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SUMMARY

Aetiology

- Tinnitus can be related to many different aetiologies such as hearing loss or a noise trauma, but it can also be related to the somatosensory system of the cervical spine, called cervicogenic somatic tinnitus (CST). (106)

Epidemiology

- Tinnitus is more common in patients with Temporomandibular Disorder (5)
- Assessing the epidemiological association of smoking status and tinnitus with a systematic review and meta-analysis and to estimate the population attributable risk in Germany (27)
- Prevalence of tinnitus and hyperacusis in children and adolescents: a systematic review (99)
- A systematic review of the reporting of tinnitus prevalence and severity (108)
- Hearing impairment and tinnitus: prevalence, risk factors, and outcomes in US service members and veterans deployed to the Iraq and Afghanistan wars. (129)

Pathophysiology

- Pathophysiology of subjective tinnitus: Triggers and maintenance. (46)
- Some models of tinnitus pathophysiology suggest that networks associated with attention, memory, distress and multisensory experience are involved in tinnitus perception. (131)
- This systematic review points out neuroimaging studies that contribute to identifying the structures involved in the pathophysiological mechanism of generation and persistence of various forms of tinnitus (132)
- Changes in the cochlear microcirculation, resulting in hearing loss, may be an adjuvant factor in tinnitus pathophysiology. (148)
- Trait- and state-related oxygenation changes indicate the potential of fNIRS for the investigation of tinnitus pathophysiology and treatment response. (162)
- Associated to plastic changes in central auditory structures, neuroimaging studies show signs of the implication of extra-auditory regions in tinnitus pathophysiology (168)
- A consistent and-at best-standardized assessment of tinnitus- and hearing-related sequelae of trauma is recommended both for the improvement of clinical care and for a deeper understanding of the various pathophysiological mechanisms of trauma-associated tinnitus. (171)
- Evidence is growing that also limbic, frontal, and parietal areas are involved in the pathophysiology of chronic tinnitus. (189)

**Risk Factors**
- Tinnitus is one of the most common hearing disorders, with wide-ranging risk factors including age, hearing loss, noise exposure, inflammatory diseases or tumors of the ear, ototoxic drugs, head or cervical vertebra trauma, and psychological disorders (e.g., anxiety and depression) (3)
- Risk factors for tinnitus during and after childhood cancer treatment (13)
- Risk factors of pediatric tinnitus: Systematic review and meta-analysis (42)
- Smoking (27)

**Treatments**

**Acoustic coordinated reset neuromodulation**
- A systematic review from 2017 found insufficient evidence for its efficacy (59)

**Bio-modulator**
- Taken under consideration the lack of easy-to-use alternative and the low risk profile, this patch device could highly be recommended to try for tinnitus relief as a conclusion based on the clinical studies and post market surveys (55)
- In a cost-risk-benefit rationale, it can be reasonable to recommend the biomodulator patch for treatment of tinnitus. Improvements were shown at Week 7 (4 weeks after the end of treatment period). (87)

**Botulinum Toxin**
- When optimally injected, BT seems to be an effective treatment of objective tinnitus due to Essential Palatal Tremor, with few adverse effects and complications. We suggest BT injections as first choice in case of EPT and present a guideline regarding diagnostics, treatment, and follow-up. (95)

**Compensatory Auditory Stimulation**
- When tailored to match a subject's frequency-specific hearing loss, brief CAS intervention provides a short-term reduction in the tinnitus percept, suggesting that long-term intervention with CAS may be promising. As this auditory stimulation works using natural stimuli, its long-term effects could be assessed using hearing aids and any positive results would immediately translate to clinical practice (118)

**Endovascular Treatment**
- In patients with debilitating Pulsatile tinnitus secondary to venous sinus lesions, endovascular treatment by stenting and/or coil embolization appears to be safe and effective (2)
- Careful exclusion of other causes of tinnitus should be performed before consideration for surgical or endovascular treatment of presumed causative lesions of venous tinnitus. (114)

**Hearing aids**
• There is insufficient evidence to conclude that any of these devices offers greater relief from tinnitus than any other one tested. However, all devices appear to offer some improvement in the functional effects of tinnitus (76) Can work better when combined with Tinnitus Retraining Therapy (85)
• The use of hearing aids alone or hearing aids plus the use of sound generators both provide significant benefit with respect to alleviating effects of tinnitus. A larger controlled clinical trial is needed to obtain more definitive results regarding the two configurations of hearing aids. (145)
• Cochrane Review 2014 - The current evidence base for hearing aid prescription for tinnitus is limited (177)
• 62.5% of the patients presented a reduction in tinnitus annoyance in the combined fitting group and in the group with amplification alone, 78% showed a reduction. This difference between the groups was not statistically significant (184)

Intracochlear Electrical Stimulation
• Using intracochlear electrical stimulation independent of environmental sounds, the results of this study contribute to the viability of cochlear implantation based on tinnitus complaints. (54)

Laser Therapy
• 5-mV laser therapy with a wavelength of 650 nm is no better than placebo for improving hearing thresholds overall or for treating tinnitus with regard to age, sex, environmental noise level, and the duration of tinnitus. (149)
• This study found low-level laser therapy to be effective in alleviating tinnitus in patients with noise-induced hearing loss, although this effect has faded after 3 months of follow-up. (194)

Noninvasive & Minimally Invasive Electrical Stimulation
• Noninvasive or minimally invasive electric stimulation can be integrated with sound therapy, invasive cochlear implants, or other forms of coordinated stimulation to provide a systematic strategy for tinnitus treatment or even a cure. (1)
• Insufficient evidence (115)
• Handicap and dysphoria of tinnitus can be improved significantly by treating with electrical stimulation on acupoint in the distribution area of ear vagus nerve (166)

Ozone and Betahistine
• Insufficient evidence (188)

TENS
• Verum TENS may benefit patients with acute tinnitus after 4 weeks of treatment (19)

Transcranial Direct Current Stimulation
• The current literature shows moderate to significant therapeutic efficacy of tDCS on tinnitus symptoms. Further randomized placebo-controlled double-blind trials with large sample sizes are needed to reach a definitive conclusion on the efficacy of tDCS for tinnitus. (24)
• Greater reduction in distress for groups treated with tDCS as compared with those administered a sham treatment (26)
• There is no therapeutic response of tinnitus to transcranial direct current stimulation (34)
• Anodal stimulation was more effective than the cathodal and control stimulation in reducing the intensity of tinnitus in the short term (56)
• Self-administered domiciliary tDCS treatment for tinnitus was found safe and feasible (113)
• There were no significant long-term beneficial effects following tDCS of the left temporoparietal area (122)
• tDCS of the auditory and prefrontal cortices is safe, but does not improve tinnitus. Different tDCS protocols might be beneficial. (137)

**Transcranial Magnetic Stimulation**

• rTMS was effective for chronic tinnitus for up to 6 months, and the method of coil localization was not a critical factor for treatment outcome. One reason is that the exact optimal target for rTMS stimulation in tinnitus remains uncertain. Structural MRI-based nrTMS and the 10–20 EEG system-based targeting of rTMS showed similar main treatment effects. Indeed, the treatment response was even better in the non-navigated rTMS group but only concerning tinnitus intensity (6)

• No significant effect of bilateral low-frequency rTMS of the primary auditory cortex and high-frequency stimulation of the left dorsolateral prefrontal cortex was demonstrated (47)

• rTMS on non-auditory cortical sites alone may not be sufficient for treatment. Thus, dual-site rTMS in the AC and DLPFC may be preferable for controlling this condition. (64), (67)

• Despite the significant effects of rTMS on tinnitus, differences between active and placebo groups remained non-significant, due to large placebo-effect and wide inter-individual variation. (66)

• Systematic Review 2016 - moderate efficacy of low-frequency rTMS as a treatment for chronic tinnitus. The odds ratio of therapeutic success, defined by THI, is at least 15 times greater in the active rTMS group. (94)

• Real 1-Hz-rTMS over the left temporal cortex was well tolerated but not superior compared with sham rTMS in improving tinnitus severity. These findings are in contrast to results from studies with smaller sample sizes and put the efficacy of this rTMS protocol for treatment of chronic tinnitus into question. (71)

• Individualized rTMS was shown to be feasible and effective in chronic tinnitus. (72)

• Verum cTBS was not superior to sham which highlights the persistent need for improving non-invasive brain stimulation techniques for the treatment of tinnitus. (98)

• We report a tendency towards a modest, sustained long-term effect of the triple-site stimulation protocol in comparison to the single-site protocol. This descriptive advantage shows that innovative treatment protocols carry potential for a more effective treatment of subjective tinnitus (111)

• Combined central rTMS and peripheral LLLT is more beneficial as a new method for management of tinnitus rather than these two used separately. (130)

• Application of 1-Hz rTMS daily for 10 consecutive workdays resulted in a statistically significantly greater percentage of responders to treatment in the active rTMS group compared with the placebo rTMS group. Improvements in tinnitus severity experienced by responders were sustained during the 26-week follow-up period. Before this procedure can be implemented clinically, larger studies should be conducted to refine treatment protocols (147)

• The rTMS and SSRI play potential roles in the reduction of tinnitus severity, but without cumulative or synergistic effects when a combination of treatment regimens is applied. (151)

• This large study demonstrates the safety and tolerability of rTMS treatment in patients with chronic tinnitus. While the overall effect did not prove superior to placebo, secondary outcome parameters argue in favour of the active stimulation groups, and specifically the combined frontal and temporal rTMS protocol. (170)

• cTBS was more effective than high-frequency rTMS (P = 0.001). This study suggests that rTMS even in four sessions is effective in reducing tinnitus severity; moreover, compared to high-frequency TMS better results can be achieved with cTBS. (180)
• Daily low-frequency active rTMS to the left temporoparietal junction area for 4 weeks was no more effective than sham for patients with chronic bothersome tinnitus. (190)
• Bilateral low-frequency repetitive transcranial magnetic stimulation of the auditory cortex in tinnitus patients is not effective (197)

**Transcutaneous Vagus Nerve Stimulation**
• Our data demonstrate the feasibility of tVNS over a period of 6 months. There was no clinically relevant improvement of tinnitus complaints. Our data suggest tVNS to be considered safe in patients without a history of cardiac disease (172)

**Vagus Nerve Stimulation paired with tones**
• Adverse effects were mild and well-tolerated and the therapy had a similar safety profile to VNS for epilepsy. (61)

**Acupuncture**
• Moxibustion acupuncture seems to be a better trend treatment for tinnitus (8)
• The combination of periauricular and distal acupuncture and 17 to 24 acupuncture sessions contributed to a considerably better outcome. This result would serve as a reference for clinical acupuncturists to select an appropriate acupuncture strategy in the treatment of tinnitus. (17)
• Acupuncture is effective in reducing the loudness and severity of tinnitus and can be a useful treatment for nonpulsatile chronic tinnitus. (36)
• There was no statistically significant difference between systemic manual acupuncture, periauricular electroacupuncture and distal electroacupuncture in tinnitus. However, all three treatments had some effect on tinnitus within the group before and after treatment. (73)
• Systematic Review - may offer subjective benefit to some tinnitus patients. Acupuncture points and sessions used in Chinese studies may be more appropriate, whereas these studies have many methodological flaws and risk bias, which prevents us making a definitive conclusion. (110)
• Efficacy of acupuncture on brain perfusion and symptoms of tinnitus patients. • Acupuncture improved the Tinnitus Handicap Inventory scores in tinnitus patients. • No significant changes in brain perfusion were observed after 12 twice-weekly sessions. • Perfusion changes would reflect changes in neuronal function. (112)
• Chinese scalp acupuncture associated with bilateral electroacupuncture demonstrated, in the short term, a statistically significant improvement by reducing the level of tinnitus intensity, as well as improving the quality of life of individuals with tinnitus (123)

**Cognitive Behaviour Therapy**
• Although Internet-based cognitive behavior therapy (iCBT) is an effective treatment for chronic tinnitus, several patients do not improve (7) iCBT might be the preferred treatment choice for tinnitus patients being open towards new experiences. Moreover, iCBT requires autonomous work and self-motivation by the patient in order to have an impact (43). Seems to work better when guided by an Audiologist (84)
• Mindfulness Behavioural Cognitive Therapy (MBCT) was associated with significant and reliable improvements in patients with chronic, distressing tinnitus. Changes were associated with increases in tinnitus acceptance and dispositional mindfulness (39) MBCT is effective in reducing tinnitus severity in chronic tinnitus patients compared to intensive Relaxation Training. It also reduces psychological distress and disability (68), (86)
• Both iCBT and face-to-face interventions are equally effective for reducing tinnitus distress and most tinnitus-related difficulties (52)
• Implementing iCBT for tinnitus into regular health care will be an important next step to increase access to treatment for patients with tinnitus (90)
• Undertaking Audiologist guided iCBT for tinnitus led to significant improvements 1 year postintervention for tinnitus and related difficulties, for example, insomnia, anxiety, depression, hearing handicap, hyperacusis, and life satisfaction (53), (83). Audiologist-delivered CBT led to significant improvements in self-report measures of tinnitus and hyperacusis handicap and insomnia (57)

• A systematic review from 2017 found that cognitive behavioural therapy is strongly recommended (58)

• Computer-based cognitive training program is associated with self-reported changes in attention, memory, and perception of tinnitus. A possible mechanistic explanation for these changes could be neuroplastic changes in key brain systems involved in cognitive control. Cognitive training programs might have a role in the future treatment of patients with tinnitus. (74)

• The iCBT self-help program is a good treatment option for tinnitus sufferers whether or not support-on-demand is provided. (135)

• Specialized multidisciplinary tinnitus treatment based on cognitive behavioral therapy is cost-effective as compared with usual care (169)

• ICBT might be an equally effective alternative to conventional CBT in the management of chronic tinnitus. Despite encouraging results, further research is necessary to determine the actual potential of ICBT as a viable alternative to CBT, and under which circumstances it is effective. (174)

• Both cognitive behavioural therapy and tinnitus retraining therapy are effective for tinnitus, with neither therapy being demonstrably superior (179)

• Distress can be reduced as early as the acute stadium and that minimal-contact interventions are a promising way to do this. In particular, the Internet and group conditions led to a large, immediate decrease in distress, and the participants were highly satisfied with the training. (192)

• CBT self-help interventions are an effective treatment for tinnitus distress. Since few studies were identified, this conclusion must be supported by future meta-analyses. (193)

Conservative Temporomandibular Therapy

• There is low-quality evidence for a positive effect of conservative temporomandibular disorders treatment on tinnitus complaints. The combination of splint therapy and exercise treatment is currently the best investigated treatment approach, showing a decrease in tinnitus severity and intensity (12)

Educational programmes for children

• Interpersonal, interactive educational interventions such as the classroom program are more effective and have longer impact than self-directed learning experiences for NIHL and tinnitus prevention (195)

Frequency Discrimination Training

• FDT for tinnitus has now been the topic of eight published studies which taken together suggest it has a reproducible but small effect on tinnitus handicap more likely to be due to a change in cognitive representations (e.g. emotional reaction) rather than a physiological change in the auditory system (e.g. hearing) [19] [26]. For most people, delivering FDT in a way that uses standard game-play approaches to intrinsically motivate the ‘player’ is preferred to a simple task-based training regime but this does not in itself lead to compliance or to additional improvements in self-reported tinnitus severity. (175)

Ginko Biloba

• Cochrane Review - The limited evidence does not demonstrate that Ginkgo biloba is effective for tinnitus when this is the primary complaint (198)

Masking / Retraining / Counselling
• Audiologists who provided interventions to Veterans with bothersome tinnitus in the regular clinic setting were able to significantly reduce tinnitus severity over 18 months using TM, TRT, and TED approaches. These results suggest that TM, TRT, and TED, when implemented as in this trial, will provide effectiveness that is relatively similar by 6 months and beyond. (116)

• The findings obtained using either the combined devices or the masking devices with wide-band masking demonstrate that these devices are an effective tinnitus treatment alternative. (191)

Motivational Interviewing
• Tinnitus handicap scores decrease to a greater extent following brief MI than following Standard Practice (88)

Physiotherapy
• Cervical physical therapy can have a positive effect on subjective tinnitus complaints in patients with a combination of tinnitus and neck complaints. (106)

• Systematic Review - all included studies show positive treatment effects. Before recommendations can be made, these results need to be confirmed in larger, high quality studies (107)

Sound Therapy
• The mixed pure tones were more advantageous than Broad Band Noise as the sound therapy for tinnitus patients with normal to mild hearing loss. (18)

• Cochrane Review - Sound therapy is the preferred mode of audiological tinnitus management in many countries, including the United Kingdom. However, there is no evidence to support the superiority of sound therapy for tinnitus over waiting list control, placebo or education/information with no device. There is insufficient evidence to support the superiority or inferiority of any of the sound therapy options (hearing aid, sound generator or combination hearing aid) over each other. (31)

