Chapter 46
Algorithm for the Diagnostic and Therapeutic Management of Tinnitus

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Keypoints

1. Tinnitus can be a symptom of a wide range of different underlying pathologies and accompanied by many different comorbidities, indicating the need for comprehensive multidisciplinary diagnostic assessment.
2. Basic diagnostics should include a detailed case history, assessment of tinnitus severity, clinical ear examination, and audiological measurement of hearing function. For a considerable number of patients, these first diagnostic steps in combination with counseling will be sufficient.
3. Further diagnostic steps are indicated if the findings of basic diagnostics point to acute tinnitus onset, a potentially dangerous underlying condition (e.g., carotid dissection), a possible causal treatment option, or relevant subjective impairment.
4. Further diagnostic management should be guided by clinical features. There is increasing evidence that phenomenologic and etiologic aspects determine the pathophysiology and the clinical course of tinnitus. In a hierarchical diagnostic algorithm, the first differentiation should be between pulsatile vs. non-pulsatile tinnitus. In case of non-pulsatile tinnitus, differentiation between acute tinnitus with hearing loss, paroxysmal tinnitus, and chronic tinnitus is recommended. Further diagnostic procedures of constant non-pulsatile tinnitus will depend on concomitant symptoms and etiological conditions.
5. All diagnostic and therapeutic steps should be accompanied by empathic and insightful counseling.
6. The ultimate treatment goal is the complete relief from tinnitus. If causally oriented treatment options are available, these should be preferred. However, in many cases, only symptomatic therapies can be offered, and then the treatment goal in clinical practice will be defined as the best possible reduction of unpleasant hearing sensations and accompanying symptoms, that is, to improve quality of life.

Keywords Tinnitus • Pathology • Etiology • Comorbidity • Symptom • Diagnosis • Therapy

Abbreviations

AVM	Arterio-venous malformation
ABR	Auditory brainstem responses
BIH	Benign intracranial hypertension
CBT	Cognitive behavioral therapy
CHQ	Case history questionnaire
CSF	Cerebrospinal fluid
CT	Computer tomography
ECoG	Electrocochleography
EEG	Electroencephalography
FDA	US Food and Drug Administration
LP	Lumbar puncture
MRI	Magnetic resonance imaging
MVC	Microvascular compression
OAE	Otoacoustic emissions
PTSD	Posttraumatic stress disorder
SOL	Space occupying lesion
THI	Tinnitus handicap inventory
TMJ	Temporomandibular joint

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TMS	Transcranial magnetic stimulation
tDCS	Transcranial direct current stimulation
TRT	Tinnitus retraining therapy
TQ	Tinnitus questionnaire
VEMP	Vestibular evoked myogenic potentials

Introduction

Diagnostic and therapeutic management of tinnitus is challenging for a variety of reasons. Multiple etiologies can result in the same phantom sound percept. Even though hearing disorders are the most important risk factors for the development of tinnitus, other diseases such as brain tumors, neck injuries, temporomandibular dysfunction, or emotional disorders generally covered by other disciplines (e.g., neurology, psychiatry, orthopaedics, dentistry, or neurosurgery) can be critically involved in the etiology or continuation of tinnitus. Therefore, the requirements of comprehensive tinnitus diagnosis and treatment can only be met by an integrated multidisciplinary approach.

Although tinnitus itself is not dangerous, it can be the first sign of potentially dangerous diseases that can even become life threatening if left undiagnosed and untreated. Furthermore, tinnitus by itself may become life threatening if accompanied by suicidal tendencies.

The authors[1] of this chapter developed an algorithm in order to provide guidance for diagnosis and treatment of tinnitus based on currently available evidence (see Fig. 46.1).[2] In particular, this algorithm is intended to assist clinicians who occasionally see tinnitus patients and may not be fully aware of the complexity of the condition. Subgroups of tinnitus require specific management or can benefit from specific treatment. Even if some of these conditions are relatively rare, considering the possibility of their occurrence is warranted because of the availability of specific treatment options.

A stepwise decision-tree approach for tinnitus management is proposed, starting with basic diagnostic steps, which are recommended in all patients [1] (Fig. 46.1, white boxes), and includes history taking for associated symptoms (Fig. 46.1, red boxes). Depending on the findings of the first step, further diagnostic or therapeutic measures may or may not be necessary (see also Table 46.1). The second step consists of tailored technical tests (Fig. 46.1, yellow boxes) for the diagnosis of specific tinnitus-related disorders (blue boxes), leading to a causal and therapeutic management. For cases in which a causally oriented treatment is not available, not possible, or not sufficiently successful, symptomatic treatment options can be offered (Fig. 46.1, grey boxes). It is emphasized that the entire diagnostic workup should be accompanied by empathic and insightful counseling (Chap. 70).

