Washington State Health Care Authority

Key Questions and Background

Tinnitus: Non-invasive, Non-pharmacologic Treatments

Background

Tinnitus, the conscious perception of sound in the absence of an external source, is a common medical symptom (not a disease). The experience of tinnitus is very heterogeneous in terms of the type (e.g., ringing, buzzing, hissing, music), intensity (e.g., pulsatile or rhythmical), frequency (e.g., constant or intermittent), and location (e.g., one or both ears) of the perceived sound.[1] There are two main types of tinnitus: objective and subjective. In objective tinnitus, which is very rare (<1% of tinnitus cases), the sounds have an origin within the patient's body and are perceived by both the patient and examiner. In subjective tinnitus, the sounds are perceived by only the patient, are not associated with an underlying condition that might explain the sound, and can be associated with hearing loss. This common experience of tinnitus is usually described as sensorineural (i.e., tinnitus with a neurophysiologic origin) and can result in comorbidities that include depression, anxiety, and sleep disturbance, all of which may negatively impact a patient's overall quality of life.[2] Risk factors for tinnitus include hearing loss, noise exposure, and age; obesity, smoking status, alcohol use, head injuries, and hypertension have also been identified as possible risk factors.[1]

In an analysis of data from the 1999-2004 National Health and Nutrition Examination Surveys (NHANES), approximately 50 million (25%) adults in the United States (US) reported having any tinnitus and approximately 16 million (8%) reported experiencing frequent tinnitus in the past year.[3] The prevalence of tinnitus in the past 12 months was similar (10%) among respondents to the 2007 National Health Interview Survey (NHIS)[4] and in The National Study of Hearing in the United Kingdom in the 1980s.[5]

There is currently no cure for tinnitus that is not otherwise caused by an underlying anatomical condition (e.g., tumors of the head and neck, temporomandibular joint dysfunction) and because tinnitus can be chronic, treatment is focused on both the tinnitus and associated comorbidities that affect a patient's quality of life. There are no pharmacologic treatments for the primary indication of tinnitus that are approved by the US Food and Drug Administration. Non-pharmacologic, non-invasive treatments of tinnitus include sound therapies that mask the tinnitus sounds, neuromodulation techniques that may habituate the patient to the tinnitus sounds, or psychological and behavioral therapies that help the patient cope with or reduce the distress from tinnitus.

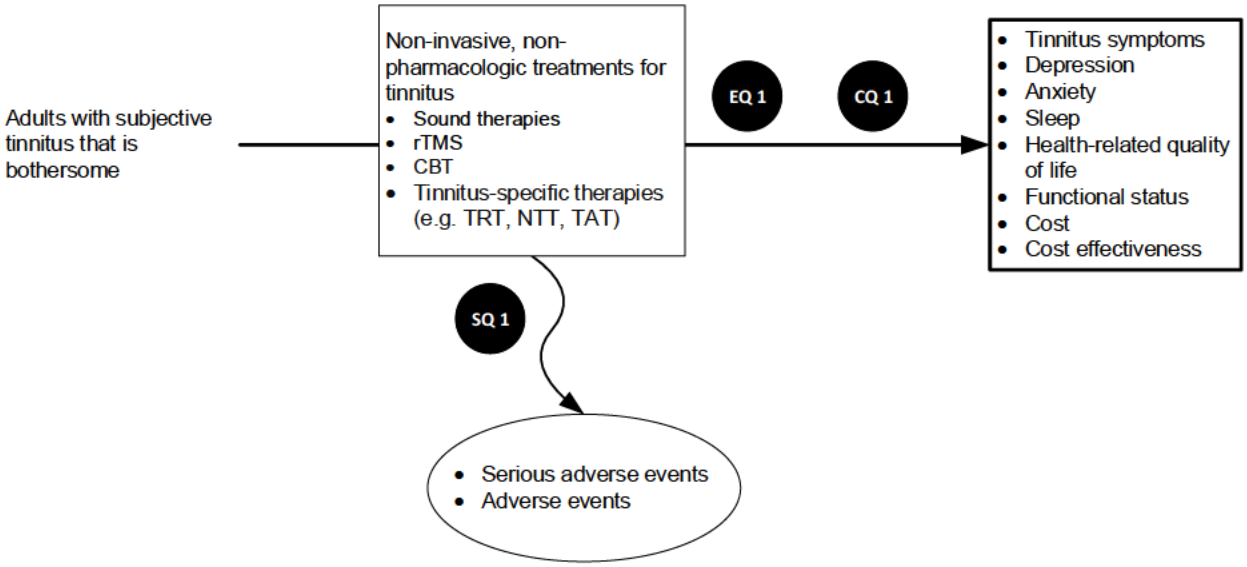
Policy context

The State of Washington Health Care Authority selected non-invasive, non-pharmacologic treatments for tinnitus for a health technology assessment (HTA) because of medium concerns of safety and high concerns for efficacy and cost.