• Any type of sound stimulation is beneficial for relieving effects of tinnitus. These results may serve as a preliminary evidence for a larger study (33)

• Cochleural Alternating Acoustic Beam Therapy seemed effective in patients of varying severities, and no side effects were observed in this trial. The CAABT can be an alternative for those who are suitable for sound therapy once a large scale of and better controlled clinical studies have validated the findings of this experiment. (41)

• There is some evidence for the use of sound therapy devices during sleep. More controlled trials are needed. (62)

• Customized sound therapy can decrease the loudness and THI scores of tinnitus patients, and the results may be superior to broadband noise. (69)

• Music Based sound therapy effective in reducing subjective tinnitus and represents a meaningful advancement in tinnitus intervention (70)

• Tailor Made Notched Music Training – after 3 months the effect of training with TMNM is observable in the most direct rating of tinnitus perception – the tinnitus loudness, while more global measures of tinnitus distress do not show relevant changes. (92)

• A study comparing Broadband Noise and nature sounds found that for most participants sound resulted in small but significant changes in secondary outcome measures of tinnitus (reduced loudness rating scale and reduced annoyance rating scale) and psychologically related measures (increased positive emotionality, reduced anxiety, reduced depression, and reduced stress). (78)

Virtual Reality Therapy
• t VR is equivalent to CBT, and effective both for the reduction of tinnitus severity and tinnitus handicap as measured by the STSS, THI and THQ inventories. Nevertheless when regarding other secondary outcome measurements, VR shows a non-significant
outcomes for both overall intrusiveness and emotional component of ST (VAS, THQ emotional and social sub-scores, HAD). [109]

**Zinc Supplementation**

- Cochrane review found no evidence [103]

**SEARCH RESULTS**

1. Zeng F-G, Richardson M, Tran P, et al. Tinnitus Treatment Using Noninvasive and Minimally Invasive Electric Stimulation: Experimental Design and Feasibility. *Trends in hearing* 2019;23:2331216518821449. Noninvasive transcranial or minimally invasive transtympanic electric stimulation may offer a desirable treatment option for tinnitus because it can activate the deafferented auditory nerve fibers while posing little to no risk to hearing. Here, we built a flexible research interface to generate and control accurately charge-balanced current stimulation as well as a head-mounted instrument capable of holding a transtympanic electrode steady for hours. We then investigated the short-term effect of a limited set of electric stimulation parameters on tinnitus in 10 adults with chronic tinnitus. The preliminary results showed that 63% of conditions of electric stimulation produced some degree of tinnitus reduction, with total disappearance of tinnitus in six subjects in response to at least one condition. The present study also found significant side effects such as visual, tactile, and even pain sensations during electric stimulation. In addition to masking and residual inhibition, neuroplasticity is likely involved in the observed tinnitus reduction. To translate the present electric stimulation into a safe and effective tinnitus treatment option, we need to optimize stimulation parameters that activate the deafferented auditory nerve fibers and reliably suppress tinnitus, with minimal side effects and tolerable sensations. Noninvasive or minimally invasive electric stimulation can be integrated with sound therapy, invasive cochlear implants, or other forms of coordinated stimulation to provide a systematic strategy for tinnitus treatment or even a cure.

2. Yang I-H, Pereira VM, Lenck S, et al. Endovascular treatment of debilitating tinnitus secondary to cerebral venous sinus abnormalities: a literature review and technical illustration. *Journal of NeuroInterventional Surgery* 2019;11(8):841-46. Background and objective Pulsatile tinnitus (PT) can be debilitating and lead to significant morbidity. Cerebral venous sinus lesions, such as venous sinus stenosis, diverticula, and high-riding jugular bulb, are uncommon causes of PT, for which there is no standard treatment. Endovascular interventions have shown promising results for PT secondary to idiopathic intracranial hypertension, and may be a valid therapeutic option for isolated venous PT. Methods We conducted a systematic literature review on the outcome and safety of endovascular treatment for patients with isolated, debilitating venous PT. The venous lesion characteristics, endovascular techniques, complications, and clinical outcomes were assessed. In addition, an illustrative case of endovascular stenting for PT caused by venous sinus stenosis was included. Results A total of 41 patients (90.2% female) from 26 papers were included. The median age was 46 years (IQR 23; range 25-72 years). Focal venous sinus stenosis (20 patients) and sinus diverticula (14 patients) were the most common culprit lesions. Endovascular treatment included venous sinus stenting in 35 patients, 11 of whom had adjuvant coil embolization, and coil embolization alone in six patients. Complete resolution of the tinnitus was achieved in 95.1% of patients. There was one complication of cerebellar infarct, and no procedure-related mortality. Conclusions In patients with debilitating PT secondary to venous sinus lesions, endovascular treatment by stenting and/or coil
embolization appears to be safe and effective. Prospective randomized studies with objective outcome assessments are needed to confirm the treatment benefits.

3. Tang D, Li H, Chen L. Advances in Understanding, Diagnosis, and Treatment of Tinnitus. *Advances in experimental medicine and biology* **2019;1130:**109-28. Tinnitus is one of the most common hearing disorders, with wide-ranging risk factors including age, hearing loss, noise exposure, inflammatory diseases or tumors of the ear, ototoxic drugs, head or cervical vertebra trauma, and psychological disorders (e.g., anxiety and depression). Tinnitus can be a lifelong disorder and will bring about annoyance, anxiety, depression, insomnia, hyperacusis, concentration difficulty, and, in some extreme cases, suicide. Not every tinnitus patient will require medical attention, and the majority often get accustomed to the phantom sound; however, about 20% of the sufferers will seek clinical intervention. As a matter of fact, evidence was rare for successful tinnitus treatment with a randomized clinical trial. With recent advances in neuroimaging approaches and development of novel tinnitus animal models, scientists have gained new insights into the neural basis of tinnitus. Current theories regarding mechanisms underlying tinnitus focus on abnormal activities in the central nervous system, such as elevated spontaneous neuronal firing rate and increased neuronal synchronization caused by the auditory deprivation, changes in the tonotopic map, auditory cortical reorganization, dysregulation of the limbic system, and the central auditory cortex. At the present, there is a lack of objective indicator of tinnitus, and the diagnosis battery for tinnitus mainly relies on subjective assessments and self-reports, such as case history, audiometric tests, detailed tinnitus inquiry, tinnitus matching, and neuropsychological assessment. While there is currently no golden standard treatment for tinnitus, counseling, psychotherapy, pharmacological approaches, masking devices, individualized sound stimulation, and cognitive behavioral therapy (CBT) are the most widely used strategies, and among these only CBT treatment has been shown to have a definite improvement effect on tinnitus in a large randomized controlled trial. In summary, this article reviews recent advances in understanding, diagnosis, and treatment of tinnitus.

4. Szibor A, Makitie A, Aarnisalo AA. Tinnitus and suicide: An unresolved relation. *Audiology Research* **2019;9**(1):222. Tinnitus is an auditory phantom sensation which can be a devastating condition for the affected person causing annoyance and discomfort. It may be associated with psychiatric conditions. Patients with highly annoying tinnitus and different comorbidities may have a higher risk of expressing suicidal behaviour and ideation. We aimed to review available reports on the prevalence of suicide and suicidal behaviour with tinnitus patients in order to collate current concepts and to identify possible alarming signs and risk factors. A comprehensive search for appropriate studies listed in PubMed, Ovid and Cochrane databases was conducted using appropriate keyword combinations. We identified 22 publications including original articles, case reports and reviews of which 10 fit our stringent search criteria. Most importantly, from the present studies it appears not feasible to univocally conclude on the co-incidence of tinnitus and suicide. This is due to methodological differences in these approaches, complex interrelations between tinnitus and other psychiatric comorbidities and co-founding factors such as the inclusion of patients suffering from post-traumatic stress disorder. More concerted actions involving different medical disciplines are needed to reflect the ethiological heterogeneity of tinnitus and suicide or suicidal behaviour to test for a relationship.Copyright © A. Szibor et al., 2019.

was to evaluate the prevalence of tinnitus in patients with temporomandibular disorders (TMD) and the possible effects of TMD treatment on tinnitus symptoms. A search of the PubMed, Web of Science and Cochrane databases from inception of each database up to January 2017 found 222 articles. After independent screening of abstracts by two of the authors, we assessed 46 articles in full text. The inclusion and exclusion criteria reduced these to 25 articles of which 22 studies reported prevalence based on 13 358 patients and 33 876 controls, and eight studies reported effect of TMD treatment on tinnitus based on 536 patients and 18 controls. The prevalence of tinnitus in patients with TMD varied from 3.7% to 70% (median 42.3%) whereas the prevalence in control groups without TMD varied between 1.7% and 26% (median 12%). The eight treatment studies indicated that treatment of TMD symptoms may have a beneficial effect on severity of tinnitus. However, only one treatment study included a control group, meaning that the overall level of evidence is low. The finding that tinnitus is more common in patients with TMD means that it can be regarded as a comorbidity to TMD. However, in view of the lack of evidence currently available, further well-designed and randomised studies with control groups are needed to investigate whether possible mechanisms common to tinnitus and TMD do exist and whether TMD treatment can be justified to try to alleviate tinnitus in patients with TMD and comorbidity of tinnitus.

6. Sahlsten H, Holm A, Rauhala E, et al. Neuronavigated Versus Non-navigated Repetitive Transcranial Magnetic Stimulation for Chronic Tinnitus: A Randomized Study. *Trends in hearing* 2019;23:1-14. Repetitive transcranial magnetic stimulation (rTMS) has shown variable effect on tinnitus. A prospective, randomized 6-month follow-up study on parallel groups was conducted to compare the effects of neuronavigated rTMS to non-navigated rTMS in chronic tinnitus. Forty patients (20 men, 20 women), mean age of 52.9 years (standard deviation [SD] = 11.7), with a mean tinnitus duration of 5.8 years (SD = 3.2) and a mean tinnitus intensity of 62.2/100 (SD = 12.8) on Visual Analog Scale (VAS 0-100) participated. Patients received 10 sessions of 1-Hz rTMS to the left temporal area overlying auditory cortex with or without neuronavigation. The main outcome measures were VAS scores for tinnitus intensity, annoyance, and distress, and Tinnitus Handicap Inventory (THI) immediately and at 1, 3, and 6 months after treatment. The mean tinnitus intensity (hierarchical linear mixed model: F3 = 7.34, p = .0006), annoyance (F3 = 4.45, p = .0093), distress (F3 = 5.04, p = .0051), and THI scores (F4 = 17.30, p < .0001) decreased in both groups with non-significant differences between the groups, except for tinnitus intensity (F3 = 2.96, p = .0451) favoring the non-navigated rTMS. Reduction in THI scores persisted for up to 6 months in both groups. Cohen’s d for tinnitus intensity ranged between 0.33 and 0.47 in navigated rTMS and between 0.55 and 1.07 in non-navigated rTMS. The responder rates for VAS or THI ranged between 35% and 85% with no differences between groups (p = .054-1.0). In conclusion, rTMS was effective for chronic tinnitus, but the method of coil localization was not a critical factor for the treatment outcome.

7. Probst T, Weise C, Andersson G, et al. Differences in baseline and process variables between non-responders and responders in Internet-based cognitive behavior therapy for chronic tinnitus. *Cognitive behaviour therapy* 2019;48(1):52-64. Although Internet-based cognitive behavior therapy (iCBT) is an effective treatment for chronic tinnitus, several patients do not improve. In the current study, baseline and process variables were compared between non-responders and responders. Data from patients participating in two randomized controlled trials on iCBT for chronic tinnitus were re-analyzed. Based on the literature, a pre-post difference on the "Tinnitus Handicap Inventory" (THI) of less than seven points improvement was used to operationalize non-response.
Associations between non-response and baseline variables (age, gender, and questionnaire scores), patient progress (THI), the process of the therapeutic alliance ("Working Alliance Inventory-Short Revised"; WAI-SR), as well as other process variables (number of logins, amount of messages sent from therapists to patients) were investigated. The results showed that non-responders had a less favorable change on the THI than responders already at mid-treatment (p < .05). The alliance (WAI-SR) during iCBT was not associated with non-response. Non-responders showed more severe sleep disturbances, logged in less in the iCBT platform, and received fewer messages from the therapists than responders, but these differences were mostly not significant anymore when correcting for multiple testing. To conclude, no symptom change in the first half of iCBT for chronic tinnitus patients is a risk factor of not benefiting from iCBT.

8. Pang P, Shi Y, Xu H, et al. Acupuncture methods put to the test for a tinnitus study: A Bayesian analysis. Complementary therapies in medicine 2019;42:205-13.BACKGROUNDThis study evaluated the effectiveness of different methods of acupuncture in the treatment of tinnitus due to neurological causes. In total, eight treatment methods were selected for this study: traditional acupuncture, electroacupuncture, moxibustion acupuncture, medicine only without acupuncture, traditional acupuncture with supplementary medicine, electroacupuncture with supplementary medicine, moxibustion acupuncture with supplementary medicine, and an electroacupuncture and moxibustion acupuncture combination. All sample data come from the results of clinical treatment studies.METHODSBoth Chinese- and English-language online databases were searched. The Chinese language databases included the Wanfang database, the China National Knowledge Infrastructure (CNKI) database, and the VIP Chinese Science and Technique Journals database. The English language databases included PubMed, Web of Science, Embase and Cochrane Library. After the previously mentioned eight interventions for the treatment of neurological tinnitus were tested in a randomized controlled trial (RCT), the data were extracted, and the effectiveness of each intervention was evaluated. A meta-analysis was performed using Stata14.0 and GeMTC 0.14.3 statistical software.RESULTS A total of 40 studies were included, which contained a total of 3657 patients and 8 intervention methods. There was a trend of greater effectiveness of moxibustion acupuncture, followed by moxibustion acupuncture combined with electroacupuncture, moxibustion acupuncture combined with supplementary medicine, acupuncture combined with drugs, electroacupuncture with supplementary medicine, electroacupuncture, traditional acupuncture, and medicine only without acupuncture. There was no significant difference between the results of indirect comparisons and direct comparisons.CONCLUSIONSEight interventions are all effective in the treatment of neurological tinnitus, but moxibustion acupuncture seems to be a better trend treatment for tinnitus.

9. Omidvar S, Jafari Z. Association Between Tinnitus and Temporomandibular Disorders: A Systematic Review and Meta-Analysis. Annals of Otology, Rhinology & Laryngology 2019;128(7):662-75.Objectives: Tinnitus is one of the most common otological symptoms in patients with temporomandibular disorders. This study aimed to investigate the possible association between tinnitus and temporomandibular disorders. Methods: The online databases of PubMed, Ovid, ScienceDirect, and Web of Science were explored for all English articles published until September 2018 using the combined keywords tinnitus and temporomandibular. Cross-sectional, cohort, or case-control studies that investigated the association between tinnitus and temporomandibular disorders (TMDs) were considered. The quality of the included papers was assessed by the Crowe Critical Appraisal Tool. Results: Twenty-two papers met the eligibility criteria
10. Neff P, Zielonka L, Meyer M, et al. Comparison of Amplitude Modulated Sounds and Pure Tones at the Tinnitus Frequency: Residual Tinnitus Suppression and Stimulus Evaluation. *Trends in hearing* 2019;23:2331216519833841. Recent studies have compared tinnitus suppression, or residual inhibition, between amplitude- and frequency-modulated (AM) sounds and noises or pure tones (PT). Results are indicative, yet inconclusive, of stronger tinnitus suppression of modulated sounds especially near the tinnitus frequency. Systematic comparison of AM sounds at the tinnitus frequency has not yet been studied in depth. The current study therefore aims at further advancing this line of research by contrasting tinnitus suppression profiles of AM and PT sounds at the matched tinnitus frequency (i.e., 10 and 40 Hz AM vs. PT). Participants with chronic, tonal tinnitus (n = 29) underwent comprehensive psychometric, audiometric, tinnitus matching, and acoustic stimulation procedures. Stimuli were presented for 3 minutes in two loudness regimes (60 dB sensation level [SL], minimum masking level [MML] + 6 dB, control sound: SL -6 dB) and amplitude modulated with 0, 10, or 40 Hz. Tinnitus loudness suppression was measured after the stimulation every 30 seconds. In addition, stimuli were rated regarding their valence and arousal. Results demonstrate only trends for better tinnitus suppression for the 10 Hz modulation and presentation level of 60 dB SL compared with PT, whereas nonsignificant results are reported for 40 Hz and MML + 6 dB, respectively. Furthermore, the 10 Hz AM at 60 dB SL and the 40 Hz AM at MML + 6 dB (trend) stimuli were better tolerated as elicited by valence ratings. We conclude that 10 Hz AM sounds at the tinnitus frequency may be useful to further elucidate the phenomenon of residual inhibition.

