progresses. An analog scale of 1 to 10 may be used with an appropriate reference at each end of the scale. It is not unusual to find patients at their first visit rating their tinnitus annoyance in the range of 7 to 10 (on a 1 to 10 most annoying scale) and, after appropriate treatment, rating their tinnitus annoyance level between 1 and 3. These ratings are also useful to document lack of progress (e.g., for patients who continue to rate their tinnitus annoyance at a 9 or 10 both pre- and post-treatment). In such cases, it is incumbent on the provider to modify treatment appropriately to achieve some degree of success or to recommend another therapeutic approach (e.g., cognitive-behavioral) or referral to another provider (e.g., to evaluate for psychotropic medications).

Patients should always be asked if they can hear the tinnitus while watching television or listening to music or the radio. This serves to reveal the nature of the patient's tinnitus experience and elucidates whether the patient can find psychological distraction or masking with a simple environmental audio source. Patients should also be asked if their tinnitus seems to be reduced or increased with any particular activity.

There should be an attempt to gauge any effect of tinnitus on work or personal life because severe tinnitus may negatively impact many spheres of an individual's life. Many recent retirees will find that although their tinnitus was a long-standing problem, it was not as bothersome when they were actively engaged in their professional/vocational activities. They might find that their new abundance of "peace and quiet" has actually provided them with less peace and more noise.

It is also appropriate to ask patients if they feel that their tinnitus causes an increased level of stress or feelings of depression. As appropriate, patients reporting associated symptoms of depression, extreme anxiety, or suicidal ideation
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should be referred to a mental health practitioner for evaluation and treatment. It can be very easy to disregard patients who have severe tinnitus because of their concomitant problems such as posttraumatic stress disorder or depression. In each of these cases, a concerted attempt should be made to ameliorate the tinnitus symptom. Issues such as how the patient spends his/her day, hobbies, social factors, employment, and internal psychological environment all play a role in creating the patient’s overall impression of his/her tinnitus problem. Any effects on sleep should also be explored, and medications that have been used to control sleep should be documented.

It is important to gain an understanding of how individuals perceive their tinnitus problem relative to their hearing problem (if they have a hearing problem) (Zaugg et al, 2002). Many patients feel that their major problem is hearing and have learned to adapt (habituate?) to the tinnitus, whereas others report the tinnitus to be overwhelming and their hearing loss to be of minor import. These perceptions will be to some extent dependent on the severity of each of these problems, yet there are many cases in which very substantial hearing loss is considered hardly bothersome. In other cases, such as when professional demands place a high value on unimpeded communication, considerably loud tinnitus is found not as disabling as a mild to moderate degree of hearing loss. These distinctions are important for they may weigh heavily in choosing between a hearing aid, tinnitus masker, or tinnitus instrument. Furthermore, the kinds of difficulty a patient is experiencing should be elucidated. Patients who find themselves in a variety of noisy environments may require more sophisticated hearing aid options such as multimemory devices, remote control, or directional hearing aids.

When presented with a patient complaining of bothersome tinnitus, any symptomology possibly related to the tinnitus problem or serving as a potential source of the problem should be determined. Possible related etiologic factors such as temporomandibular joint syndrome, fluctuant or progressive vertigo, familial hearing loss, treatment with ototoxic medications, facial palsy, and head trauma will often be revealed in a complete history. This history is in addition to the tinnitus questionnaire because every tinnitus patient should have a complete audiologic history to gain an awareness of any suspect history suggestive of retrocochlear pathology.

Finally, it is important to ask patients about any previous treatments (e.g., hearing aids, masking devices, or counseling). If any type of therapy has been offered to treat tinnitus in the past, this area should be fully explored to determine what paths might now lead to success or to help to determine why these approaches were not satisfactory for the patient.