Scope of this HTA

The analytic framework (Figure 1), research questions, and key study selection criteria (Table 1) are listed in this section.

Figure 1. Analytic Framework Depicting Scope of this Health Technology Assessment



Abbreviations: CBT = cognitive behavioral therapy; CQ = cost question; EQ = efficacy question; NTT = Neuromonics Tinnitus Treatment; rTMS = repetitive transcranial magnetic stimulation; SQ = safety question; TAT = Tinnitus Activities Treatment; TRT = Tinnitus Retraining Therapy.

Research Questions

Efficacy Question 1 (EQ 1). What is the effectiveness of non-invasive, non-pharmacologic therapies for the treatment of bothersome, subjective tinnitus?

Safety Question 2 (SQ 1). What are the harms associated with non-invasive, non-pharmacologic therapies for the treatment of bothersome, subjective tinnitus?

Cost Question (CQ 1). What are the costs and cost-effectiveness of non-invasive, non-pharmacologic therapies for the treatment of bothersome, subjective tinnitus?

Study Selection Criteria

Table 1 provides the study selection criteria we will use to include studies in the HTA and are organized by population, intervention, comparator, outcomes, timing, setting, and study design criteria.

Table 1. Population, Intervention, Comparator, Outcome, Timing, and Setting for Health Technology Assessment

Domain	Included	Excluded
Population	• Adults with subjective tinnitus that is bothersome (i.e., warrants treatment) • Adults whose tinnitus is described as primary, idiopathic, or neurophysiologic • Adults for whom an underlying, anatomical condition as the source of the tinnitus has already been ruled out • Adults whose tinnitus may be attributed to acoustic trauma (e.g., prolonged noise exposure, blast exposure), head and neck trauma (e.g., whiplash), traumatic brain injury (e.g., concussion), or ototoxic medication exposure that is irreversible	• Adults with subjective tinnitus that is not bothersome (i.e., does not warrant treatment) • Adults with objective tinnitus • Adults whose tinnitus is caused by an underlying, anatomical condition (e.g., tumors of the head and neck, vascular disorders, TMJ, eustachian tube dysfunction, cervical-spinal disorders, obstructions in the middle ear) • Studies conducted in adolescents, children, in animals, in vitro, or in silico
Intervention	• Sound generators/maskers • Hearing aids with specific sound generation/masking capabilities • Repetitive transcranial magnetic stimulation (rTMS)a • Cognitive behavioral therapy (CBT)b • Tinnitus Retraining Therapy (TRT) • Neuromonics Tinnitus Treatment (NTT) • Tinnitus Activities Treatment (TAT) • Combination therapies that combine any of the included interventions	• Other non-invasive neuromodulation therapiesa and psychological/behavioral therapiesb not already included • Pharmacologic treatments • Supplements, herbal, and homeopathic remedies • Cochlear implantation • Invasive neuromodulation therapiesc • Alternative and complementary medicine therapiesd • Diet, exercise, and sleep hygiene modifications • Low level laser therapy • Progressive Tinnitus Management (PTM) that is being studied as an implementation or delivery strategy
Comparator	• No treatment • Usual care • Wait list • Sham treatment	• All excluded interventions above • Another included interventione • No comparator group
Outcomes	• EQ: Validated tinnitus symptom severity or handicap, depression, anxiety, sleep, health-related quality of life, functional status • SQ: Serious adverse events, adverse events, side effects including device-related complications • CQ: Cost; cost-effectiveness	• EQ: Outcomes related to hearing loss • EQ: Outcomes measured by non-validated scales