11. Mottaghi A, Menéndez-Díaz I, Cobo JL, et al. Is there a higher prevalence of tinnitus in patients with temporomandibular disorders? A systematic review and meta-analysis. *Journal of Oral Rehabilitation* 2019;46(1):76-86. Summary: The aim of this study was to determine whether there exists a higher prevalence of tinnitus in patients with temporomandibular disorders (TMDs) than in patients without TMDs. A systematic review was conducted in PubMed/MEDLINE for articles published between January 1992 and April 2018 in accordance with the PRISMA statement. Studies were included in this review only if they assessed TMDs using the research diagnostic criteria (RDC)/TMD or DC/TMD. A total of five studies were included in the systematic review, and a random-effects meta-analysis of three of the studies was conducted. In all of the selected studies, the prevalence of tinnitus was higher in patients with TMDs (35.8% to 60.7%) than in patients without TMDs (9.7% to 26.0%). The odds ratio of suffering from tinnitus among patients with TMDs was 4.45 (95% CI 1.64-12.11. P = 0.003). Thus, despite the limitations of the included studies, this review demonstrates that the prevalence of tinnitus in TMD patients is significantly higher than that in patients without TMD.

2019;33(3):308-17. Aims: To investigate whether temporomandibular disorders treatment can positively influence tinnitus complaints. Methods: Four online databases (PubMed, Web of Science, Scopus, and the Cochrane Library) were searched up to August 2018 for relevant studies. Two independent reviewers extracted the data and performed a risk of bias assessment. Results: A total of 11 studies were included. These studies showed an overall positive effect of the combination of splint therapy and exercise treatment on tinnitus severity and intensity (as measured on a visual analog or numeric rating scale), as well as on global perceived effect. One study specified that the treatment effect was only present in patients with severe to very severe tinnitus, while the others found an effect in the overall study group. The risk of bias in the included studies was high, mainly due to lack of statistical analyses between groups and before vs after treatment, incomplete presentation of the data, and selective reporting. Additionally, most included studies showed a lack of information concerning blinding of the subjects, therapists, and investigators. The heterogeneity of the inclusion criteria, outcome measurements, and treatments made data pooling and meta-analysis impossible. Conclusion: There is low-quality evidence for a positive effect of conservative temporomandibular disorders treatment on tinnitus complaints. The combination of splint therapy and exercise treatment is currently the best investigated treatment approach, showing a decrease in tinnitus severity and intensity. Despite the low level of evidence and the methodologic issues in the included studies, it is noteworthy that all included studies show positive treatment effects.

13. Meijer AJM, Clemens E, Hoetink AE, et al. Tinnitus during and after childhood cancer: A systematic review. Critical reviews in oncology/hematology 2019;135:1-7. BACKGROUND Tinnitus can occur during and after treatment for childhood cancer. Studies on the occurrence of, and risk factors for tinnitus during and after childhood cancer treatment are scarce. The aim of this study is to get insight into the frequency and risk factors of tinnitus during and after childhood cancer therapy, based on a review of all previously reported literature. MATERIALS AND METHODS Systematic electronic literature searches that combined childhood cancer with different treatments and tinnitus terms were performed in the databases EMBASE, Medline, Cochrane, Web of Science, and Google Scholar. Studies were included based on reporting the frequency of tinnitus during and/or after childhood cancer, with 75% of participants being under the age of 25 at time of diagnosis, diagnosed with any type of childhood malignancy and treated with any type of chemotherapy and/or radiotherapy. A risk of bias assessment per research question was performed. RESULTS Tinnitus incidence rates were reported up to 15.9 (95% CI 11.8-21.4) during therapy and up to 5.4 (95% CI 4.3-6.9) more than 5 years after diagnosis. The relative risk of developing tinnitus as compared to siblings during and after childhood cancer therapy were reported up to 17.2 (95% CI 11.8-25.0) during therapy and up to 3.7 (95% CI 2.7-5.1) more than 5 years after diagnosis. Independent risk factors for tinnitus development included high dose cranial radiation and platinum based chemotherapy. CONCLUSION The frequency of and risk to develop tinnitus seems to be higher in childhood cancer patients and survivors as compared to the normal population. Regular tinnitus screening before, during and after therapy with standardized questionnaires for early detection seems therefore reasonable in order to identify high-risk patients and eventually develop successful clinical preventive, supportive and management strategies.

14. Manning C, Grush L, Thielman E, et al. Comparison of Tinnitus Loudness Measures: Matching, Rating, and Scaling. American journal of audiology 2019;28(1):137-43. Purpose Chronic tinnitus ("ringing in the ears") is a phantom auditory perception with no cure. A goal of treatment is often to reduce the loudness of tinnitus. However, tinnitus loudness cannot be measured objectively. It is
most commonly assessed by obtaining a loudness match (LM) with a pure tone and by using a numeric rating scale (NRS). Constrained loudness scaling (CLS) is a more recent measure of tinnitus loudness that utilizes auditory training of a fixed loudness scale to guide tinnitus loudness judgments. The purpose of this study was to compare results using these 3 measures of tinnitus loudness.

Method This study obtained tinnitus loudness measures of LM, NRS, and CLS with 170 participants. These participants are part of a larger study obtaining repeated measures over 6 months. Only baseline data are presented. Results Correlations between all measures were weak to moderate: LM versus CLS \( r = .46 \), CLS versus NRS \( r = .49 \), and LM versus NRS \( r = .38 \). Conclusion Further systematic research is needed to more fully understand the relationships between these different measures and to establish a valid measure of tinnitus loudness.


**BACKGROUND** Patients suffering from chronic, subjective tinnitus are on a quest to find a cure or any form of alleviation for their persistent complaint. Current recommended therapy forms provide psychotherapeutic interventions that are intended to train the patient how to deal with the tinnitus sound. Pharmaceutical managements are used to reduce secondary effects of the tinnitus sound such as sleep deprivation, emotional and concentration difficulties, but these treatments do not cure the tinnitus. Recent studies have shown that Tinnitus Retraining Therapy (TRT) significantly improves the quality of life for tinnitus patients. Furthermore, several studies have reported that cognitive behavioral therapy (CBT) relieves a substantial amount of distress by changing dysfunctional cognitions. However, when the tinnitus causes great interference with daily functioning, these treatment methods are not always sufficiently effective. Recent insights show that Eye Movement Desensitization Reprocessing (EMDR) is a highly effective therapy for medically unexplained symptoms such as chronic pain and phantom pain. In scientific research, tinnitus is compared to phantom limb pain. Starting from tinnitus as a phantom percept we therefore aim to demonstrate that the operating mechanisms of EMDR may also be an effective treatment method for patients with subjective tinnitus. The aim of this randomized controlled study with blind evaluator is to examine the effect of EMDR compared to CBT in chronic tinnitus patients. To our knowledge, there are no other studies that evaluate both methods simultaneously.

**METHODS/DESIGN** A total of 166 patients with subjective, chronic, non-pulsatile tinnitus will be randomized in two treatment groups: TRT + CBT versus TRT + EMDR. The experimental group will receive the bimodal therapy TRT/EMDR and the active control group will receive the bimodal therapy TRT/CBT. Evaluations will take place at baseline before therapy, at the end of the treatment and 3 months after therapy. The score on the Tinnitus Functional Index (TFI) will be used as the primary outcome measurement. Secondary outcome measurements are the Visual Analogue Scale of Loudness (VAS), Tinnitus Questionnaire (TQ), Hospital Anxiety and Depression Scale (HADS), Hyperacusis Questionnaire (HQ), psychoacoustic measurements and event-related potentials (ERP).

**DISCUSSION** The objective is to evaluate whether the bimodal therapy TRT and EMDR can provide faster and/or more relief from the annoyance experienced in chronic tinnitus patients’ daily lives compared to the bimodal therapy TRT and CBT. So far there has been no prospective, randomized controlled, clinical trial with blind evaluator that compares CBT and EMDR as a treatment for tinnitus.

**TRIAL REGISTRATION** ClinicalTrials.gov, ID: NCT03114878. April 14, 2017.
OBJECTIVE To systematically review literature evidence on temporal bone resurfacing techniques for pulsatile tinnitus (PT) associated with vascular wall anomalies.

DATA SOURCES We searched PubMed, Embase, and the Cochrane Database. The period covered was from 1962 to 2018.

REVIEW METHODS We included studies in all languages that reported resurfacing outcomes for patients with PT and radiographic evidence or direct visualization of sigmoid sinus wall anomaly, jugular bulb wall anomaly, or dehiscent or aberrant internal carotid artery.

RESULTS Of 954 citations retrieved in database searches and 5 citations retrieved from reference lists, 20 studies with a total of 141 resurfacing cases involving 138 patients were included. Resurfacing outcomes for arterial sources of PT showed 3 of 5 cases (60%) with complete resolution and 2 (40%) with partial resolution. Jugular bulb sources of PT showed 11 of 14 cases (79%) with complete resolution and 1 (7%) with partial resolution. Sigmoid sinus sources of PT showed 91 of 121 cases (75%) with complete resolution and 12 (10%) with partial resolution. Symptoms occurred more in females and on the right side. Most cases (94%) used hard-density materials for resurfacing. Material density did not appear to be associated with resurfacing outcomes. Use of autologous materials was associated with improved outcomes for arterial sources resurfacing. Major complications involving sigmoid sinus thrombosis or compression were reported in 4% of cases without long-term morbidity or mortality.

CONCLUSIONS Resurfacing surgery is likely effective and well tolerated for select patients with PT associated with various vascular wall anomalies.


An effective acupuncture treatment must comprehend the influence of various factors, but studies in this aspect remain limited. This study aimed to identify relevant factors and search for the best practical method of acupuncture for patients with tinnitus. The study was a retrospective review of patients' data with a prospective design who had subjective idiopathic tinnitus and received acupuncture between May 2012 and August 2017. Patients' demographics, tinnitus characteristics, previous diseases, underlying diseases, oral habits, audiograms, acupuncture sessions, and acupoints were recorded and analyzed. A visual analog scale (VASloudness) was used for measuring the loudness of tinnitus, and the Clinical Global Impression-Improvement scale (CGI-I) was used for assessing the suffering of patients. Good treatment responses in patients were defined as the magnitude of change from the baseline VASloudness for >= 30% plus CGI-I <= 3 points. In total, 107 patients were enrolled. Most factors were not significantly associated with the treatment effectiveness of acupuncture in tinnitus patients. Only the combination of acupoints and the number of acupuncture sessions reached statistically significant differences. Further analyzing these two factors, we confirmed that the combination of periauricular and distal acupuncture and 17 to 24 acupuncture sessions contributed to a considerably better outcome. This result would serve as a reference for clinical acupuncturists to select an appropriate acupuncture strategy in the treatment of tinnitus. Copyright © 2019 Tung-Yi Lin et al.


Background: Tinnitus treatments present a quandary for clinicians, but no thoroughly satisfactory medical treatments are offered to tinnitus patients. Objective: We compared sound therapy effects of the broad band noise (BBN) and the mixed pure tones on tinnitus patients with normal to mild hearing loss, and the possible mechanisms were discussed. Material and methods: This study was a
double-blinded randomized controlled trial. The patients in two groups were followed up for three months. We used a BBN in group A, and mixed pure tones of nine different frequencies in group B. The Tinnitus Handicap Inventory (THI) and Visual Analog Scale (VAS) measuring were used to evaluate the handicap, loudness and anxiety of tinnitus. Results: The THI, VAS scores of group B after 3 months were lower than those at baseline. The VAS scores of group B were lower than those of group A at 8 and 12 weeks. Conclusions: The mixed pure tones were more advantageous than BBN as the sound therapy for tinnitus patients with normal to mild hearing loss. Significance: This trial provides a special and effective sound therapy method. Tinnitus patients with normal to mild hearing loss will experience more positive effects.

19. Li L, Shi H, Wang M. A Pilot Randomized Controlled Trial of Transcutaneous Electrical Nerve Stimulation for Patients With Acute Tinnitus. *Medicine* 2019;98(1):e13793. BACKGROUND This pilot study aimed to evaluate the feasibility, effectiveness, and safety of transcutaneous electrical nerve stimulation (TENS) for patients with acute tinnitus. METHODS A total of 46 eligible patients with acute tinnitus were entered and included in this randomized controlled trial. All the included patients were equally and randomly divided into a verum TENS group and a sham TENS group, each group 23 participants. All patients received parenteral intramuscular therapy of 1 ml Vitamin B12 weekly for a total of 4 weeks. In addition, they also underwent verum or sham TENS 30 min daily, 3 times weekly for 4 weeks. The primary efficacy endpoint was measured by the Tinnitus Severity Scale (TSS) and Tinnitus Questionnaire (TQ) sum score. The secondary efficacy endpoints were assessed by the Tinnitus Handicap Inventory (THI), 12-Item Short Form Health Survey (SF-12) questionnaire, and adverse events. All outcome efficacy endpoints were measured at baseline and after 4 weeks of treatment. RESULTS After 4-week treatment, the patients undergoing verum TENS showed statistically efficacy of symptoms relief, as measured by the scales of TSS (P < .01), TQ (P < .01), and THI (P < .01), and improvement of quality of life, as assessed by the SF-12 (P < .01), compared with patients receiving sham TENS. In addition, no adverse events related to the treatment were recorded in either group. CONCLUSION The results of this study showed that verum TENS may benefit patients with acute tinnitus after 4 weeks of treatment.

20. Ji Eun C, Min Young L, Phil-Sang C, et al. A preliminary study on the efficacy and safety of low level light therapy in the management of cochlear tinnitus: A single blind randomized clinical trial. *International Tinnitus Journal* 2019;23(1):52-57. Objectives: To evaluate the efficacy and safety of low-level light therapy (LLLT) using new irradiation parameters for chronic unilateral tinnitus with cochlear dysfunction. Design: A single-blind, randomized clinical trial Setting: Tertiary-care hospital center Participants: Participants who had a history of chronic unilateral tinnitus (> 3 months) and pure-tone thresholds greater than 15dB (averaged for 3k, 4k, and 6k Hz). Main outcome measures: Numerical rating scales (NRS) measuring loudness, duration, and annoyance, the tinnitus handicap inventory (THI), and psychoacoustical matches of tinnitus loudness and minimum masking levels (MML). Results: Thirty-eight participants were received either a 100-mW diode laser at 830-nm (TINI group; n = 19) or placebo (sham group; n = 19) irradiation through the tympanic membrane. No adverse events were reported during 2 weeks of 10-interventions (20 minutes/day, five days/week). The NRS measuring duration of tinnitus and psychoacoustical matches of tinnitus loudness significantly decreased over times in the TINI group (p<0.05). However, post-hoc analysis revealed that there was no significant decrease of tinnitus among different time points (baseline, during LLLT, immediately after LLLT, and two weeks after LLLT). There was no placebo effect in the Sham group. Participants who improved the duration by at least one point or improved the loudness matches by
more than 5 dB SL two weeks after LLLT tended to have worse pure-tone thresholds. It may suggest that further study is needed in patients with worse pure-tone thresholds to evaluate the therapeutic efficacy of LLLT. Conclusion: Although this preliminary result is insufficient to support the therapeutic efficacy of new laser device for chronic tinnitus, further study is needed in a large number of selected patients.

21. Henry JA, Thielman EJ, Zaugg TL, et al. Telephone-Based Progressive Tinnitus Management for Persons With and Without Traumatic Brain Injury: A Randomized Controlled Trial. Ear & Hearing (01960202) 2019;40(2):227-42. Objectives: This randomized controlled trial evaluated the efficacy of delivering coping skills education from Progressive Tinnitus Management (PTM) by telephone (Tele-PTM). The trial followed a previous pilot study that showed positive results for Tele-PTM. Design: Participants included individuals with bothersome tinnitus (N = 205) located anywhere within the United States. A special emphasis was given to including individuals who had experienced one or more traumatic brain injuries (TBIs). Participants were randomized to either Tele-PTM intervention or 6-month wait-list control (WLC). The Tele-PTM intervention involved five telephone appointments—two led by an audiologist (teaching how to use therapeutic sound) and three by a psychologist (teaching coping skills derived from cognitive-behavioral therapy). It was hypothesized that Tele-PTM would be more effective than WLC in reducing functional effects of tinnitus as measured with the Tinnitus Functional Index. Additional outcome measures included the Self-Efficacy for Managing Reactions to Tinnitus questionnaire and the Hospital Anxiety and Depression Scale. The effect of Tele-PTM on outcomes was estimated using linear mixed models. Results: Overall results showed convincingly that the Tele-PTM group had significantly better outcomes than the WLC group. These results were consistent across all outcome measures, indicating not only a reduction of tinnitus functional distress but also increased self-efficacy. Improvements in measures of anxiety and depression were also observed. Tele-PTM participants in all TBI categories showed significant improvement. Conclusions: Results provide strong support for use of Tele-PTM methodology for persons with bothersome tinnitus, regardless of whether the person also has TBI symptoms. The effect size for Tele-PTM was high for the primary outcome measure, the Tinnitus Functional Index, and all other outcome measures showed significant improvement. Combined with our previous pilot study, the Tele-PTM method is validated for potential nationwide provision of tinnitus services.