Otoscopic Inspection

One of the treatable forms of tinnitus is cerumen impaction. Less evident, however, is the small amount of cerumen that may be located on the tympanic membrane and is obscured by incomplete visualization of the tympanic membrane. The mass effect of cerumen on the tympanic membrane will sometimes create tinnitus that is associated with a mild high-frequency conductive loss. Bone-conduction testing is essential in these cases. If the loss is conductive, referral to an ENT physician for complete removal of the debris should eliminate the high-frequency conductive loss and possibly the tinnitus as well. Referral of tinnitus patients to other treatment clinics for cerumen removal introduces increased risk. It has been reported that cerumen removal has caused tinnitus in some patients (Folmer and Shi, 2002). Improper cerumen removal procedures can also exacerbate existing tinnitus.

Tinnitus Psychoacoustic Assessment

Basic tinnitus measurements (loudness and pitch matching, MML, and residual inhibition) were advocated as necessary components of a standardized tinnitus evaluation nearly two decades ago (Vernon and Fenwick, 1984). Unfortunately, there is still no consensus on a standard protocol for tinnitus assessment. Detailed descriptions of these techniques may be found in the companion articles (Henry et al, 2002a, 2002b).

Tinnitus matching measurements are particularly important for a tinnitus masking program. There are a number of important reasons why these measurements are useful, as summarized by Vernon and Meikle (2000). In general, such measurements quantify the patient’s tinnitus perception, which may be helpful for selecting the optimal masking sound, for monitoring potential changes of the tinnitus percept as a result of treatment, and for counseling purposes.

Tyler (2000) has provided a summary of reasons for taking the time to attempt tinnitus
pitch, loudness, and masking measurements. Tyler uses measurements of tinnitus pitch and loudness to provide reassurance to patients, to demonstrate the sensation to friends and family, to help to note any changes in tinnitus quality over time, and to determine if treatment has an effect (especially in relation to loudness matches). Demonstrating the masking effect is important for patients to have the experience that their tinnitus may be partially or completely blocked and to demonstrate the ability to gain some restoration of control over the disturbing symptom. The demonstration of masking further provides some prediction as to how successful other masking sources might be. Although these psychoacoustic tinnitus measurements are important, high response variability for some patients will limit their usefulness in those cases.

Overlying all of the expected measurement variability inherent in tinnitus measurement will be the variability present in testing a broad range of tinnitus sufferers varying in cognitive status, frustration tolerance, psychoacoustic test skills, educational level, and ability to follow the test instructions. It is a very different experience to attempt to test a patient who is an accomplished musician compared with listeners who are less sophisticated, have slightly diminished cognitive status, have multiple medical problems, or who require more time, training, and repeated explanation. Some patients will not be candidates for tinnitus evaluations simply based on their inability to participate in the evaluation procedures. It is probably more important, however, to spend less time trying to find the best acoustic match to the tinnitus than to find an appropriate noise that effectively masks or diminishes the tinnitus in an acceptable way.

**Tinnitus Pitch Matching**

Although some patients are very capable of consistently identifying a specific matched frequency, many others find it difficult to match their tinnitus to a specific frequency or frequencies in 1 kHz or octave intervals. Some patients may require combinations of tonal presentations or additional noise stimuli to obtain an acceptable match. If special equipment is not available, often the potential pitch match will end at 8 kHz, whereas in a limited number of cases, higher frequencies may be required to obtain an accurate match. Further, there may be poor agreement in both pitch and loudness when measurements are compared from one visit to another (Meikle et al, 1987; Stouffer and Tyler, 1990). Such inconsistency may be attributable to changing tinnitus characteristics over time or just poor test–retest reliability in attempting to match a very complex neural signal to a simple pure tone or other noise combination. One can imagine that if a significant amount of variability in tinnitus measurement is present under the rigors of a research protocol, what the expectation might be in a normal clinical environment.

In the first author’s informal observations of tinnitus matching over the past 20 years and spending many hours using a Starkey Corporation (Minneapolis, MN) TRA tinnitus measurement system, it is offered that tinnitus pitch matches (in patients with high-frequency sensorineural loss) characteristically fall in the frequency range or frequencies of greatest loss (e.g., noise induced 3 to 6 kHz). This observation is in agreement with Axelsson and Sandh (1985) and others who have also found tinnitus most frequently located in the range of greatest loss. When tinnitus is not present in the region of greatest loss, it may frequently be found on the edge of the loss or the sharpest slopes of the loss, either above or below the area of greatest sensorineural loss.