Domain	Included	Excluded
Timing & Language	• No timing restrictions • English language articles	• No timing exclusions • Non-English language articles
Setting	• Countries categorized as "very high human development" according to the United Nations Development Programme's 2018 Human Development Reportf,6 • Primary or specialty care (audiology, otolaryngology, neurology, mental health)	• Countries not categorized as "very high human development" according to the United Nations Development Programme's 2018 Human Development Reportf,6 • No exclusions based on care setting
Study Design	• EQ: RCTs, CCTs; if fewer than 3 some- or low-risk of bias RCTs or CCTs are included, then cohort studies with a concurrent comparator group will also be included • SQ: RCTs, CCTs, cohort studies with a concurrent comparator group • CQ: CEA, CUA, or CBA performed from the societal or payor perspective	• Editorial, comments, or letters; conference abstracts; case reports or case series; case-control studies; other observational study designs without a comparator group not already specified • Relevant narrative or systematic reviews (or similar publications) will be handsearched to identify potentially eligible primary studies

Abbreviations: CBA = cost-benefit analysis; CCT = controlled clinical trial; CEA = cost-effectiveness analysis; CQ = cost question; CUA = cost-utility analysis; EQ = efficacy question; PICOTS = population, intervention, comparator, outcome, timing, and setting; RCT = randomized controlled trial; SQ = safety question

[a] Studies of other non-invasive neuromodulation therapies will be excluded and listed in an appendix for future reference. This includes but is not limited to: transcranial direct current stimulation (tDCS); neurofeedback; transcutaneous vagus nerve stimulation (VNS); and transcutaneous electrical nerve stimulation (TENS).

[b] Studies of other psychological/behavioral therapies will be excluded and listed in an appendix for future reference. This includes but is not limited to: mindfulness-based stress reduction (MBSR/MBTSR); acceptance and commitment Therapy (ACT); biofeedback; and other psychological, behavioral, or counseling therapies, including relaxation techniques.

[c] Including, but not limited to: implanted vagus nerve stimulation; deep brain stimulation (DBS); and brain surface implants.

[d] Including, but not limited to: acupuncture; hyperbaric oxygen therapy; hypnosis; manipulative and body-based approaches (e.g., chiropractic care, massage); and whole body approaches (e.g., traditional Chinese medicine, Ayurvedic medicine).

[e] Comparative-effectiveness analyses of eligible interventions will be excluded and listed in an appendix for future reference.

[f] Andorra, Argentina, Australia, Austria, Bahamas, Bahrain, Barbados, Belarus, Belgium, Brunei Darussalam, Bulgaria, Canada, Chile, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong China (SAR), Hungary, Iceland, Ireland, Israel, Italy, Japan, Kazakhstan, Korea (Republic of), Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, Malaysia, Malta, Montenegro, Netherlands, New Zealand, Norway, Oman, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan,[g] United Arab Emirates, United Kingdom, United States, Uruguay

[g] The United Nations does not recognize Taiwan (i.e., Republic of China) as a sovereign state and does not include it in the Human Development Index (HDI) report. However, based on data from 2014, Taiwan's government calculated its 2017 HDI value to be 0.907 using the same methodology as the United Nations.[7] This HDI value would place Taiwan among countries in the "very high" human development category and will be included in this report.

References

1. Baguley D, McFerran D, Hall D. Tinnitus. *Lancet.* 2013;382(9904):1600-1607. PMID: 23827090. doi: 10.1016/S0140-6736(13)60142-7
2. Henry JA, Roberts LE, Caspary DM, Theodoroff SM, Salvi RJ. Underlying mechanisms of tinnitus: review and clinical implications. *J Am Acad Audiol.* 2014;25(1):5-22; quiz 126. PMID: 24622858. doi: 10.3766/jaaa.25.1.2
3. Shargorodsky J, Curhan GC, Farwell WR. Prevalence and characteristics of tinnitus among US adults. *Am J Med.* 2010;123(8):711-718. PMID: 20670725. doi: 10.1016/j.amjmed.2010.02.015
4. Bhatt JM, Lin HW, Bhattacharyya N. Prevalence, Severity, Exposures, and Treatment Patterns of Tinnitus in the United States. *JAMA Otolaryngol Head Neck Surg.* 2016;142(10):959-965. PMID: 27441392. doi: 10.1001/jamaoto.2016.1700
5. Davis AC. The prevalence of hearing impairment and reported hearing disability among adults in Great Britain. *Int J Epidemiol.* 1989;18(4):911-917. PMID: 2621028. doi: 10.1093/ije/18.4.911
6. Programme UND. *Human Development Indices and Indicators 2018 Statistical Update.* Programme UND; 2018.
7. (Taiwan) RoC. Human Development Index (HDI). *Key Figures for Calculating Composite Gender Equality Index* https://eng.stat.gov.tw/ct.asp?xItem=25280&ctNode=6032&mp=5. Published 2018. Updated 10/30/2018. Accessed 9/12/2019.