22. Cardon E, Van Rompaey V, Jacquemin L, et al. Sequential dual-site High-Definition transcranial Direct Current Stimulation (HD-tDCS) treatment in chronic subjective tinnitus: study protocol of a double-blind, randomized, placebo-controlled trial. Trials 2019;20(1):471. Background: Chronic tinnitus is a highly prevalent symptom, with many patients reporting considerable effects of tinnitus on quality of life. No clear evidence-based treatment options are currently available. While counseling-based methods are valuable in some cases, they are not sufficiently effective for all tinnitus patients. Neurmodulation techniques such as high-definition transcranial direct current stimulation (HD-tDCS) are proposed to have positive effects on tinnitus severity but, to date, these effects have not been proven conclusively. The proposed trial will investigate the hypothesis that chronic tinnitus patients receiving HD-tDCS will report a positive effect on the impact of tinnitus on daily life, as compared to patients receiving sham stimulation. Method: This study proposes a randomized, double-blind, placebo-controlled trial with parallel group design. A total of 100 chronic tinnitus patients will be randomly allocated to an experimental group or a sham group, with allocation stratified according to gender and tinnitus severity. Patient and researcher will be blinded.
to the patient’s allocation. Patients will undergo six sessions of sequential dual-site HD-tDCS of the left temporal area and the right dorsolateral prefrontal cortex. Evaluations will take place at baseline, immediately following treatment, and at three and six months after the start of the therapy. The primary outcome measure is the change in Tinnitus Functional Index (TFI) score. Secondary outcome measures include audiological measurements, cortical auditory evoked potentials, the Repeatable Battery for the Assessment of Neuropsychological Status adjusted for hearing-impaired individuals (RBANS-H), and supplementary questionnaires probing tinnitus severity and additional symptoms. By use of a linear regression model, the effects of HD-tDCS compared to sham stimulation will be assessed.

DISCUSSION The objective of this study is to evaluate whether HD-tDCS can reduce the impact of tinnitus on daily life in chronic tinnitus patients. To date, published trials on the effects of HD-tDCS on tinnitus suffer from a lack of standardization and few randomized controlled trials exist. The proposed study will be the first adequately powered trial to investigate the effects of sequential dual-site HD-tDCS on tinnitus severity.

TRIAL REGISTRATION ClinicalTrials.gov, NCT03754127. Registered on 22 November 2018.


Previous studies have confirmed the efficacy of acupuncture treatment for tinnitus. However, no relevant studies of the exact mechanism of acupuncture efficacy on tinnitus have been published. Enrolled participants with left-sided tinnitus received acupuncture treatment at TE3 and TE5. The acupuncture session lasted for 30 minutes. The infrared thermography (IRT) test of each participant’s bilateral aural regions and visual analog scale scores were taken before and after the first acupuncture treatment session. Fifty-four participants accepted acupuncture treatment and the IRT test. The temperature differentials of both sides were reduced significantly, but the maximum, minimum, and average temperature of bilateral aural regions did not have a significant difference before and after acupuncture session. The acupuncture’s effects for tinnitus were associated with the improvement of cochlear blood flow via the IRT test. We have planned a full-scale randomized controlled trial to find out more about the underlying mechanisms of acupuncture for tinnitus.


Background: Tinnitus is the perception of sound in the absence of any external acoustic stimulation. Transcranial direct current stimulation (tDCS) has shown promising though heterogeneous therapeutic outcomes for tinnitus. The present study aims to review the recent advances in applications of tDCS for tinnitus treatment. In addition, the clinical efficacy and main mechanisms of action of tDCS on suppressing tinnitus are discussed.

Methods: The study was performed in accordance with the PRISMA guidelines. The databases of the PubMed (1980-2018), Embase (1980-2018), PsycINFO (1850-2018), CINAHL, Web of Science, BIOSIS Previews (1990-2018), Cambridge Scientific Abstracts (1990-2018), and google scholar (1980-2018) using the set search terms. The date of the most recent search was 20 May, 2018. The randomized controlled trials that have assessed at least one therapeutic outcome measured before and after tDCS intervention were included in the final analysis.

Results: Different tDCS protocols were used for tinnitus ranging single to repeated sessions (up to 10) consisting of daily single session of 15 to 20-min and current intensities ranging 1-2 mA. Dorsolateral prefrontal cortex (DLPFC) and auditory cortex are the main targets of stimulation. Both single and repeated sessions showed moderate to significant treatment effects on tinnitus symptoms. In addition to improvements in tinnitus symptoms, the tDCS
interventions particularly bifrontal DLPFC showed beneficial outcomes on depression and anxiety comorbid with tinnitus. Heterogeneities in the type of tinnitus, tDCS devices, protocols, and site of stimulation made the systematic reviews of the literature difficult. However, the current evidence shows that tDCS can be developed as an adjunct or complementary treatment for intractable tinnitus. TDCS may be a safe and cost-effective treatment for tinnitus in the short-term application.

Conclusions: The current literature shows moderate to significant therapeutic efficacy of tDCS on tinnitus symptoms. Further randomized placebo-controlled double-blind trials with large sample sizes are needed to reach a definitive conclusion on the efficacy of tDCS for tinnitus. Future studies should further focus on developing efficient disease- and patient-specific protocols.

25. Yadollahpour A, Mayo M, Saki N, et al. A chronic protocol of bilateral transcranial direct current stimulation over auditory cortex for tinnitus treatment: Dataset from a double-blinded randomized controlled trial. F1000Research 2018;7:733. Preliminary studies have demonstrated the therapeutic potential of transcranial direct current stimulation (tDCS) for chronic tinnitus. However, the findings are controversial and most of the studies investigated effects of a single session of tDCS and short after-effects, ranging from hours to days. To our knowledge, there is no published study investigating the effects of a chronic protocol of bilateral tDCS over auditory cortex (AC) with one month follow-up in a double blinded randomized clinical trial. This dataset presents the results of a double-blinded placebo controlled trial investigating the effects of chronic protocol (10 sessions) of tDCS over AC with 1 month follow-up. The data of the two groups, real tDCS (n=25) and sham tDCS (n=15), are reported. The dataset includes three main data groups: patient- and tinnitus-specific data, data of the primary and secondary outcomes, and data on the adverse effects of and tolerability to tDCS. The first group includes demographic information, audiometric assessments, and tinnitus-specific characteristics. The second group includes tinnitus handicap inventory (THI) scores, tinnitus loudness, and tinnitus related distress based on 0-10 numerical visual analogue scale (VAS) scores. The values of the primary and secondary outcomes for pre-intervention and at different time points following interventions are presented. THI scores pre-intervention and immediately post-intervention and at 1 month follow-up; the scores of tinnitus loudness and distress scores for pre-intervention, and immediately, 1 hour, 1 week, and at 1 month after the last stimulation session are presented. Moreover, the adverse effects of and tolerability to the tDCS were assessed using a customized questionnaire after the last tDCS session. This dataset can be used alone or in combination with other datasets using advanced statistical analyses and modeling to investigate the treatment efficacy of tDCS in chronic intractable tinnitus.

26. Wang T-C, Tyler RS, Chang T-Y, et al. Effect of Transcranial Direct Current Stimulation in Patients With Tinnitus: A Meta-Analysis and Systematic Review. Annals of Otology, Rhinology & Laryngology 2018;127(2):79-88. Objectives: Subjective tinnitus is a phantom sensation experienced without any external source of sound that profoundly impacts the quality of life. Some investigations have claimed that transcranial direct current stimulation (tDCS) reduces tinnitus, but studies on tDCS have demonstrated variable results. This meta-analysis aimed to examine the effect of tDCS on patients with tinnitus. Methods: We searched for articles published through January 5, 2016, in Medline, Cochrane, EMBASE, and Google Scholar using the following keywords: tinnitus, transcranial direct current stimulation, and tDCS. The study outcomes were change in magnitude estimates of loudness (loudness), tinnitus-related distress (distress), and Tinnitus Handicap Inventory (THI). Results: Pooled results demonstrated that tDCS did not have a beneficial effect on loudness (pooled standardized difference in means = 0.674, 95% CI, -0.089 to 1.437, P = .083). Further, the pooled
results demonstrated a greater reduction in distress for the tDCS group (pooled standardized difference in means = 0.634, 95% CI, 0.021-1.247, P = .043). Conclusions: We conclude that the pooled results demonstrated a greater reduction in distress for groups treated with tDCS as compared with those administered a sham treatment.

27. Veile A, Zimmermann H, Lorenz E, et al. Is smoking a risk factor for tinnitus? A systematic review, meta-analysis and estimation of the population attributable risk in Germany. BMJ open 2018;8(2):e016589. OBJECTIVETo assess the epidemiological association of smoking status and tinnitus with a systematic review and meta-analysis and to estimate the population attributable risk in Germany. DATA SOURCESA systematic literature search in PubMed and ISI-Web of Science Core Collection resulted in 1026 articles that were indexed until 15 September 2015. Additionally, proceedings of the international tinnitus seminars and reference lists of relevant articles were screened. STUDY SELECTION Two reviewers searched independently for epidemiological studies. Tinnitus as a manifestation of tumours, vascular malformations, specific syndromes or as a consequence of surgical and medical treatment was not considered. Moreover, studies conducted among patients of ear, nose and throat clinics were excluded. DATA EXTRACTION If only raw data were provided, effect sizes were calculated. Further unpublished data were received by corresponding authors. DATA SYNTHESIS Data of 20 studies were pooled. Current smoking (OR 1.21, 95% CI 1.09 to 1.35), former smoking (OR 1.13, 95% CI 1.01 to 1.26) and ever smoking (OR 1.20, 95% CI 1.11 to 1.30) were significantly associated with tinnitus. Moreover, sensitivity analyses for severe tinnitus (OR 1.32, 95% CI 1.10 to 1.58) and for studies of superior quality (OR 1.15, 95% CI 1.03 to 1.29) showed increased risks. According to this, the population attributable risk estimate in Germany is 3.5%. CONCLUSION There is sufficient evidence that smoking is associated with tinnitus. As the review mainly consists of cross-sectional studies, the observed correlation does not give evidence of a causal relationship. Due to the impact of various confounders, further research is needed to provide more evidence on the strength of association and causal relationships.

28. Theodoroff SM, Stevens AA, McMillan G, et al. MRI Verification of a 10-20 Targeting Protocol Used During Transcranial Magnetic Stimulation Sessions for Tinnitus. Brain topography 2018;31(4):690-99. Langguth et al. (2006) described a method for targeting primary auditory cortex (PAC) during transcranial magnetic stimulation (TMS) using the 10-20 electroencephalography system. Study aims were to measure the degree of accuracy in placing the TMS coil on the scalp overlying PAC using the 10-20 method and determine the extent to which accuracy depends on the hemisphere of the coil placement. Twelve participants underwent anatomical magnetic resonance imaging (MRI) of their head in a 3T scanner. Before imaging, a fiducial marker was placed on their scalp corresponding to the TMS coil position. MRI scans were analyzed to determine the distance from the fiducial marker to PAC for each participant. On average, the 10-20 method resulted in distances in the medial-lateral, anterior-posterior, and inferior-superior dimensions that were within a few millimeters (~ 4 mm) of each other between the left and right hemispheres. The fiducial marker was, on average, 10.4 mm superior and 10.8 mm posterior to the optimal scalp location that minimized the distance to PAC. Individual asymmetries and other systematic differences found in this study raise important considerations to keep in mind that might necessitate using an MRI-guided method of coil-positioning when targeting PAC for TMS.

discomfort or even pain. Because patients with tinnitus frequently have psychological problems, self-reporting of the severity of tinnitus is unreliable. We developed a new grading system and practical protocol for the systematic treatment of tinnitus that accounts for its severity, patients' psychological problems, and the frequency of catastrophic episodes. The aim of this study is to employ and validate the new system in patients with tinnitus.

Methods: This study comprised two parts: (i) We identified 113 patients, who were then analyzed in terms of severity of tinnitus, psychological problems, and catastrophic episodes. They were then classified into 5 grades, and the records of their previous treatments were scrutinized. From these records, we designed a practical treatment protocol suitable for each of the 5 grades. (ii) We then identified 82 new patients, and graded and treated them according to the system developed in part (i). Patients were followed-up for at least 6 months; treatment efficacy was evaluated using the pre- and post-treatment scores on the Tinnitus Handicap Inventory (THI) and Hospital Anxiety and Depression Scale (HADS).

Psychological status was also assessed with the DSM-IV.

Results: (i) The overall patient group was categorized as follows: Grade I, 38 patients, average THI=37.6 points, average HADS=10.9 points, catastrophic episodes=0 points; Grade II, 24 patients, THI=70.6, HADS=13.1, catastrophic episodes=0; Grade III, 5 patients, THI=73.2, HADS=28.4, catastrophic episodes=0; Grade IV, 33 patients, THI=63.5, HADS=18.8, catastrophic episodes=1.0; Grade V, 13 patients, THI=73.2, HADS=22.4, catastrophic episodes=2.2. The treatment records revealed treatment via psychotropic drugs for 40% of Grade III, 45.5% of Grade IV, and 84.6% of Grade V patients; psychiatric consultation was provided for 20% of Grade III, 12.5% of Grade IV, and 53.8% of Grade V patients. (ii) THI scores improved significantly in Grades II, IV, and V after treatment using the new protocol; HADS scores improved significantly in Grades IV and V. Catastrophic episode scores improved significantly in Grades IV and V.

Conclusion: We found large enough differences in THI and HADS scores to successfully classify patients with tinnitus into 5 distinct grades that accounted for tinnitus severity, psychological problems, and catastrophic episodes. We found significant improvements in tinnitus severity and psychological problems in the higher (more severe) grades when this system was used to guide treatment. This system not only provided a reasonably reliable categorization system, it simplified treatment without sacrificing efficacy.

30. Shekhawat GS, Vanneste S. High-definition transcranial direct current stimulation of the dorsolateral prefrontal cortex for tinnitus modulation: a preliminary trial. *Journal of neural transmission (Vienna, Austria : 1996) 2018;125(2):163-71.* Tinnitus is the perception of sound in the absence of its external source. Non-invasive neuromodulation techniques have been used in the past decade to investigate the impact of stimulation on tinnitus perception. The objective is to invest the impact of high-definition transcranial direct current stimulation (HD-tDCS) of dorsolateral prefrontal cortex (DLPFC) stimulation on tinnitus loudness and annoyance. Thirteen participants underwent two sessions of HD-tDCS (real and sham) in a double blind, sham controlled, randomized trial. The washout period between the real and sham stimulation session was 1 week. Tinnitus loudness and annoyance was measured using a ten-point tinnitus loudness/annoyance numeric rating scale at the baseline, after 5, 10, 15 and 20 min of stimulation. There was a significant reduction in the tinnitus loudness after the HD-tDCS of DLPFC. A comparison of the different time points (5, 10, 15 and 20 min) with the baseline measurement for tinnitus loudness showed a statistically significant reduction after 15 min (t = 1.82, p = 0.047) and 20 min (t = 1.82, p = 0.047) of stimulation using the real HD-tDCS; this effect was not observed for tinnitus annoyance. HD-tDCS of DLPFC is a safe technique for tinnitus modulation. The most common transient sensations experienced during HD-
tDCS were tingling, sleepiness and scalp pain. HD-tDCS of DLPFC resulted in transient tinnitus loudness suppression after 15 min of stimulation. We propose the optimum stimulation duration for HD-tDCS of DLPFC for tinnitus suppression to be 15 min instead of 20 min.


BACKGROUND Tinnitus affects 10% to 15% of the adult population, with about 20% of those experiencing symptoms that negatively affect quality of life. In England alone there are an estimated ¾ million general practice consultations every year where the primary complaint is tinnitus, equating to a major burden on healthcare services. Clinical management strategies include education and advice, relaxation therapy, tinnitus retraining therapy (TRT), cognitive behavioural therapy (CBT), sound enrichment using ear-level sound generators or hearing aids, and drug therapies to manage co-morbid symptoms such as insomnia, anxiety or depression. Hearing aids, sound generators and combination devices (amplification and sound generation within one device) are a component of many tinnitus management programmes and together with information and advice are a first line of management in audiology departments for someone who has tinnitus.