**Tinnitus Loudness Matching**

Although loudness match levels have been reported to be and appear to be much more reliable than pitch matches (Penner, 1983; Henry et al, 1999), many clinicians will find a considerable amount of variability in this parameter as well (Meikle et al, 1987). Some patients do not have an easy time matching loudness when the pitch or quality of the matched tone or noise is significantly different from the tinnitus perception. Most patients have to be taught the task of performing tinnitus matching, and this will often require considerable time. Many patients must learn the basic jargon of acoustics (e.g., loudness, pitch) before they can be instructed. Additionally, when using a contralateral loudness matching paradigm, differences in loudness growth and cochlear processing between ears and between different frequencies can considerably confound the question of what is actually being experienced by the patient and measured by the examiner.

In patients who have bilateral tinnitus of unequal loudness, the less prominent tinnitus will often not even become evident until the louder tinnitus is masked out. This situation can present great difficulty in attempting to make accurate measurements of tinnitus in each ear.
**Tinnitus Loudness Ratings**

In contrast to the neurophysiologic model of tinnitus (Jastreboff, 1996b), it is the opinion of the first author that there is a strong correlation between the reported loudness rating of the tinnitus and the degree of distress/annoyance noted by the patient, as well as the prognosis for amelioration. As support, one need only look to the extremes of loudness and annoyance ratings to observe at least some type of relationship between the two. It is often observed that tinnitus that is barely audible to the patient also finds readily accessible masking with almost any type of acoustic source or psychological distraction. At the other extreme is the tinnitus that is reported to be equivalent to the loudness of a jet aircraft or jack hammer and as such is not easily attenuated, thus requiring ear-level sound-generating devices. It is generally patients with mild loudness ratings of tinnitus (1–3 on a 1–10 subjective loudness scale) very annoying, yet many others find moderate loudness levels (4–6 on a 1–10 scale) not too bothersome. It has been the first author's experience that the majority of patients with mild loudness ratings of tinnitus are most distressed at the initiation of the symptom. They often do very well over time, however, with appropriate counseling and basic sound stimulation strategies—often without the necessity of using ear-level devices. It is generally patients reporting moderate to loud tinnitus who have the most difficulty attaining relief from the symptom, thus requiring ear-level sound-generating devices.

**Selection of Ear-Level Devices**

Once a determination of the approximate pitch, loudness level, and the effectiveness of noise as a masking source has been made, it is then necessary to determine what type of ear-level device will be most appropriate for the patient. This is done in the clinic using a trial-and-error approach, thus necessitating an inventory of stock devices. Because hearing aids may provide enough sound stimulation to gain some level of relief from the loudness level of tinnitus, stock hearing aids must be on hand in addition to tinnitus maskers and tinnitus instruments.

If the patient has a significant hearing loss, a stock hearing aid may be worn in the clinic waiting area or in other realistic environments with subsequent patient feedback as to whether the hearing aid(s) provides a significant decrease in the level of tinnitus. Hearing aids may also be used in some patients with borderline normal hearing because they, too, may receive a masking benefit from additional auditory stimulation. This approach may be controversial, but it is simply using a hearing aid for a different purpose, specifically relief from the perception of tinnitus. When tinnitus maskers are used by patients with borderline normal or mild loss, the noise source may have a deleterious effect on communication ability.

If hearing aids provide no masking benefit, then a tinnitus instrument may be tried, permitting the combined use of amplification and masking. Patients are instructed to first set the volume control of the hearing aid and then add in masking noise to provide the desired effect (Vernon and Meikle, 2000). Patients are cautioned not to set the level of noise any higher than is required to mask the tinnitus. Patients should then provide an opinion of the effects of the device and be questioned about any residual inhibition. In patients with normal hearing, trial use of tinnitus maskers would be attempted to note any perceived masking benefit or residual inhibition.

Through years of experience (first author) in the use of stock instruments, several important assessment issues have become apparent. When one attempts to use stock in-the-ear hearing aids for trial use, the frequency response of the device may provide either too little, too much, or totally inappropriate levels of gain. Often stock devices will be inappropriately vented, which may create an occlusion effect and more low-frequency gain than is warranted (Schechter et al, 2002). The stock device will generally be a very poor fit, thereby increasing the likelihood of acoustic feedback at low volume settings. A hearing aid that fits poorly may also create a negative psychological impression, which ideally should not even be a factor during the initial assessment.