More detailed descriptions of the different diagnostic and therapeutic steps can be found in the specific book chapters in Part II (Causes of Tinnitus), Part III (Differential Diagnosis of Tinnitus), and Part IV (Clinical Characteristics of Different Forms of Tinnitus).

Basic Diagnostic Assessment

This first step, to be performed in every patient and not requiring any sophisticated instrumentation, will reveal enough clinical information about tinnitus, hearing, and comorbidities to decide whether further diagnostic steps are needed – if yes, the diagnostic assessment indicates which of them would be most appropriate. These basic diagnostics should include an in-depth case history including assessment of tinnitus severity (using screening tools or questionnaires) (for details see Chap. 47); clinical ear examination (for details, see Chap. 48); and audiological measurement [1] (for details, see Chap. 49.

As previously discussed, for a considerable number of patients, these first diagnostic steps in combination with counseling will be sufficient (see Table 46.1). For example, further diagnostic steps are not necessary if there is no hint of a dangerous underlying disease and

[1]The authors are clinicians from different specialties who all have extensive experience in the management of tinnitus patients. The algorithm for the diagnostic and therapeutic management of tinnitus patients has been developed in the framework of the Tinnitus Research Initiative (http://www.tinnituresearch.org). In order to avoid bias due to specific disciplines or specific health care systems, the group was multidisciplinary (consisting of otolaryngologists, audiologists, neurologists, psychiatrists, psychotherapists, and a neurosurgeon) and multinational (Belgium, Brazil, France, Germany, Italy, New Zealand, and Spain).

[2]In the original powerpoint version of the flowchart (available at http://www.tinnitusresearch.org), a mouse click on any item opens a separate slide, which provides more detailed additional information. In order to avoid redundancy, only the synopsis is presented in this chapter.