OBJECTIVE To assess the effects of sound therapy (using amplification devices and/or sound generators) for tinnitus in adults.

SEARCH METHODS The Cochrane ENT Information Specialist searched the Cochrane ENT Register; Central Register of Controlled Trials (CENTRAL, via the Cochrane Register of Studies); Ovid MEDLINE; Ovid Embase; CINAHL; Web of Science; ClinicalTrials.gov; ICTRP and additional sources for published and unpublished trials. The date of the search was 23 July 2018.

SELECTION CRITERIA Randomised controlled trials (RCTs) recruiting adults with acute or chronic subjective idiopathic tinnitus. We included studies where the intervention involved hearing aids, sound generators or combination hearing aids and compared them to waiting list control, placebo or education/information only with no device. We also included studies comparing hearing aids to sound generators, combination hearing aids to hearing aids, and combination hearing aids to sound generators.

DATA COLLECTION AND ANALYSIS We used the standard methodological procedures expected by Cochrane. Our primary outcomes were tinnitus symptom severity as measured as a global score on multi-item tinnitus questionnaire and significant adverse effects as indicated by an increase in self-reported tinnitus loudness. Our secondary outcomes were depressive symptoms, symptoms of generalised anxiety, health-related quality of life and adverse effects associated with wearing the device such as pain, discomfort, tenderness or skin irritation, or ear infections. We used GRADE to assess the quality of evidence for each outcome; this is indicated in italics.

MAIN RESULTS This review included eight studies (with a total of 590 participants). Seven studies investigated the effects of hearing aids, four combination hearing aids and three sound generators. Seven studies were parallel-group RCTs and one had a cross-over design. In general, risk of bias was unclear due to lack of detail about sequence generation and allocation concealment. There was also little or no use of blinding. No data for our outcomes were available for any of our three main comparisons (comparing hearing aids, sound generators and combination devices with a waiting list control group, placebo or education/information only). Data for our additional comparisons (comparing these devices with each other) were also few, with limited potential for data pooling.

Hearing aid only versus sound generator device only One study compared patients fitted with sound generators versus those fitted with hearing aids and found no difference between them in their effects on our primary outcome, tinnitus symptom severity measured with the Tinnitus Handicap Inventory (THI) at 3, 6 or 12 months (low-quality evidence).
The use of both types of device was associated with a clinically significant reduction in tinnitus symptom severity. Combination hearing aid versus hearing aid only. Three studies compared combination hearing aids with hearing aids and measured tinnitus symptom severity using the THI or Tinnitus Functional Index. When we pooled the data we found no difference between them (standardised mean difference -0.5, 95% confidence interval -0.52 to 0.22; three studies; 114 participants) (low-quality evidence). The use of both types of device was again associated with a clinically significant reduction in tinnitus symptom severity.

Adverse effects were not assessed in any of the included studies. None of the studies measured the secondary outcomes of depressive symptoms or depression, anxiety symptoms or generalised anxiety, or health-related quality of life as measured by a validated instrument, nor the newly developed core outcomes tinnitus intrusiveness, ability to ignore, concentration, quality of sleep and sense of control.

AUTHORS’ CONCLUSIONSThere is no evidence to support the superiority of sound therapy for tinnitus over waiting list control, placebo or education/information with no device. There is insufficient evidence to support the superiority or inferiority of any of the sound therapy options (hearing aid, sound generator or combination hearing aid) over each other. The quality of evidence for the reported outcomes, assessed using GRADE, was low. Using a combination device, hearing aid or sound generator might result in little or no difference in tinnitus symptom severity. Future research into the effectiveness of sound therapy in patients with tinnitus should use rigorous methodology. Randomisation and blinding should be of the highest quality, given the subjective nature of tinnitus and the strong likelihood of a placebo response. The CONSORT statement should be used in the design and reporting of future studies. We also recommend the use of validated, patient-centred outcome measures for research in the field of tinnitus.

32. Scherer RW, Sensinger LD, Sierra-Irizarry B, et al. Lessons learned conducting a multi-center trial with a military population: The Tinnitus Retraining Therapy Trial. Clinical Trials 2018;15(5):429-35. Background: The Tinnitus Retraining Therapy Trial (TRTT), a randomized, placebo-controlled, multi-center trial, evaluated the efficacy of tinnitus retraining therapy and its individual components, tinnitus-specific educational counseling and sound therapy versus the standard of care, in military practice to improve study participants’ quality of life. The trial was conducted at six US military hospitals to take advantage of the greater prevalence of tinnitus in the military population. Methods: During the trial, various challenges arose that were uniquely related to the military setting. To convey these challenges to investigators planning future multi-center trials in military hospitals, we itemized various challenges that arose during the trial, interviewed clinic directors and coordinators to elicit their viewpoints, and then collated and organized their responses, together with those challenges presented while conducting the Tinnitus Retraining Therapy Trial. Results: We encountered challenges in site selection, the approval process, administrative issues, study personnel training and retention, participant recruitment methods and issues, adherence to protocol, reimbursement issues, and military security. Site selection involved visiting 20 military hospitals to identify six sites that enrolled and followed study participants. We found that commitment for the trial must be obtained from the full military chain of command, but with ongoing changes in staff or military priorities, initial commitments were insufficient to sustain support throughout the entire trial. More time is required to obtain necessary administrative approvals by various military authorities and institutional review boards than is typically experienced in civilian settings. Recruitment strategies must be flexible due to changing military regulations regarding display of materials. Protracted periods of inactivity were due to sequestration and delays
in institutional review board approval of required study personnel or protocol amendments. While mostly adherent to the protocol, study staff had difficulties in integrating study visits into the military clinical schedule. Unexpected study expenses revolved around hiring civilian study staff and obtaining associated security clearance while maintaining a consistent flow of funds to each site. The added expense negated cost savings realized by conducting the National Institutes of Health-funded trial at federal institutions, whose personnel could not be reimbursed for their efforts. Military security concerns impacted the use of web-based data systems and led to increased time and effort required for site visits. Conclusion: Overall, US military hospitals provide a unique setting to conduct multi-center trials. Challenges arise mainly due to ever-changing authority personnel and military priorities. Pre-planning and flexibility are keys in overcoming these challenges. Multi-center trials conducted in the military will likely take longer to initiate and complete than those in the civilian sector due to multiple levels of command and administrative approvals.

33. Schad ML, McMillan GP, Thielman EJ, et al. Comparison of acoustic therapies for tinnitus suppression: a preliminary trial. International journal of audiology 2018;57(2):143-49.OBJECTIVEThis study obtained preliminary data using two types of sound therapy to suppress tinnitus and/or reduce its functional effects: (1) Notched noise (1000-12,000 Hz notched within a 1-octave range centred around the tinnitus pitch match [PM] frequency); and (2) Matched noise (1-octave wide band of noise centred around the PM frequency). A third (Placebo) group listened to low frequency noise (250-700 Hz).DESIGNParticipants with bothersome tinnitus were randomised into one of the three groups and instructed to listen to the acoustic stimulus for 6 hours a day for 2 weeks. Stimuli were delivered using an iPod Nano, and tinnitus counselling was not performed. Outcome measures were recorded at the 0, 2 and 4 week study visits.STUDY SAMPLLEThirty participants with constant and bothersome tinnitus were recruited and randomised.RESULTSAll groups showed, on average, overall improvement, both immediately post-treatment and 2 weeks following treatment. Outcomes varied between groups on the different measures and at the two outcome points.CONCLUSIONThis study showed improvement for all of the groups, lending support to the premise that any type of sound stimulation is beneficial for relieving effects of tinnitus. These results may serve as a preliminary evidence for a larger study.

34. Santos ADHM, Santos APS, Santos HS, et al. The use of tDCS as a therapeutic option for tinnitus: a systematic review. Brazilian journal of otorhinolaryngology 2018;84(5):653-59.INTRODUCTIONDue to the subjectivity of the tinnitus diagnosis and its diverse etiologies, establishing an effective treatment is complex. In this context, transcranial direct current stimulation, a noninvasive option, is available for most patients and has shown good results in the treatment of other symptoms such as chronic pain.OBJECTIVETo evaluate the therapeutic response of tinnitus to transcranial direct current stimulation.METHODSA systematic review of the literature was performed using the following descriptors: tinnitus, transcranial direct current stimulation and randomized clinical trial. The research was carried out in the MEDLINE/PUBMED, Lilacs, and Scielo databases. The inclusion criteria were: patients over 18 years of age with no associated comorbidities, who had a diagnosis established by a specialist or through the application of previously validated scales and criteria applied by a non-specialist physician.RESULTSA total of 4165 studies were found, and a total of six were selected after the inclusion criteria were applied, obtaining a sample of 602 patients. Based on the defined criteria, there was a positive response to transcranial direct current stimulation in 14.86% of the participants.CONCLUSIONBased on literature studied, there is no therapeutic response of tinnitus to transcranial direct current stimulation.
35. Phillips JS, McFerran DJ, Hall DA, et al. The natural history of subjective tinnitus in adults: A systematic review and meta-analysis of no-intervention periods in controlled trials. *Laryngoscope* 2018;128(1):217-27. Objectives: Tinnitus is a prevalent condition, but little has been published regarding the natural history of the condition. One technique for evaluating the long-term progression of the disease is to examine what happens to participants in the no-intervention control arm of a clinical trial. The aim of this study was to examine no-intervention or waiting-list data reported in trials, in which participants on the active arm received any form of tinnitus intervention. Data Sources: CINAHL, PsychINFO, EMBASE, ASSIA, PubMed, Web of Science, Science Direct, EBSCO Host, and Cochrane. Methods: Inclusion criteria followed the PICOS principles: Participants, adults with tinnitus; Intervention, none; Control, any intervention for alleviating tinnitus; Outcomes, a measure assessing tinnitus symptoms using a multi-item patient-reported tinnitus questionnaire. Secondary outcome measures included multi-item patient-reported questionnaires of mood and health-related quality of life and measures that quantified change in tinnitus loudness; Study design, randomized controlled trials or observational studies utilizing a no-intervention or waiting-list control group. Data were extracted and standardized mean difference was calculated for each study to enable meta-analysis. Results: The evidence strongly favored a statistically significant decrease in the impact of tinnitus over time, though there was significant heterogeneity and clinical significance cannot be interpreted. Outcome data regarding secondary measures did not demonstrate any clinically significant change. Conclusions: Participants allocated to the no-intervention or waiting-list control arm of clinical trials for a tinnitus intervention show a small but significant improvement in self-reported measures of tinnitus with time; the clinical significance of this finding is unknown. There is, however, considerable variation across individuals. These findings support previous work and can cautiously be used when counseling patients.

36. Naderinabi B, Soltanipour S, Nemati S, et al. Acupuncture for chronic non-pulsatile tinnitus: A randomized clinical trial. *Caspian Journal of Internal Medicine* 2018;9(1):38-45. Background: There is challenge to find an effective treatment for tinnitus. Few studies were done on the effects of acupuncture on chronic non-pulsatile tinnitus. Method(s): This randomized double-blind clinical trial was conducted from December 2014 to September 2015. Patients suffering from chronic non-pulsatile tinnitus were randomly allocated into two groups: acupuncture vs. placebo. They were treated in 15 sessions and at the end of the fifteenth sessions and 3 weeks after completion of the treatment, visual analog scale (VAS) for tinnitus loudness and tinnitus severity index (TSI) questionnaires were completed. Result(s): The case group included 26 males and 18 females, and in the control group there were 27 males and 17 females: with mean age of 49.11 +/- 1.07 and 55.20 +/- 8.33 years, respectively (p=0.005). TSI and VAS before treatment were 43.84 +/- 2.81 and 9.56 +/- 0.43 in cases and 43.52 +/- 2.94 and 9.54 +/- 0.45 in controls, respectively. Both measures improved after 15 sessions in cases to 24.82 +/- 1.04 and 2.88 +/- 0.33, and to 33.16 +/- 1.24 and 7.86 +/- 0.23 in controls. The changes of TSI and VAS were significant in all groups (p < 0.001). TSI and VAS in acupuncture group were lower than placebo group in each session (p < 0.001), except TSI in the tenth session (p=0.392). Conclusion(s): Acupuncture is effective in reducing the loudness and severity of tinnitus and can be a useful treatment for non-pulsatile chronic tinnitus.

Electrical nerve stimulation (TENS) involves a neuromodulatory effect using electrical stimulation and has been widely used due to its safety and convenience. It has been used for treating tinnitus for decades. Acupuncture has also been used for tinnitus and several research studies have shown that acupuncture can improve a certain kind of tinnitus by stimulating the somatosensory system. Moreover, several studies have shown the efficacy of electroacupuncture, which is a combination of acupuncture and electrical stimulation, for tinnitus. However, the comparative effectiveness of TENS, manual acupuncture, and electroacupuncture for the treatment of tinnitus has not been determined previously. Herein, we design a randomized, non-blind clinical trial to investigate and compare the effects and safety of TENS, manual acupuncture, and electroacupuncture for tinnitus.

**METHODS**

After screening, 45 patients are randomly assigned to three groups: (1) patients in the TENS group are treated at four sites (tender points of masseter and the sternocleidomastoid muscle, in front of tragus, and mastoid process); (2) the manual acupuncture group patients are treated at 11 acupoints (TE21, SI19, GB2, TE22, ST7, TE17, GB20 of tinnitus affected side, and GB20, TE05, KI3 of both sides); (3) electroacupuncture group patients are treated by using acupuncture as in the manual acupuncture group and electrical stimulation at TE21, SI19, TE17, and GB20. Patients are treated for ten sessions, twice a week. The primary outcome measurement is the change of Tinnitus Handicap Inventory (THI) score between visit 1 and visit 10. The secondary outcome measurements are the response rate of THI, change in visual analogue scale associated with the loudness and annoyance of tinnitus, pure-tone audiometry and speech discrimination, and changes in parameters of heart rate variability.

**DISCUSSION**

The purpose of this study is to compare the effect of TENS, manual acupuncture, and electroacupuncture in the auricular area on tinnitus. If the specific treatment shows a significant effect compared to other treatments, it could have potential for use in clinical practice as a primary treatment.

**TRIAL REGISTRATION**


**BACKGROUND**

Tinnitus is a highly prevalent symptom affecting 10-15% of the adult population. It often affects patient quality of life and frequently causes distress. When subjective tinnitus can be elicited by the somatosensory system of the cervical spine or temporomandibular area it is termed somatic tinnitus. The first aim of the current study is to investigate the effect of the best evidence conservative temporomandibular disorder (TMD) treatment on tinnitus in patients with co-existence of tinnitus and TMD or oral parafunctions compared to no treatment. The second aim is to identify a subgroup of patients with tinnitus that benefits from the conservative temporomandibular joint treatment.

**METHODS AND DESIGN**

This study is a randomised controlled trial with a delayed treatment design. Patients with a TMD (TMD pain screenner ≥ 3 points) or oral parafunctions (such as clenching and bruxism), who are suffering from moderate to severe subjective tinnitus (Tinnitus Functional Index (TFI) between 25 and 90 points), will be recruited from the tertiary tinnitus clinic of the University Hospital of Antwerp, Edegem, Belgium. Patients will be excluded in case of clear otological or neurological causes of the tinnitus, progressive middle ear pathology, intracranial pathology, traumatic cervical spine or temporomandibular injury in the past 6 months, severe depression as diagnosed by a psychologist, tumours, previous surgery in the orofacial area, substance abuse that may affect the outcome measures, any contra-indication for physical therapy treatment directed to the orofacial area or when they received TMD treatment in the past 2 months. After screening for eligibility,
baseline data among which scores on the TFI, tinnitus questionnaire (TQ), mean tinnitus loudness as measured with visual analogue scale (VAS), TMD pain screener, and a set of temporomandibular joint tests will be collected. Patients will be randomised in an early-start group and in a delayed-start group of therapy by 9 weeks. Patients will receive conservative TMD treatment with a maximum of 18 sessions within 9 weeks. At baseline (week 0), at the start of therapy (weeks 0 or 9), 9 weeks after therapy (weeks 9 or 18), and at follow-up (weeks 18 or 27) data from the TFI, TQ, VAS mean tinnitus loudness and the TMD pain screener will be collected.

**DISCUSSION**

Herein, we aim to improve the quality of care for patients with tinnitus attributed to TMD or oral parafunctions. By evaluating the effect of state-of-the-art TMD treatment on tinnitus complaints, we can investigate the usefulness of TMD treatment in patients with somatic tinnitus.

**TRIAL REGISTRATION**

3 July 2017, version 1 of the protocol, ClinicalTrials.gov NCT03209297.

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**Objectives:** Mindfulness-based approaches may benefit patients with chronic tinnitus, but most evidence is from small studies of nonstandardized interventions, and there is little exploration of the processes of change. This study describes the impact of mindfulness-based cognitive therapy (MBCT) in a "real world" tinnitus clinic, using standardized MBCT on the largest sample of patients with chronic tinnitus to date while exploring predictors of change.