This situation could be improved if a "more complete set" of trial devices could be assembled. These would include a variety of different size...
devices with an ample variety of vent sizes. Another possibility is to have programmable postauricular units that might be coupled to the ear with a temporary flextip earmold. It is a challenge to attempt to maintain an appropriate selection of stock devices, and most often the true trials of the devices occur with the issuing of custom-fit instruments. Many patients have been successfully fit with commercially available devices including tinnitus maskers (e.g., Starkey) and tinnitus instruments such as the Starkey Corporation’s TML and TMC in-the-ear devices and General Hearing Instruments’ Tranquil and Harmony devices. The recent introduction of digital noise generators (e.g., Siemens Sereniti TCI and TCI-C) should present the clinician with innovative assessment and treatment strategies. The ability to compare different noise spectra and customize the many amplification parameters of these digital units will permit greater therapeutic flexibility.

Once a device or set of devices has been selected, a thorough discussion of the treatment plan should be shared with the patient. The patient should understand what is being ordered (including the size) and reasonable expectations from appropriate use. The goals of this approach should also be reviewed so that the patient clearly understands what might be interpreted as a successful fitting. Patients should not leave the clinic expecting that when the devices are received that their tinnitus will completely disappear. The idea that only a partial diminution of the tinnitus might provide some relief should be communicated.

Counseling

In the tinnitus masking literature, there is very little said about counseling patients. This has led to a misconception that counseling is not part of this treatment approach, as discussed in detail in the companion article (Henry et al., 2002b). Counseling is a critical component of tinnitus masking as Vernon has discussed in his most recent book (Vernon and Sanders, 2001).

Patients who are evaluated for treatment with tinnitus masking should receive a thorough discussion of the test results, implications for treatment, therapeutic plan, possible confounding or exacerbating factors, use of sound-conditioning techniques, hearing conservation, and the provision of written materials that summarize relevant tinnitus management techniques.

If a patient has been fit with a tinnitus instrument, the patient will require counseling on the use of the tinnitus-masker filter potentiometer, which is a standard option on tinnitus instruments. It is the patients themselves who will often find the most effective and efficient noise for masking their tinnitus. Patients are counseled about the importance of combining the amplification of environmental stimulation, as well as masking noise to gain maximal effect. It should be evident that creating a “rich auditory environment” is elemental to the fitting of a tinnitus instrument. A hearing aid is paired with a noise source predominantly for this purpose. The use of multimemory hearing aid products now permits variability in shaping the auditory stimulation. Anecdotally, some patients report that one memory setting may be more effective than another in providing an environmental masking effect.

DISCUSSION

The preceding overview was provided to offer some basic information and structure to clinicians attempting to evaluate and treat tinnitus problems using the method of tinnitus masking.

Audiologists as Tinnitus Specialists

Because tinnitus management is not normally included in audiology training programs, tinnitus patients will receive very different levels of services from different audiologists. Audiologists without specific tinnitus training will generally restrict their treatment to the provision of hearing aids and possibly counseling of patients to use environmental sound stimulation. Audiologists who have received tinnitus training may offer different types of tinnitus treatment, including tinnitus masking, tinnitus retraining therapy (TRT), and cognitive-behavioral therapeutic techniques. Nonetheless, audiologists are uniquely qualified to provide comprehensive tinnitus management provided that they make appropriate referrals to physicians and psychologists. It is not clear if a multidisciplinary team approach provides advantages to the majority of patients. Folmer and colleagues (2002), however, have reported on their recent successes with individualized treatment programs using a team approach to choose the most effective form of tinnitus therapy for each patient.