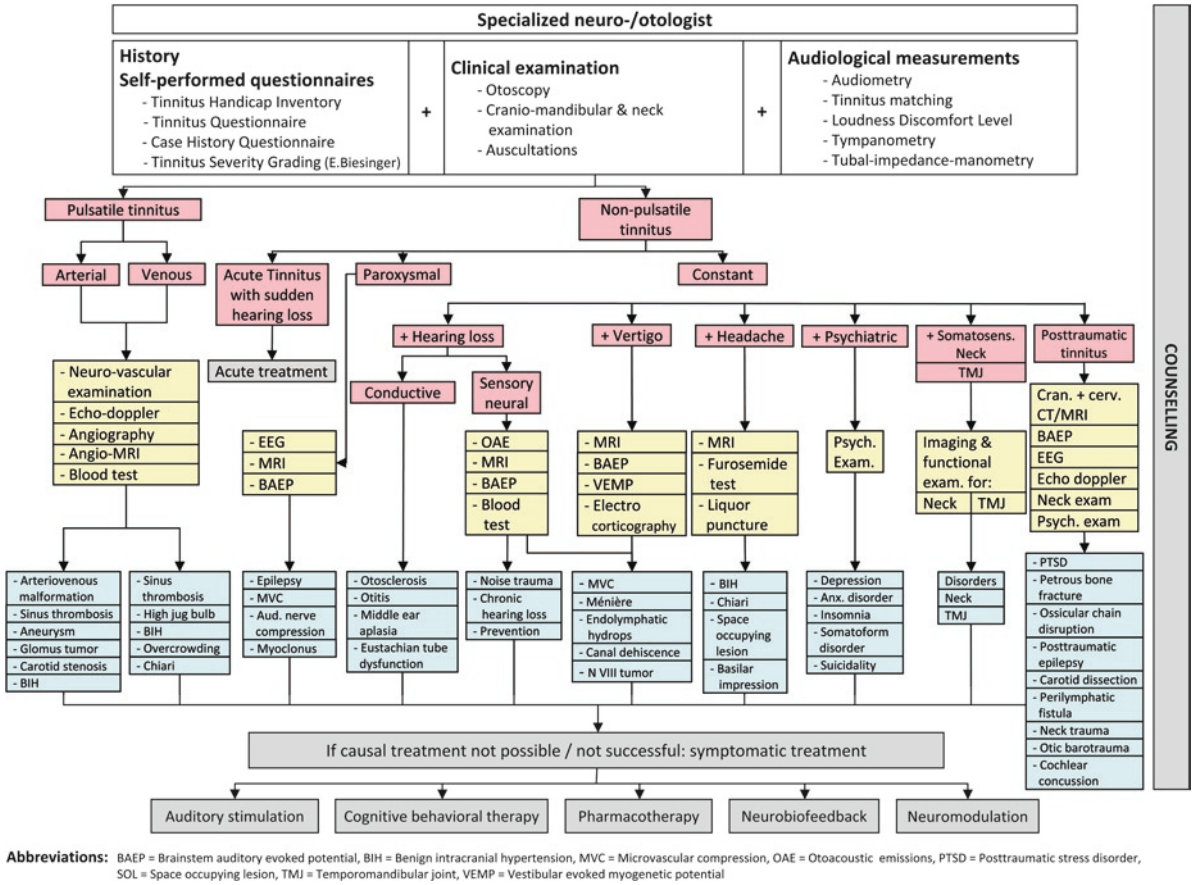

Fig. 46.1 Diagnostic and therapeutic algorithm. In the original powerpoint version of the flowchart (available at http://www.tinnitus-research.org), a mouse click on any item of the flowchart opens a separate slide, which provides more detailed additional information

Table 46.1 Further diagnostic or therapeutic measures that may or may not be necessary

Indications for further detailed diagnostic steps	Indications for immediate therapeutic management
Subjective impairment by tinnitus	Tinnitus with suicidality or with severe impairment
Heart synchronous pulsatile tinnitus	Acute tinnitus with sudden hearing loss
Tinnitus with hearing loss of unknown etiology	
Posttraumatic tinnitus	

Following basic assessment further diagnostic and therapeutic procedures may or may not be necessary. Here important indications for further diagnostic steps and immediate treatment are summarized

if the patient is not impaired by the tinnitus. However, the basic assessment will also identify those cases where further diagnostic and/or therapeutic steps are required and those where further steps should be performed immediately.

An example for a life-threatening emergency is concomitant suicidal tendencies, which require immediate therapeutic action (see Chap. 54). Other conditions, such as acute tinnitus in combination with sudden hearing loss of recent onset, should also be treated as soon as possible (see Chap. 56). In conditions where a severe underlying disease cannot be excluded or when a patient is bothered by his tinnitus, further diagnostic steps are clearly indicated.

Further diagnostic procedures should be guided by clinical features (Fig. 46.1, red boxes). In a hierarchical diagnostic algorithm, the first differentiation should be between pulsatile vs. non-pulsatile tinnitus. This differentiation acknowledges the fundamental pathophysiological difference between these two forms of tinnitus.

Pulsatile Tinnitus

It is important to note that pulsatile refers to heart synchronous or respiration synchronous (venous hum) pulsatile tinnitus. Pulsatile tinnitus with a rhythm different from the heart rate or respiration rate should be classified here as pseudopulsatile or non-pulsatile tinnitus (see Chap. 59). Further diagnostic assessment of heart synchronous pulsatile tinnitus requires a neurovascular examination (yellow box). Diseases such as arteriovenous malformation, sinus venous thrombosis, benign intracranial hypertension, or high jugular bulb may be identified as potential causes of pulsatile tinnitus. A detailed description of the diagnostic management of pulsatile tinnitus is found in the chapter on pulsatile tinnitus.

Non-pulsatile Tinnitus

Non-pulsatile tinnitus is much more common than pulsatile tinnitus and requires further differentiation according to chronicity, concomitant symptoms, and etiologic factors. As a first step, a differentiation between acute tinnitus with sudden hearing loss, paroxysmal tinnitus, and chronic tinnitus can be useful. In case of acute tinnitus accompanied by sudden hearing loss, diagnostic and therapeutic procedures should not be postponed in order to identify possible causes for the hearing loss and start appropriate treatment. This is described in detail in the chapter on sudden hearing loss and tinnitus.

Paroxysmal or intermitent tinnitus can be a symptom of auditory nerve compression, superior canal dehiscence syndrome, Ménière's disease, palatal myoclonus, or even epilepsy (blue boxes). For a differential diagnosis, magnetic resonance imaging (MRI), auditory-evoked potentials, and electroencephalography (EEG) are indicated (yellow boxes) (for more details, see Chap. 58).

Further diagnostic procedures of constant non-pulsatile tinnitus will depend on concomitant symptoms and etiological conditions (Fig. 46.1, red boxes). Constant non-pulsatile tinnitus can be accompanied by conductive or sensorineural hearing loss. Conductive hearing loss can be caused by otosclerosis, different forms of otitis, or Eustachian tube dysfunction. More information about tinnitus with conductive hearing loss is given in Chap. 34.

In case of sensorineural hearing loss, further diagnostic procedures are indicated for identifying the exact etiology. These can include magnetic resonance imaging (MRI) and auditory brainstem responses (ABR) (e.g., for excluding vestibular schwannoma) and also otoacoustic emissions for assessment of outer hair cell function (detailed description in Chaps. 35 and 36).