**Design:** Participants were 182 adults with chronic and distressing tinnitus who completed an 8-week MBCT group. Measures of tinnitus-related distress, psychological distress, tinnitus acceptance, and mindfulness were taken preintervention, postintervention, and at 6-week follow-up.

**Results:** MBCT was associated with significant improvements on all outcome measures. Postintervention, reliable improvements were detected in tinnitus-related distress in 50% and in psychological distress in 41.2% of patients. Changes in mindfulness and tinnitus acceptance explained unique variance in tinnitus-related and psychological distress postintervention.

**Conclusions:** MBCT was associated with significant and reliable improvements in patients with chronic, distressing tinnitus. Changes were associated with increases in tinnitus acceptance and dispositional mindfulness. This study doubles the combined sample size of all previously published studies. Randomized controlled trials of standardized MBCT protocols are now required to test whether MBCT might offer a new and effective treatment for chronic tinnitus.

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The aim of this study was to evaluate the early and sustained effects of tinnitus educational counseling on chronic primary tinnitus and related problems. A descriptive longitudinal cohort study was conducted with 159 adult patients suffering from chronic primary tinnitus and sleep problems. All patients received tinnitus educational counseling, sleep adjustment, and vegan dietary advice. At short-term assessment within 3 months and long-term follow-up at 6-26 months, perceived changes in tinnitus were assessed with the Tinnitus Handicap Inventory (THI) and the Tinnitus Evaluation Questionnaire (TEQ), respectively. In TEQ, the volume of subjective tinnitus was scored according to realistic environments in which tinnitus could be heard. Sleep quality was assessed with questionnaires developed in our laboratory. Most of the subjects showed significant early improvement in their THI scores (96/159, 60.38%; from 46.11 ± 22.74 to 31.94 ± 20.41, t = 11.16, p < 0.001, Cohen's d = 0.66). Tinnitus volume (39/159, 24.53%, from 2.2 to 2.1, z = -3.56, p < 0.001) and sleep quality (68/159, 42.77%; from 7.13 ± 3.11 to 6.31 ± 2.75, t = 3.73, p < 0.001, Cohen's d = 0.28)
were also improved. Long-term follow-up TEQ results indicated that tinnitus loudness, the impact of tinnitus on sleep, concentration, and emotional state were all improved since the prior consultation (p = 0.001, 0.026, 0.012, and <0.001). Short-term improvement of tinnitus severity correlated directly with improvement of sleep quality (odds ratio (OR) = 0.30, 95% confidence interval (CI): 0.14-0.64, p = 0.002), initial THI score (OR = 1.02, 95% CI: 1.01 to 1.04, p = 0.006), compliance with sleep advice (OR = 2.27, 95% CI: 1.02-5.05, p = 0.044), and nervous disposition (OR = 2.80, 95% CI: 1.25-6.30, p = 0.013). A future randomized controlled trial would be carried out to examine the effect of sole tinnitus educational counseling.

41. Liu C, Lv H, Jiang T, et al. The Cochleural Alternating Acoustic Beam Therapy (CAABT): A preclinical trial. American journal of otolaryngology 2018;39(4):401-09. PURPOSE We intend to assess the effectiveness of a novel tinnitus treatment therapy, the Cochleural Alternating Acoustic Beam Therapy (CAABT) using the psychoacoustic measures, the questionnaires and rs-fMRI. MATERIALS AND METHODS In this study, we enrolled 11 older than 18 years old Chinese patients with normal hearing who had unilateral, chronic (longer than 6 months), sensorineural tinnitus, of frequencies between 125-8000 Hz, and an average loudness of 31 dB. The patients underwent the treatment with the CAABT method for 12 weeks and the outcomes were evaluated with tinnitus questionnaire scores, a set of psychoacoustic measures, and rs-fMRI testing before treatment and at 3 months. This was an earlier study of the controlled randomized clinical trial which was registered with ClinicalTrials.gov, number NCT02774122. RESULTS Almost all the patients reported reduced tinnitus annoyance after the three-month treatment. The THI and VAS scores showed decreased tinnitus severity. The rs-fMRI results indicated that the right middle frontal gyrus and the right superior temporal gyrus displayed noticeable decreases of the ReHo values for the subjects between the before and after treatment, supporting the clinical evidence of significant tinnitus reduction. CONCLUSION The therapy seemed effective in patients of varying severities, and no side effects were observed in this trial. The CAABT can be an alternative for those who are suitable for sound therapy once a large scale of and better controlled clinical studies have validated the findings of this experiment.

42. Lee DY, Kim YH. Risk factors of pediatric tinnitus: Systematic review and meta-analysis. The Laryngoscope 2018;128(6):1462-68. OBJECTIVES/HYPOTHESIS Medications for pediatric tinnitus are not widely used due to a lack of evidence-based information. The modification of risk factors is essential in pediatric tinnitus; however, there is a lack of systematic reviews despite several reports on risk factors. This study performed a systematic review and meta-analysis of available literature to evaluate risk factors of pediatric tinnitus. METHODS Studies reporting the risk factors of pediatric tinnitus were systematically reviewed by searching the MEDLINE, PubMed, and Embase databases for studies published from database inception to 2016. The selected articles included clinical or epidemiological studies conducted with at least 50 subjects and at least one risk factor, including age, gender, hearing loss, noise exposure, or smoking. RESULTS Eleven studies involving a total of 28,358 individuals were identified. Increased age was not a significant risk factor with a standardized median difference of 0.16 (95% confidence interval [CI]: -0.01 to 0.33). However, there was a significant correlation between increased age and tinnitus in the adolescent population. The odds ratio (OR) was 1.37 for female gender (95% CI: 1.17 to 1.60), 2.39 for hearing loss (95% CI: 1.48 to 3.87), and 11.35 for noise exposure (95% CI: 1.87 to 68.77). Two studies in adolescents showed statistical significance for smoking as a risk factor in developing tinnitus (OR: 6.05, 95% CI: 1.81 to 20.21). CONCLUSIONS Older-aged adolescents, as well as those who are females and those with
hearing loss may have a higher risk of tinnitus. Noise exposure in the general pediatric population and smoking in adolescents may represent especially important risk factors in pediatric tinnitus.

43. Kleinstäuber M, Weise C, Andersson G, et al. Personality traits predict and moderate the outcome of Internet-based cognitive behavioural therapy for chronic tinnitus. *International journal of audiology* 2018;57(7):538-44. OBJECTIVE The aim of this study is to investigate whether the Big Five personality traits predict the outcome of Internet-based cognitive behavioural therapy (ICBT) and whether they moderate the outcome between ICBT and face-to-face group cognitive behavioural therapy (GCBT). DESIGN This study investigated the Big Five personality traits as predictors and moderators of the outcome (tinnitus handicap) in a trial comparing ICBT and GCBT for chronic tinnitus. STUDY SAMPLE N = 84 patients with chronic tinnitus were randomised to either ICBT (n = 41) or GCBT (n = 43). RESULTS A multilevel model for discontinuous change was performed. Higher scores on the "openness" scale of the Big Five Personality Inventory (BFI-10) predicted a lower tinnitus handicap (Tinnitus Handicap Inventory, THI) at post-treatment in ICBT (p < 0.05). Openness moderated the outcome at post-treatment in favour of ICBT (p < 0.05). Higher scores on the BFI-10 "conscientiousness" scale predicted a more favourable outcome in ICBT at 6-month (p < 0.05) and 12-month follow-up (p < 0.05), but the BFI-10 "conscientiousness" scale was positively associated with the THI at baseline (p < 0.05). CONCLUSIONS ICBT might be the preferred treatment choice for tinnitus patients being open towards new experiences. Moreover, ICBT requires autonomous work and self-motivation by the patient in order to have an impact.

44. In 't Veld M, Fronczek R, de Laat JA, et al. The Incidence of Cranial Arteriovenous Shunts in Patients With Pulsatile Tinnitus: A Prospective Observational Study. *Otolaryngology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2018;39(5):648-53. OBJECTIVES Finding the underlying cause for pulsatile tinnitus can be challenging. We aimed to determine the incidence of arteriovenous shunts, i.e., arteriovenous malformations (AVMs) or dural arteriovenous fistulas (dAVFs), in patients referred for catheter angiography (digital subtraction angiography [DSA]). Furthermore, we assessed which clinical features were predictive for the presence of such a lesion. STUDY DESIGN AND METHODS Fifty-one patients with pulsatile tinnitus, who were referred to us for DSA to exclude an arteriovenous shunt, were enrolled, prospectively. MAIN OUTCOME MEASURES DSA determined the presence of a dAVF or AVM. Clinical characteristics were recorded systematically and all patients underwent a physical examination. RESULTS Fifty patients were included in the final analyses. While no AVMs were found, a dAVF was found in 12 cases (24%). Three of these demonstrated cortical venous reflux, thus requiring treatment due to the risk of hemorrhage. In three cases (6%), DSA demonstrated a non-arteriovenous-shunt abnormality, likely causing the tinnitus. The odds of having a dAVF were significantly raised by unilaterality, objective bruit, and the ability to influence the tinnitus with compression. Unilaterality even had a negative predictive value of 1 and, if used as selection criterion, would have raised dAVF prevalence from 24 to 32%. CONCLUSION In a tertiary care setting, the prevalence of dAVFs in patients with pulsatile tinnitus is not negligible. Thus, patients with unilateral pulsatile tinnitus should be offered dynamic vascular imaging to rule out a dAVF. Especially, since some of these patients are at risk of intracranial hemorrhage and treatment options exist.

45. Hall DA, Smith H, Hibbert A, et al. The COMiTI'D Study: Developing Core Outcome Domains Sets for Clinical Trials of Sound-, Psychology-, and Pharmacology-Based Interventions for Chronic
Subjective Tinnitus in Adults. Trends in hearing 2018;22:2331216518814384. Subjective tinnitus is a chronic heterogeneous condition that is typically managed using intervention approaches based on sound devices, psychologically informed therapies, or pharmaceutical products. For clinical trials, there are currently no common standards for assessing or reporting intervention efficacy. This article reports on the first of two steps to establish a common standard, which identifies what specific tinnitus-related complaints ("outcome domains") are critical and important to assess in all clinical trials to determine whether an intervention has worked. Using purposive sampling, 719 international health-care users with tinnitus, health-care professionals, clinical researchers, commercial representatives, and funders were recruited. Eligibility was primarily determined by experience of one of the three interventions of interest. Following recommended procedures for gaining consensus, three intervention-specific, three-round, Delphi surveys were delivered online. Each Delphi survey was followed by an in-person consensus meeting. Viewpoints and votes involved all stakeholder groups, with approximately a 1:1 ratio of health-care users to professionals. "Tinnitus intrusiveness" was voted in for all three interventions. For sound-based interventions, the minimum set included "ability to ignore," "concentration," "quality of sleep," and "sense of control." For psychology-based interventions, the minimum set included "acceptance of tinnitus," "mood," "negative thoughts and beliefs," and "sense of control." For pharmacology-based interventions, "tinnitus loudness" was the only additional core outcome domain. The second step will next identify how those outcome domains should best be measured. The uptake of these intervention-specific standards in clinical trials will improve research quality, enhance clinical decision-making, and facilitate meta-analysis in systematic reviews.

46. Haider HF, Bojic T, Ribeiro SF, et al. Pathophysiology of subjective tinnitus: Triggers and maintenance. Frontiers in Neuroscience 2018;12(NOV):00866. Tinnitus is the conscious perception of a sound without a corresponding external acoustic stimulus, usually described as a phantom perception. One of the major challenges for tinnitus research is to understand the pathophysiological mechanisms triggering and maintaining the symptoms, especially for subjective chronic tinnitus. Our objective was to synthesize the published literature in order to provide a comprehensive update on theoretical and experimental advances and to identify further research and clinical directions. We performed literature searches in three electronic databases, complemented by scanning reference lists from relevant reviews in our included records, citation searching of the included articles using Web of Science, and manual searching of the last 6 months of principal otology journals. One-hundred and thirty-two records were included in the review and the information related to peripheral and central mechanisms of tinnitus pathophysiology was collected in order to update on theories and models. A narrative synthesis examined the main themes arising from this information. Tinnitus pathophysiology is complex and multifactorial, involving the auditory and non-auditory systems. Recent theories assume the necessary involvement of extra-auditory brain regions for tinnitus to reach consciousness. Tinnitus engages multiple active dynamic and overlapping networks. We conclude that advancing knowledge concerning the origin and maintenance of specific tinnitus subtypes origin and maintenance mechanisms is of paramount importance for identifying adequate treatment.

The aim of this randomized double-blinded controlled trial was to determine the effect of rTMS with unique settings for tinnitus treatment. Method(s): Fifty-three adult patients suffering from chronic subjective unilateral or bilateral nonpulsatile primary tinnitus for at least 6 months were randomly assigned to rTMS (group 1, n = 20), sham stimulation (group 2, n = 12), or medicament therapy only (group 3, n = 21). The dorsolateral prefrontal cortex (frequency 25 Hz, 300 pulses, and 80% resting motor threshold [RMT]) on the left side and primary auditory cortex (1 Hz, 1000 pulses, 110% RMT) were stimulated on both sides in patients in group 1 for 5 consecutive days. The Tinnitus Reaction Questionnaire (TRQ), Tinnitus Handicap Questionnaire (THQ), Tinnitus Handicap Inventory (THI), Beck Depression Inventory (BDI), pure-tone audiometry with Fowler scoring of hearing loss, and tinnitus analysis were used to evaluate tinnitus in all patients. Data were recorded the day the patient was included in the study and at 1- and 6-month follow-up. Result(s): The study groups were homogenous. No significant effect of rTMS was found at 1 or 6 months based on the BDI, THQ, and TRQ scores or tinnitus masking. There was a significant but clinically irrelevant effect on the THI score after 1 and 6 months. Interpretation(s): No significant effect of bilateral low-frequency rTMS of the primary auditory cortex and high-frequency stimulation of the left dorsolateral prefrontal cortex was demonstrated.


Background: The precise mechanisms underlying tinnitus perception and distress are still not fully understood. A recent proposition is that auditory prediction errors and related memory representations may play a role in driving tinnitus perception. It is of interest to further explore this. Purpose: To obtain a comprehensive narrative synthesis of current research in relation to auditory prediction and its potential role in tinnitus perception and severity. Research Design: A narrative review methodological framework was followed. Data Collection and Analysis: The key words Prediction Auditory, Memory Prediction Auditory, Tinnitus AND Memory, Tinnitus AND Prediction in Article Title, Abstract, and Keywords were extensively searched on four databases: PubMed, Scopus, SpringerLink, and PsychINFO. All study types were selected from 2000--2016 (end of 2016) and had the following exclusion criteria applied: minimum age of participants,18, nonhuman participants, and article not available in English. Reference lists of articles were reviewed to identify any further relevant studies. Articles were short listed based on title relevance. Study Sample: After reading the abstracts and with consensus made between coauthors, a total of 114 studies were selected for charting data. Results: The hierarchical predictive coding model based on the Bayesian brain hypothesis, attentional modulation and top-down feedback serves as the fundamental framework in current literature for how auditory prediction may occur. Predictions are integral to speech and music processing, as well as in sequential processing and identification of auditory objects during auditory streaming. Although deviant responses are observable from middle latency time ranges, the mismatch negativity (MMN) waveform is the most commonly studied electrophysiological index of auditory irregularity detection. However, limitations may apply when interpreting findings because of the debatable origin of the MMN and its restricted ability to model real-life, more complex auditory phenomenon. Cortical oscillatory band activity may act as neurophysiological substrates for auditory prediction. Tinnitus has been modeled as an auditory object which may demonstrate incomplete processing during auditory scene analysis resulting in tinnitus salience and therefore difficulty in habituation. Within the electrophysiological domain, there is currently mixed evidence
regarding oscillatory band changes in tinnitus. Conclusions: There are theoretical proposals for a relationship between prediction error and tinnitus but few published empirical studies.