Even if a clinician does not have the awareness to offer comprehensive tinnitus counseling, in many cases, the clinician will find that patients demand it through their questions and
urgency for information about their disturbing symptom. An audiologist is in the position to provide much of the basic counseling even without specialized tinnitus expertise. Many patients who are initially very distressed by new-onset mild tinnitus do very well from just receiving accurate information, basic tinnitus management strategies, and reassurance. At the Portland VA Medical Center, counseling materials have been available for many years that have advocated the use of portable tape and compact disc players, sound conditioners, relaxation tapes, tabletop fountains, music, books on tape, or the radio or television to seek relief. Patients have also been provided with materials that describe organizations such as the American Tinnitus Association and self-help groups such as SHHH (Self Help for Hard of Hearing), where they may find useful information and support.

The goal of any tinnitus masking approach is to provide relief from the level of distress that the patient is experiencing. Some of the strategies described in this article have been used successfully by audiologists for years, either through acquired knowledge from different sources and disciplines, by experience, by trial and error, or by standard comprehensive audiology practice. For patients who have tinnitus yet find their hearing loss to be of greater concern, the approach of carefully fitting an appropriate set of hearing aids is not a new one. Encouraging patients to employ a variety of different external audio devices for sound stimulation or creating a rich auditory environment is also a long-established technique for the successful amelioration of tinnitus in some patients.

When fitting hearing aids, it is extremely important to ensure that the devices provide adequate gain (without overamplifying) and that they contain features that are optimal for the user so that the likelihood of rejection is minimized. These are equally important issues when fitting ear-level devices to tinnitus patients.

It is important for audiologists to have a structured set of protocols for evaluation of patients with different types of problems (hearing loss, tinnitus, and hyperacusis). Tinnitus treatment requires restructuring of basic audiological protocols to synthesize those components of treatment that are most effective and to establish protocols that may be easily transferable from one clinical milieu to another.

Patients who are suffering from tinnitus are often preoccupied by its perception. There is great satisfaction in seeing patients after treatment who are aware of their tinnitus only 5 percent of the time rather than 90 percent of the time. This, of course, is one way of measuring the success of treatment according to the method of TRT (Jastreboff and Jastreboff, 1999).

Predicting Treatment Efficacy

It has been suggested that the psychoacoustic characteristics of tinnitus are not predictive of the success or failure of treatment (Jastreboff et al., 1994; Jastreboff, 1996b). From the first author’s experience, it appears that tinnitus, which is most easily and efficiently masked, is most easily treated. Further, those with the highest levels of tinnitus loudness ratings combined with the greatest levels of hearing loss generally tend to have poorer outcomes and are more likely to have limited benefit from tinnitus treatment. Some patients with severe hearing loss often require such a high level of noise stimulation that masking is not practical. Additionally, they are so dependent on amplification that noise stimulation serves only as interference to their already limited communication abilities.

Effects of Hearing Loss on Noise Stimulation

When conducting trials of potential ear-level devices for sound stimulation, it is interesting to note that many patients cannot even hear the noise present in many of the available noise generation devices. When they can hear it, it is not known what the sensation levels of stimulation are at various frequencies. These levels will prove highly variable depending on the actual spectral content of the noise delivered, as well as the slope and degree of hearing loss present. These variables have not been systematically examined, yet the prescription is often noise stimulation without the actual noise dosage being considered or known. If one relies solely on patient report, one should be reminded of the new hearing aid user who reports “ideal loudness” when the device is not even turned on.

Until the exact source of each individual’s tinnitus is determined, treatment must focus on alleviating the symptom of tinnitus and its associated effects. There are many approaches to treating the tinnitus symptom, which will always be found embedded within the complex and idiosyncratic psychological state of the sufferer, which includes personality, exogenous psychological factors, and emotional reactions to tin-
nitus. A multitude of sources have pointed out the similarities of tinnitus perception to pain perception and have also modeled tinnitus based on the theoretical constructs of pain perception (e.g., Tonndorf, 1995; Turk, 2002). Current zeitgeist further places a significant emphasis on the limbic system and its role in the resultant annoyance of the tinnitus symptom. The use of sound ("sound therapy") to treat tinnitus can be thought of with respect to providing palliative relief (Vernon, 1977; Vernon and Schleuning, 1978; Vernon and Meikle, 2000) or to attaining long-term habituation (Jastreboff, 1996a; Jastreboff et al, 1996; Jastreboff and Hazell, 1998). It would seem that any sound that obscures and desensitizes the tinnitus signal will be helpful in reducing the confounding issues associated with the alerting and fear mechanisms of perception.