Diagnostic assessment and therapeutic management of tinnitus occurring together with vertigo is indicative of specific pathologies such as Ménière's disease, superior canal dehiscence, or damage to the vestibulocochlear system. More details are found in Chaps. 36, 38–40, 60, and 84.

If tinnitus presents with associated headache, increased intracranial pressure has to be excluded. Potential underlying pathologies such as space occupying lesions (SOL), benign intracranial hypertension (BIH), disorders of cerebrospinal fluid (CSF) circulation, or craniocervical anomalies can be diagnosed by MRI. In specific cases, lumbar puncture and furosemide tests may help determine whether reduced CSF pressure also alleviates tinnitus (more details are found in Chap. 61).

The co-occurrence of depression, anxiety, and insomnia with severe tinnitus has been frequently described. Immediate action is required when a patient reports acute suicidal thoughts. A detailed explanation of diagnostic procedures in case of psychiatric comorbidity is provided in Chap. 58, 63–65.

When tinnitus is associated with neck or temporomandibular dysfunction or pain, a more detailed examination of these systems should be considered. Radiologic tests are indicated if structural alterations are suspected, whereas functional impairments can be best detected by physical examination performed by experienced dentists and physiotherapists. More details are presented in Chap. 43, 44, 52, 53, and 95.

Specific diagnostic tests are indicated if tinnitus begins or worsens within 3 months after a traumatic event. It is important to note that a delay of several weeks between trauma and tinnitus onset does not exclude a potential etiologic relationship. Traumatic events may cause tinnitus in different ways. The indication for further diagnostic procedures depends on the trauma mechanism. In particular, noise, ear, head, neck, and even emotional trauma should be considered. In case of posttraumatic pulsatile tinnitus, immediate

diagnostic workup for vascular pathologies (especially carotid dissection) is mandatory. A detailed description of pathologies, which can occur as a consequence of trauma and which may be involved in the generation of tinnitus, is given in Chap. 66. A separate chapter is devoted to blast injuries (Chap. 67) since tinnitus has become one of the most relevant warfare-related health problems in the last years. Blast injuries are a particular diagnostic challenge since the tinnitus-inducing mechanisms may include noise, ear, head, neck, and emotional trauma.

Hyperacusis and phonophobia occur frequently together with tinnitus and require specific management, which is described in detail in Chaps. 3 and 4.

Symptomatic Treatment

Symptomatic treatment should be considered in every patient who feels impaired by his tinnitus if specific causally oriented treatments are not available, not sufficiently effective, or not indicated for any other reason. Cognitive behavioral therapy (CBT) (see Chap. 71) and auditory stimulation with counseling are the most established treatment options. Auditory stimulation can be essentially differentiated in the use of sound for masking or partially masking tinnitus (see Chaps. 74 and 75) and in attempts to compensate for hearing deficits, for example, by hearing aids (see Chaps. 74, 76, and 77). Also, specific forms of sound stimulation with a frequency composition according to the individual audiogram have been proposed (see Chap. 75). Tinnitus retraining therapy (TRT), a specific combination of auditory stimulation and counseling, is widely used and described in Chap. 73.

Pharmacotherapeutic options for the treatment of tinnitus are limited. However, even if there is currently no drug, which is approved by the US Food and Drug Administration (FDA) for the treatment of tinnitus, there are some promising results from clinical studies indicating beneficial effects of specific drugs for subgroups of patients (Chap. 78). Neuromodulatory approaches have been proposed very recently. Most evidence is available for transcranial magnetic stimulation (TMS); neurobiofeedback, transcranial direct current stimulation (tDCS), cutaneous stimulation, and cortical electrical stimulation have also demonstrated promising results. A description of how these techniques are performed and which results have been obtained is given in the respective Chaps. 86, 88–90.

In summary, a wide range of different pathologies can underlie tinnitus. The diagnostic challenge can best be met by a stepwise approach consisting of basic assessment procedures followed by more detailed diagnostic tests in selected patients. Here, important indications for further diagnostic steps and immediate treatment are summarized. If these diagnostic procedures do not reveal causally oriented treatment options or if results from such therapies are not satisfying, the available symptomatic treatment possibilities should be considered. It should also be mentioned that this algorithm is based on currently available knowledge and is expected to evolve and be refined with time and criticism.

Reference

1. Langguth, B., Goodey, R., Azevedo, A., Bjorne, A., Cacace, A., Crocetti, A., et al. (2007) Consensus for tinnitus patient assessment and treatment outcome measurement: Tinnitus Research Initiative Meeting, Regensburg, July 2006. Prog. Brain Res., 166: p. 525–36.