49. Bousema EJ, Koops EA, van Dijk P, et al. Association Between Subjective Tinnitus and Cervical Spine or Temporomandibular Disorders: A Systematic Review. *Trends in hearing* 2018;22:2331216518800640. Movements of the neck and jaw may modulate the loudness and pitch of tinnitus. The aim of the present study was to systematically analyze the strength of associations between subjective tinnitus, cervical spine disorders (CSD), and temporomandibular disorders (TMD). A systematic literature search of the Medline, Embase, and Pedro databases was carried out on articles published up to September 2017. This covered studies in which tinnitus and CSD or TMD were studied as a primary or a secondary outcome and in which outcomes were compared with a control group. Included articles were evaluated on nine methodological quality criteria. Associations between tinnitus and CSD or TMD were expressed as odds ratios. In total, 2,139 articles were identified, of which 24 studies met the inclusion criteria. Twice, two studies were based on the same data set; consequently, 22 studies were included in the meta-analysis. Methodological quality was generally limited by a lack of blinding, comparability of groups, and nonvalidated instruments for assessing CSD. Results indicated that patients with tinnitus more frequently reported CSD than subjects without tinnitus. The odds ratio was 2.6 (95% CI [1.1, 6.4]). For TMD, a bidirectional association with tinnitus was found; odds ratios ranged from 2.3 (95%CI [1.5, 3.6]) for arthrogenous TMD to 6.7 (95%CI [2.4, 18.8]) for unspecified TMD. Funnel plots suggested a publication bias. After adjusting for this, the odds ratios decreased, but associations persisted. There is weak evidence for an association between subjective tinnitus and CSD and a bidirectional association between tinnitus and TMD.

50. Beukes EW, Manchaiah V, Baguley DM, et al. Process evaluation of Internet-based cognitive behavioural therapy for adults with tinnitus in the context of a randomised control trial. *International journal of audiology* 2018;57(2):98-109. OBJECTIVE The research objective was to identify processes that could either facilitate or hinder clinical implementation of an Internet-based cognitive behavioural therapy intervention for tinnitus in the UK. This was done by exploring the research context, the intervention components and the factors that contributed to the outcomes obtained. DESIGN This study investigated eight processes including the recruitment strategies, reach, research context, treatment dose delivered and received, implementation fidelity, barriers to implementation and effectiveness of the intervention. STUDY SAMPLE Of the 169 registered participants, 146 were randomly assigned to the experimental or control groups (23 were excluded). The mean age was 55.57 years with an average tinnitus duration of 11.63 years. RESULTS The intended sample of people with distressing tinnitus who were underserved with evidence-based tinnitus interventions was reached. The full guided intervention was delivered. The recommended modules were read more than the optional modules. Intervention components such as the easily readable format and the benefits of the applied relaxation programme facilitated significant positive post-intervention outcomes. Barriers hampering the intervention application included time pressures and low self-motivation. CONCLUSIONS Results of this process evaluation together with the outcome data can be used to facilitate translating this research into clinical practice.

way of delivering accessible healthcare for various conditions including hearing and balance disorders. A comprehensive review regarding the evidence-base of Internet-based interventions for auditory-related conditions is required to determine the existing evidence of their efficacy and effectiveness. The objective of the current protocol is to provide the methodology for a systematic review regarding the effects of Internet-based interventions for adults with hearing loss, tinnitus and vestibular disorders.

**METHOD**

This protocol was developed according to the Preferred Reporting Items for Systematic reviews and Meta-analyses for Protocols (PRISMA-P) 2015 guidelines. Electronic database searches will include EBSCOhost, PubMed and Cochrane Central Register performed by two researchers. This will be complemented by searching other resources such as the reference lists for included studies to identify studies meeting the eligibility for inclusion with regard to study designs, participants, interventions, comparators and outcomes. The Cochrane risk of bias tool (RoB 2) for randomised trials will be used for the bias assessments in the included studies. Criteria for conducting meta-analyses were defined.

**DISCUSSION**

The result of this systematic review will be of value to establish the effects of Internet-based interventions for hearing loss, tinnitus and vestibular disorders. This will be of importance to guide future planning of auditory intervention research and clinical services by healthcare providers, researchers, consumers and stakeholders.

**SYSTEMATIC REVIEW REGISTRATION**

PROSPERO CRD42018094801.


**Importance**

Accessible clinical care is not always available to individuals with distressing tinnitus. Internet-based cognitive behavioral therapy has the potential to increase access to evidence-based services that manage tinnitus. Research comparing the effectiveness of this internet-based intervention with face-to-face care is required.

**Objective**

To evaluate whether an internet-based cognitive behavioral therapy intervention is at least as effective as established individualized face-to-face clinical care in reducing tinnitus distress and tinnitus-related difficulties.

**Design, Setting, and Participants**

A randomized, multicenter, 2-arm parallel group, noninferiority trial with 2-month follow-up was performed between October 4, 2016, and July 14, 2017. Invited to participate were 374 adults based in the United Kingdom who had been referred to their local tinnitus clinics because of bothersome tinnitus. The experimental group received the internet-based intervention online, and the active control group underwent the usual face-to-face tinnitus care at 1 of 3 UK-based National Health Service hospitals. Participants were randomly assigned (1:1) to either intervention using variable permuted block sizes of 4 and 6. Of 92 participants who were randomized (46 each in the experimental and control groups), 88 participants completed the assessment immediately after intervention and 74 participants completed the follow-up assessment.

**Interventions**

Participants were randomized to receive either 8 weeks of guided internet-based cognitive behavioral therapy or a mean of 2 to 3 individualized face-to-face appointments in a tinnitus clinic.

**Main Outcomes and Measures**

The primary outcome was a change in tinnitus distress (assessed by the Tinnitus Functional Index). Secondary assessment measures were included for insomnia, anxiety, depression, hearing disability, hyperacusis, cognitive failures, and satisfaction with life.

**Results**

Of 92 patients overall, 55 (60%) were men with a mean (SD) age of 52.96 (12.07) years and mean (SD) tinnitus duration of 6.54 (9.25) years. The between-group difference in the Tinnitus Functional Index scores after intervention were 5.18 (95% CI, -4.17 to 14.53) at the initial assessment and 5.52 (95% CI, -4.60 to 15.61) at follow-up; both differences were within the noninferiority margin of 13 points for the lower 95% CI.
secondary outcomes, only outcomes for insomnia fell outside the noninferiority margin, both after intervention and at follow-up, favoring internet-based cognitive behavioral therapy. Conclusions and Relevance This is the first trial, to our knowledge, to compare an internet-based intervention with standard individualized face-to-face care for tinnitus. It revealed that both interventions are equally effective for reducing tinnitus distress and most tinnitus-related difficulties. Trial Registration ClinicalTrials.gov identifier: NCT02665975.

53. Beukes EW, Allen PM, Baguley DM, et al. Long-Term Efficacy of Audiologist-Guided Internet-Based Cognitive Behavior Therapy for Tinnitus. American Journal of Audiology 2018;27:431-47. Purpose: The purpose of this study was to investigate the long-term outcomes 1 year after undertaking an audiologist-guided Internet-based cognitive behavioral therapy (iCBT) intervention for tinnitus. Secondary aims were to identify any predictors of outcome and whether there were any unwanted events related to undertaking iCBT for tinnitus. Method: Participants who had previously undertaken a randomized iCBT efficacy trial for tinnitus were invited to participate. Of the 146 who were initially randomized for the efficacy trial, 104 participants completed the 1-year postintervention assessment measures. The primary outcome was a change in tinnitus distress as assessed by the Tinnitus Functional Index. Secondary assessment measures were included for insomnia, anxiety, depression, hearing handicap, hyperacusis, cognitive failures, and satisfaction with life. An intention-to-treat analysis using repeated-measures analysis of variance and hierarchical multiple regression was used for statistical analysis. Unwanted effects were categorized according to the unwanted events checklist. Results: Undertaking iCBT for tinnitus led to significant improvements 1 year postintervention for tinnitus and related difficulties, for example, insomnia, anxiety, depression, hearing handicap, hyperacusis, and life satisfaction. The best predictors of improving tinnitus severity at 1-year postintervention were greater baseline tinnitus severity scores, reading more of the modules, and higher satisfaction with the intervention. Unwanted events were reported by 11% of the participants and were more likely to be reported by women than men. These events were related to worsening of symptoms, the emergence of new symptoms, negative wellbeing, and prolongation of treatment. Conclusions: The clinical benefits of audiologist-guided iCBT for tinnitus and tinnitus-related difficulties were sustained 1 year postintervention. Predictors of outcome indicated that the intervention is applicable to a wide range of participants regardless of their demographic backgrounds. Attempts should be made to minimize unwanted events in subsequent trials.

54. Arts RAGJ, George ELJ, Janssen MAML, et al. The effect of tinnitus specific intracochlear stimulation on speech perception in patients with unilateral or asymmetric hearing loss accompanied with tinnitus and the effect of formal auditory training. International Journal of Audiology 2018;57(6):426-39. Objectives: Previous studies show that intracochlear electrical stimulation independent of environmental sounds appears to suppress tinnitus, even long-term. In order to assess the viability of this potential treatment option it is essential to study the effects of this tinnitus specific electrical stimulation on speech perception. Design: A randomised, prospective crossover design. Study sample: Ten patients with unilateral or asymmetric hearing loss and severe tinnitus complaints. Results: The audiological effects of standard clinical CI, formal auditory training and tinnitus specific electrical stimulation were investigated. Results show that standard clinical CI in unilateral or asymmetric hearing loss is shown to be beneficial for speech perception in quiet, speech perception in noise and subjective hearing ability. Formal auditory training does not appear to improve speech perception performance. However, CI-related discomfort reduces significantly
more rapidly during CI rehabilitation in subjects receiving formal auditory training. Furthermore, tinnitus specific electrical stimulation has neither positive nor negative effects on speech perception. Conclusions: In combination with the findings from previous studies on tinnitus suppression using intracochlear electrical stimulation independent of environmental sounds, the results of this study contribute to the viability of cochlear implantation based on tinnitus complaints.

55. Ahnblad P. A Review of a Steady State Coherent Bio-modulator for Tinnitus Relief and Summary of Efficiency and Safety Data from the Clinical Study Program and Post Market Clinical Follow-up. The international tinnitus journal 2018;22(1):72-76. OBJECTIVE To evaluate a non-energy consuming light bio-modulator patch creating coherency for tinnitus relief. MATERIALS AND METHODSThree independent clinical studies and continuous post market clinical follow up have been performed during the year 2012 to 2018. The first study was a limited interventional investigation with 10 patients, the second was a larger interventional study with finally 48 patients further investigated, and the third a randomized, placebo-controlled, double-blind study with 82 patients. In the clinical studies patch performance evaluated with questionnaires related to tinnitus, quality-of-life, and safety were assessed prior, during and after the end of treatment. In all studies the treatment time was 3 weeks and the patches were placed behind one ear. RESULTS The first study indicated a relief with half of the patients at the end of the treatment. Still two years after the study one third reported tinnitus relief. However, the numbers of patients were low. The second study showed a responder relief in 58% directly after end of treatment and 60% one month after. The third study showed that the biomodulator patch had statistical significant three times more responders than placebo one month after end of treatment, measured as a decrease from baseline in at least 2 points in tinnitus annoyance visual analogue scale as a minimal clinical significant difference. Tinnitus handicap inventory was improved by mean-16 points significantly for the active responder group, but with no statistically significant changes for the placebo group or between the groups. The biomodulator patch was safe and well-tolerated in all three studies. The post market clinical follow up has shown a 30% reported relief and with no new risks or unexpected issues affecting the effectiveness or safety. CONCLUSION Taken under consideration the lack of easy-to-use alternative and the low risk profile, this patch device could highly be recommended to try for tinnitus relief as a conclusion based on the clinical studies and post market surveys. Further studies of how this bio-modulator more specific act on the auditory system, how long this may sustain and if there can be subgroups of patients or variations in the treatment time, delayed onset, number of patches, and frequency for more efficiency needs to be considered.

56. Abtahi H, Okhovvat A, Heidari S, et al. Effect of transcranial direct current stimulation on short-term and long-term treatment of chronic tinnitus. American journal of otolaryngology 2018;39(2):94-96. OBJECTIVE This study was conducted to investigate the effectiveness of anodal and cathodal methods in reducing the intensity of tinnitus and to compare them with the control. METHODOLOGY This randomized double-blind clinical trial with case and control groups was conducted in Al-Zahra Hospital in Isfahan between 2015 and 2016. In this trial, 51 patients with tinnitus, for at least one year, were selected among those outpatients visiting the throat, nose and ear clinic within this period. Inclusion criteria were patients on electrical stimulation prohibition, with Ménière's disease, otosclerosis, chronic headache, and pulsatile tinnitus. Patients were randomly divided in three equal-sized groups: anodal stimulation group, cathodal stimulation group, and control group. The subjects received 20-min current stimulation (2 mA). Five subjects were selected from those with a significant difference between the stimulated states (anodal or cathodal).
and/or control. They received weekly transcranial electrical stimulation for two months, and their long-term recovery from tinnitus was investigated. Data analysis was done with SPSS20.

RESULTS
Findings showed no significant between-groups difference in mean scores of tinnitus before the intervention (p = .68); whereas, this difference was significant immediately after the intervention (p = .02) and 1 h after it (p = .03). The mean score of tinnitus in the anodal stimulation group was significantly lower than the control; whereas, no significant difference was observed between the anodal and cathodal stimulation groups, and between the cathodal and control groups (p < .05). Findings also showed that the mean scores of tinnitus in two cathodal stimulation groups (p = .24) and control group (p = .62) were not significantly different at three different points of time; whereas, this score was significantly different in the anodal group at these time points (p = .01).

CONCLUSION
In conclusion, anodal stimulation was more effective than the cathodal and control stimulation in reducing the intensity of tinnitus in the short term.

57. Aazh H, Moore BCJ. Effectiveness of Audiologist-Delivered Cognitive Behavioral Therapy for Tinnitus and Hyperacusis Rehabilitation: Outcomes for Patients Treated in Routine Practice. American Journal of Audiology 2018;27(4):547-58. Objective: The aim was to assess the effectiveness of cognitive behavioral therapy (CBT) for tinnitus and/or hyperacusis delivered by audiologists working in the National Health Service in the United Kingdom. Design: This was a retrospective study, based on questionnaires assessing tinnitus and hyperacusis and insomnia before and after CBT. Study Sample: Data were gathered for 68 consecutive patients (average age = 52.5 years) who enrolled for CBT. Results: All measures showed significant improvements after CBT. Effect sizes for patients who completed CBT were 1.13 for Tinnitus Handicap Inventory scores; 0.76 for Hyperacusis Questionnaire scores; 0.71, 0.95, and 0.93 for tinnitus loudness, annoyance, and effect on life, respectively, measured using the Visual Analog Scale; and 0.94 for the Insomnia Severity Index score. An analysis including those who dropped out also showed significant improvements for all measures. Conclusion: Audiologist-delivered CBT led to significant improvements in self-report measures of tinnitus and hyperacusis handicap and insomnia. The methods described here may be used when designing future randomized controlled trials of efficacy.

58. Zenner H-P, Delb W, Kröner-Herwig B, et al. A multidisciplinary systematic review of the treatment for chronic idiopathic tinnitus. European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery 2017;274(5):2079-91. The majority of tinnitus patients are affected by chronic idiopathic tinnitus, and almost 60 different treatment modalities have been reported. The present study is a multidisciplinary systematic analysis of the evidence for the different forms of treatment for chronic tinnitus. The results are used to form the basis of an S3 guideline. A systematic search was carried out in PubMed and the Cochrane Library. The basis for presenting the level of evidence was the evidence classification of the Oxford Centre of Evidence-based Medicine. Whenever available, randomised controlled trials were given preference for discussing therapeutic issues. All systematic reviews and meta-analyses were assessed for their methodological quality, and effect size was taken into account. As the need for patient counselling is self-evident, specific tinnitus counselling should be performed. Due to the high level of evidence, validated tinnitus-specific, cognitive behaviourial therapy is strongly recommended. In addition, auditory therapeutic measures can be recommended for the treatment of concomitant hearing loss and comorbidities; those should also be treated with drugs whenever appropriate. In particular, depression should be treated, with pharmacological support if necessary.
If needed, psychiatric treatment should also be given on a case-by-case basis. With simultaneous deafness or hearing loss bordering on deafness, a CI can also be indicated. For auditory therapeutic measures, transcranial magnetic or direct current stimulation and specific forms of acoustic stimulation (noiser/masker, retraining therapy, music, and coordinated reset) for the treatment of chronic tinnitus the currently available evidence is not yet sufficient for supporting their recommendation.