Types of tinnitus treatment are extremely varied, many of which would be classified as "alternative." More mainstream nonaudiologic types of treatment programs include mainly pharmacologic approaches (Brummett, 1989; Johnson et al, 1993; Dobie and Sullivan, 1998) and psychological treatments (Sweetow, 1986; Henry and Wilson, 2001). Otologic surgery is an option for a small proportion of tinnitus patients. Postoperative effects on tinnitus are, however, often unpredictable (Hazell, 1990).

**CONCLUSION**

Many people experience tinnitus; however, it is the 20 percent who have disturbing tinnitus that interferes with sleep and daily living activities who require special treatment such as masking (Vernon and Meikle, 2000). The patient suffering from severe tinnitus or who reports the tinnitus to be very intrusive and bothersome requires extra attention and care.

Tinnitus assessment presents a challenge to clinicians in light of the absence of methodologic standards, as well as the variable and complex nature of tinnitus itself. Tinnitus masking success is dependent on the types of amplification or sound generation devices that are recommended. A poor hearing aid fitting will decrease the likelihood of successful treatment. Fitting a set of hearing aids may help many tinnitus sufferers; however, it should not be the only choice considered or offered. Clinicians can improve their level of tinnitus care by assembling additional resources, conducting a minimum set of measurements, and providing counseling materials.

It appears that this is a time of rapid change in the area of tinnitus treatment. What is most important is that hearing health care providers maintain a sensitivity to the suffering that can be caused by tinnitus. With an increasing awareness of the effectiveness of a variety of tinnitus treatment options, it becomes the clinician's responsibility to grow professionally and offer tinnitus assessment and treatment strategies to the patients who are in need of these services.

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**REFERENCES**


APPENDIX

Tinnitus Questionnaire

Portland VA Medical Center Audiology Clinic

Patient: ____________________________ Clinician: _______________________
Date: ______________________________

(Circle the choice that best describes what you experience most of the time)

1. I would say that my tinnitus (ringing in the ear) is located mostly or completely in:
   - Right ear
   - Left ear
   - Both Ears
   - Center of head
   - Somewhere else

2. On a scale of 1 to 10 in terms of loudness, 1 being like a barely audible (very soft) tone on a hearing test and 10 being extremely loud, like aircraft, I would rate my tinnitus (in quiet) as
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

3. If you notice tinnitus in both ears, but it is softer on one side, rate the loudness of the softer tinnitus in the ear on the same scale as above.
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

4. The pitch (frequency) of the tinnitus is most like:
   - High-pitched tone
   - Low-pitched tone
   - Roaring
   - Hissing
   - Crickets
   - Pulselike (vascular)
   - Chirping
   - Siren
   - Buzzing
   Other type of sound that describes it better: ____________________________

5. In terms of how often I hear the ringing in a quiet room, I would say I hear the ringing:
   - Always
   - Most of the time
   - Some of the time
   - Rarely

6. In terms of how often I hear the ringing in the presence of background noise or while watching television (or listening to the radio), I hear the ringing:
   - Always
   - Most of the time
   - Some of the time
   - Rarely
   - Never

7. I would say I am aware of the ringing about:
   - 10–20% of the time
   - 30–50% of the time
   - 60–80% of the time
   - 90% of the time
   - All the time
   a. The tinnitus occurs about:
      - One time weekly or less
      - Several times weekly
      - Everyday or almost everyday
   b. The usual duration of a bout of tinnitus is:
      - Less than 1 minute
      - Several minutes
      - More than half an hour to 1 hour
      - One hour
      - Many hours per day
      - Constant

8. The ringing in my ears prevents me from falling asleep:
   - Always
   - Frequently
   - Some of the time
   - Rarely
   - Never

9. The ringing in my ears wakes me up:
   - Always
   - Frequently
   - Some of the time
   - Rarely
   - Never

10. I would say that I have adjusted (bothers me less than it once did) to my tinnitus:
    - Not at all
    - Slightly
    - Moderately
    - Near completely
11. Since the ringing started, I would say it has:
   - Remained about the same loudness level
   - Gotten slightly louder
   - Gotten much louder
   - Gotten intolerably loud

12. I know when the ringing started and it was:
   Date:__________ Year:__________
   Or approximately: Past year 2–5 years ago 5–10 years ago
   Greater than 10 years Greater than 20 years

13. The circumstances that I think caused the ringing:
   Explain:________________________________________________________

14. I have not been around any significant noise or high noise levels for the past 3 months.
   True False
   If false, describe:________________________________________________

15. In terms of annoyance (1 being that I hardly think about the ringing in the average day and 10
   being where I think about the ringing all of the time and even get depressed about it), I would
   rate the ringing at:
   1 2 3 4 5 6 7 8 9 10

16. I would say the ringing affects my ability to perform my job:
   Never Rarely 1–2 times weekly More than 3 times weekly
   Always or almost always

17. I would say the ringing affects my ability to concentrate:
   Never Rarely 1–2 times weekly More than 3 times weekly
   Always or almost always

18. The environments you have worked in or noises you have been exposed to without
   the use of any hearing protection:
   Construction sites Sawmill or lumber mill Flight line/airplanes
   Air or jack hammers/chippers Gunfire/artillery/bombs/grenades
   Demolition/dynamite Noisy machinery or equipment (grinders, drills)
   Tractors, engines, turbines Chainsaws
   Loud music or concerts, bands Snowmobiles/motorcycles
   Other, list:

19. I would say my hearing is:
   Completely normal Slightly reduced Moderately reduced Very poor

20. If I think about my hearing problems and my tinnitus problem, I would say:
   My tinnitus bothers me more The hearing loss bothers me more
   Both problems are equally bothersome to me

21. I have used a hearing aid in the past
   Yes No (If no, proceed to question 25.)

22. My opinion of the hearing aid was that they were:
   Not at all helpful Slightly helpful Helpful but disappointing
   Very helpful

23. When I wore the hearing aids, I heard the ringing:
   Just about the same Seemed to make it less noticeable Seemed to make it louder
24. The hearing aids were okay, but I didn’t like (circle any items that apply):
   - The quality of sound
   - The loudness
   - The size
   - Maintaining them
   - The squealing (feedback)
   - Performance in noise
   - Putting them in and taking them out
   Other problems:_________________________________________________________

25. I have heard of a device called a tinnitus masker or tinnitus instrument.
   Yes  No

26. I have tried a tinnitus masker/instrument or some type of sound-conditioning device.
   Yes  No

27. I have had a tinnitus evaluation in the past:
   When:____________  Where:_____________________

28. I have tried a masker or tinnitus instrument in the past, but it worked poorly.
   Yes  No  Explain:___________________________

29. I sometimes feel like my tinnitus makes me:
   - Stressed out
   - Anxious
   - Depressed
   - Suicidal
   - None of these

30. My current medications (as I can best describe them) are (please list the name of all medications you are currently taking):_________________________________________________________

31. Circle any of the following substances if you ingest them:
   - Quinine
   - More than 3 cups of coffee daily
   - Diuretics (water pills)
   - Several aspirin daily

32. I would say my general health is good:
   True  False

33. I would say that normal everyday sounds bother me a lot.
   True  False

34. I think I have greater sensitivity to loud sounds than most people.
   True  False

35. Circle any of the following treatments, conditions, or health problems if they are current or in your medical history:
   - Head injury (trauma)
   - Stroke
   - Tumors or treatment for tumors (cancer)
   - Antibiotic therapy for life-threatening infections
   - Chronic neck or back pain
   - Malaria
   - Ear infections
   - Allergies
   - Chronic ear itching or fungus
   - Chronic jaw or facial pain
   - Barotrauma
   - Poisons, metals, or toxic agents
   - Depression
   - Any chronic pain
   - Ruptured eardrum
   - Chronic sinuses problems
   - Excessive earwax
   - High blood pressure
   - Temporomandibular joint syndrome
   - Blast trauma
   - Posttraumatic stress disorder
   Any other health problems not listed above:__________________________________