59. Wegger M, Ovesen T, Larsen DG. Acoustic coordinated reset neuromodulation: A systematic review of a novel therapy for tinnitus. Frontiers in Neurology 2017;8(FEB):36. Background: There are growing technological advances in the development of sound-based methods for the treatment of tinnitus. Most of these methods intend to affect the speculated underlying neurological causes of tinnitus. Acoustic coordinated reset (CR) neuromodulation is one of them. A novel method that as of yet seems inadequately reviewed. Purpose(s): To evaluate the current evidence on acoustic CR neuromodulation as a method for the treatment of tinnitus and to assess whether the method can be implemented in daily clinical practice. Method(s): A systematic literature search was performed in 13 databases in the period from February 1, 2015 to May 1, 2016. Studies regarding acoustic CR neuromodulation as a treatment method for tinnitus were included in the present review. Result(s): A total of 8 studies were eligible for being reviewed comprising a total of 329 patients. Overall, the evidence level of the published literature was low. The main findings in the included studies were that acoustic CR neuromodulation was safe and well tolerated and most patients reported reduction of tinnitus symptoms. The neurophysiological basis of the method was claimed to be desynchronization, anti-kindling, and change of abnormal frequency couplings in a widespread tinnitus network comprising both auditory and non/auditory brain areas based on EEG analyses. Conclusion(s): The available evidence is insufficient for clinical implementation of acoustic CR neuromodulation. The limited level of evidence suggests that acoustic CR neuromodulation may have positive effects on tinnitus symptoms. Preliminary electroencephalographic data are compatible with the claim that tinnitus reduction after CR treatment is mediated by a desynchronizing effect. However, a proof for this claim is still lacking. © 2017 Wegger, Ovesen and Larsen.

60. Wang AC, Nelson AN, Pino C, et al. Management of Sigmoid Sinus Associated Pulsatile Tinnitus: A Systematic Review of the Literature. Otology & Neurotology 2017;38(10):1390-96. Objectives: Although studies demonstrate 4 to 20% of patients with pulsatile tinnitus (PT) have associated sigmoid sinus anomalies, no consensus exists regarding optimal management. Our objective was to perform a systematic review exploring surgical and endovascular intervention of PT caused by sigmoid sinus anomalies. Data Sources/extraction: A systematic review was performed using the Preferred Reporting Systems for Systematic Reviews and Meta-Analysis guidelines for reporting of results, with a target population encompassing patients with PT and either sigmoid sinus diverticulum or sigmoid wall dehiscence. From an initial search yielding 74 articles, 21 manuscripts met inclusion criteria. Data Synthesis: Of 139 patients, 90.4% were female. Mean age was 39.0 years. Diagnosis was sigmoid sinus diverticulum/aneurysm in 47.5% of patients, sigmoid sinus dehiscence in 35.3% of patients, and both in 17.3%. Sigmoid sinus wall reconstruction/resurfacing (SSW R/R) was used in 91.4% and endovascular procedures in 7.9% of patients. Postoperative recurrence was 3.5% (mean follow-up 21.1 m). Although there was no association between resolution rate and age or sex, right-sided PT resolved at a higher rate. For every increase in body mass index by 1 kg/m, the odds of PT resolution increased 9.2%. Conclusion: PT as a result of sigmoid sinus diverticula,
aneurysms, and dehiscence is a rare, but largely treatable condition. Available interventions include SSW R/R, endovascular intervention, and cardiac U-clip techniques. In SSW R/R, bone pate, unspecified soft-tissue graft, and bone cement had the highest rates of PT resolution. While temporalis fascia and autologous bone chips were the materials most commonly used, they had significantly lower rates of PT resolution compared with the other materials, with the exception of auricular cartilage and bone cement. Most episodes of recurrence are resolved with medical management or a revision procedure. This study serves to summarize the current state of knowledge on the treatment of pulsatile tinnitus across disciplines.

61. Tyler R, Cacace A, Stocking C, et al. Vagus Nerve Stimulation Paired with Tones for the Treatment of Tinnitus: A Prospective Randomized Double-blind Controlled Pilot Study in Humans. *Scientific reports* 2017;7(1):11960. The aim of the pilot study was to evaluate the effect of Vagus Nerve Stimulation (VNS) paired with sounds in chronic tinnitus patients. All participants were implanted and randomized to a paired VNS (n = 16) or control (n = 14) group. After 6 weeks of home therapy, all participants received paired VNS. The device was used on 96% of days with good compliance. After 6 weeks, the paired VNS group improved on the Tinnitus Handicap Inventory (THI) (p = 0.0012) compared to controls (p = 0.1561). The between-group difference was 10.3% (p = 0.3393). Fifty percent of the participants in the paired VNS group showed clinically meaningful improvements compared to 28% in controls. At one year, 50% of participants had a clinically meaningful response. The therapy had greater benefits for participants with tonal and non-blast induced tinnitus at the end of 6 (24.3% vs. 2%, p = 0.05) and 12 weeks (34% vs. 2%, p = 0.004) compared to controls with 80% and 70% responding at 6 months and 1 year, respectively. Adverse effects were mild and well-tolerated and the therapy had a similar safety profile to VNS for epilepsy. VNS paired with tones may be effective for a subgroup of tinnitus patients and provides impetus for a larger pivotal study.

62. Theodoroff SM, McMillan GP, Zaugg TL, et al. Randomized Controlled Trial of a Novel Device for Tinnitus Sound Therapy During Sleep. *American Journal of Audiology* 2017;26(4):543-54. Purpose: The aim of this study was to determine if a customized stimulus from the Otoharmonics Levo System reduces tinnitus perceptions and reactions for people with bothersome tinnitus. Method: Sixty participants were randomized to 1 of 3 groups that used sound therapy devices during sleep that differed in their acoustic stimulus: (a) tinnitus-matched (TM), (b) noise stimulus (NS), and (c) bedside sound generator (BSG). Outcome measures were the Tinnitus Functional Index (TFI), numeric rating scale of tinnitus loudness, and tinnitus loudness match. A Bayesian hierarchical model was fit to estimate the differences in treatment efficacy among groups. Results: Average tinnitus reactions and perceptions improved across treatment groups. We are at least 87% certain that treatment with TM or NS reduces mean TFI compared to treatment with BSG, with an estimated relative efficacy of 4.5–5 points greater reduction. We are at least 95% certain that treatment with TM results in greater reduction in mean numeric rating scale (NRS) of tinnitus loudness compared to the other groups, with an estimated relative efficacy of about 0.75 points greater reduction. Conclusions: This study offers some support for greater average improvement in reactions to tinnitus with TM or NS devices compared to the BSG device. The TM group, compared to the BSG and NS groups, showed a greater reduction in ratings of tinnitus loudness on the NRS on average.

63. Theodoroff SM, Griest SE, Folmer RL. Transcranial magnetic stimulation for tinnitus: using the Tinnitus Functional Index to predict benefit in a randomized controlled trial. *Trials* 2017;18:1-
6. Background: Identifying characteristics associated with transcranial magnetic stimulation (TMS) benefit would offer insight as to why some individuals experience tinnitus relief following TMS treatment, whereas others do not. The purpose of this study was to use the Tinnitus Functional Index (TFI) and its subscales to identify specific factors associated with TMS treatment responsiveness. Methods: Individuals with bothersome tinnitus underwent 2000 pulses of 1-Hz TMS for 10 consecutive business days. The primary outcome measure was the TFI which yields a total score and eight individual subscale scores. Analyses were performed on baseline data from the active arm (n = 35) of a prospective, double-blind, randomized placebo-controlled clinical trial of TMS for tinnitus. Results: Baseline total TFI score and three of the eight TFI subscales were useful in differentiating between responders and non-responders to TMS intervention for tinnitus. These findings are not definitive, but suggest potential factors that contribute to perceived benefit following TMS. Conclusions: Overall, the main factor associated with TMS benefit was a higher tinnitus severity score for responders at baseline. The TFI subscales helped to clarify the factors that contributed to a higher severity score at baseline. Large-scale prospective research using systematic approaches is needed to identify and describe additional factors associated with tinnitus benefit following TMS. Trial Registration: ClinicalTrials.gov, ID: NCT01104207. Registered on 13 April 2010.

64. Tae-Soo N, Jeong Sug K, Mun Young C, et al. Comparison of Treatment Outcomes Following Either Prefrontal Cortical-only or Dual-site Repetitive Transcranial Magnetic Stimulation in Chronic Tinnitus Patients: A Double-blind Randomized Study. Otology & Neurotology 2017;38(2):296-303. Objectives: We evaluated treatment outcomes following single-site repetitive transcranial magnetic stimulation (rTMS) in the dorsolateral prefrontal cortex (DLPFC) and dual-site rTMS in the auditory cortex (AC) and DLPFC (AC+FC). Study Design and Patients: This prospective randomized double-blind trial initially included 19 patients with chronic tinnitus and 17 of these patients received rTMS on the left AC and left DLPFC or only the left DLPFC. The subjects were randomly allocated to either the dual-site rTMS (AC+FC) protocol (Group 1, n = 9) or the single-site rTMS (DLPFC) protocol (Group 2, n = 8). Group 1 received daily treatments with 2,000 pulses applied to the AC and 1,000 pulses applied to the DLPFC for 4 days (total of 12,000 pulses) and Group 2 received daily treatments with 3,000 pulses applied to the DLPFC for 4 days (total of 12,000 pulses). Main Outcome Measures: The severity of tinnitus was assessed before rTMS treatment using the Tinnitus Handicap Inventory (THI) and the self-rated Visual Analog Scale. These measures were used to determine the awareness, loudness, annoyance, and effects of tinnitus on daily life at 1, 2, 4, and 12 weeks after treatment. Results: The improvement in THI score was significantly better in Group 1 than in Group 2, even after controlling for the between-group differences in pretreatment THI score. In terms of psychological factors, Group 1 exhibited significant improvements in scores on the State-Trait Anxiety Inventory (STAI) for both state anxiety (STAI-X1) and trait anxiety (STAI-X2) at 12 weeks posttreatment and scores on the Pittsburgh Sleep Quality Index at 4 weeks posttreatment. Group 2 showed an improvement in only the STAI-X2 score at 12 weeks posttreatment. Conclusions: The rTMS protocol effectively suppressed tinnitus in the dual-site rTMS (AC+FC) group but not in the single-site rTMS (DLPFC) group. Although recent evidence has shown that non-auditory cortices in the tinnitus network play an important role in the generation of tinnitus, our findings indicate that rTMS on non-auditory cortical sites alone may not be sufficient for treatment. Thus, dual-site rTMS in the AC and DLPFC may be preferable for controlling this condition.

Background: Hearing loss is defined as worsening of hearing acuity and is usually expressed as an increase in the hearing threshold. Tinnitus, defined as "ringing in the ear", is a common and often disturbing accompaniment of hearing loss. Hearing loss and environmental exposures to noise are increasingly recognized health problems. Objectives: The objective was to assess whether the exposure-response relationship can be established between exposures to non-occupational noise and permanent hearing outcomes such as permanent hearing loss and tinnitus. Methods: Information sources: Computer searches of all accessible medical and other databases (PubMed, Web of Science, Scopus) were performed and complemented with manual searches. The search was not limited to a particular time span, except for the effects of personal listening devices (PLDs). The latter was limited to the years 2008-June 2015, since previous knowledge was summarized by SCENIHR descriptive systematic review published in 2008. Study eligibility criteria: The inclusion criteria were as follows: the exposure to noise was measured in sound pressure levels (SPLs) and expressed in individual equivalent decibel values (LEX,8h), the studies included both exposed and reference groups, the outcome was a permanent health effect, i.e., permanent hearing loss assessed with pure-tone audiometry and/or permanent tinnitus assessed with a questionnaire. The eligibility criteria were evaluated by two independent reviewers. Study appraisal and synthesis methods: The risk of bias was assessed for all of the papers using a template for assessment of quality and the risk of bias. The GRADE (grading of recommendations assessment, development, and evaluation) approach was used to assess the overall quality of evidence. Meta-analysis was not possible due to methodological heterogeneity of included studies and the inadequacy of data. Results: Out of 220 references identified, five studies fulfilled the inclusion criteria. All of them were related to the use of PLDs and comprised in total of 1551 teenagers and young adults. Three studies used hearing loss as the outcome and three tinnitus. There was a positive correlation between noise level and hearing loss either at standard or extended high frequencies in all three of the studies on hearing loss. In one study, there was also a positive correlation between the duration of PLD use and hearing loss. There was no association between prolonged listening to loud music through PLDs and tinnitus or the results were contradictory. All of the evidence was of low quality. Limitations: The studies are cross-sectional. No study provides odds ratios of hearing loss by the level of exposure to noise. Conclusions: While using very strict inclusion criteria, there is low quality GRADE evidence that prolonged listening to loud music through PLDs increases the risk of hearing loss and results in worsening standard frequency audiometric thresholds. However, specific threshold analyses focused on stratifying risk according to clearly defined levels of exposure are missing. Future studies are needed to provide actionable guidance for PLDs users. No studies fulfilling the inclusion criteria related to other isolated or combined exposures to environmental noise were identified.

66. Sahlsten H, Virtanen J, Joutsa J, et al. Electric field-navigated transcranial magnetic stimulation for chronic tinnitus: a randomized, placebo-controlled study. International Journal of Audiology 2017;56(9):692-700. Objective: Repetitive transcranial magnetic stimulation (rTMS) may alleviate tinnitus. We evaluated effects of electric field (E-field) navigated rTMS targeted according to tinnitus pitch. No controlled studies have investigated anatomically accurate E-field-rTMS for tinnitus. Design: Effects of E-field-rTMS were evaluated in a prospective randomised placebo-controlled 6-month follow-up study on parallel groups. Patients received 10 sessions of 1 Hz rTMS or placebo targeted to the left auditory cortex corresponding to tonotopic representation of tinnitus pitch. Effects were evaluated immediately after treatment and at 1, 3 and 6 months. Primary outcome measures were
visual analogue scores (VAS 0–100) for tinnitus intensity, annoyance and distress, and the Tinnitus Handicap Inventory (THI). Study sample: Thirty-nine patients (mean age 50.3 years). Results: The mean tinnitus intensity ($F_3 = 15.7$, $p < 0.0001$), annoyance ($F_3 = 8.8$, $p = 0.0002$), distress ($F_3 = 9.1$, $p = 0.0002$) and THI scores ($F_4 = 13.8$, $p < 0.0001$) decreased in both groups over time with non-significant differences between the groups. After active rTMS, 42% and 37% of the patients showed excellent response at 1 and 3 months against 15% and 10% in the placebo group ($p = 0.082$ and $p = 0.065$). Conclusions: Despite the significant effects of rTMS on tinnitus, differences between active and placebo groups remained non-significant, due to large placebo-effect and wide inter-individual variation.

67. Noh T-S, Kyong JS, Chang MY, et al. Comparison of Treatment Outcomes Following Either Prefrontal Cortical-only or Dual-site Repetitive Transcranial Magnetic Stimulation in Chronic Tinnitus Patients: A Double-blind Randomized Study. Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology 2017;38(2):296-303. OBJECTIVES We evaluated treatment outcomes following single-site repetitive transcranial magnetic stimulation (rTMS) in the dorsolateral prefrontal cortex (DLPFC) and dual-site rTMS in the auditory cortex (AC) and DLPFC (AC+FC). STUDY DESIGN AND PATIENTS This prospective randomized double-blind trial initially included 19 patients with chronic tinnitus and 17 of these patients received rTMS on the left AC and left DLPFC or only the left DLPFC. The subjects were randomly allocated to either the dual-site rTMS (AC+FC) protocol (Group 1, $n = 9$) or the single-site rTMS (DLPFC) protocol (Group 2, $n = 8$). Group 1 received daily treatments with 2,000 pulses applied to the AC and 1,000 pulses applied to the DLPFC for 4 days (total of 12,000 pulses) and Group 2 received daily treatments with 3,000 pulses applied to the DLPFC for 4 days (total of 12,000 pulses). MAIN OUTCOME MEASURES The severity of tinnitus was assessed before rTMS treatment using the Tinnitus Handicap Inventory (THI) and the self-rated Visual Analog Scale. These measures were used to determine the awareness, loudness, annoyance, and effects of tinnitus on daily life at 1, 2, 4, and 12 weeks after treatment. RESULTS The improvement in THI score was significantly better in Group 1 than in Group 2, even after controlling for the between-group differences in pretreatment THI score. In terms of psychological factors, Group 1 exhibited significant improvements in scores on the State-Trait Anxiety Inventory (STAI) for both state anxiety (STAI-X1) and trait anxiety (STAI-X2) at 12 weeks posttreatment and scores on the Pittsburgh Sleep Quality Index at 4 weeks posttreatment. Group 2 showed an improvement in only the STAI-X2 score at 12 weeks posttreatment. CONCLUSION The rTMS protocol effectively suppressed tinnitus in the dual-site rTMS (AC+FC) group but not in the single-site rTMS (DLPFC) group. Although recent evidence has shown that non-auditory cortices in the tinnitus network play an important role in the generation of tinnitus, our findings indicate that rTMS on non-auditory cortical sites alone may not be sufficient for treatment. Thus, dual-site rTMS in the AC and DLPFC may be preferable for controlling this condition.

68. McKenna L, Marks EM, Hallsworth CA, et al. Mindfulness-Based Cognitive Therapy as a Treatment for Chronic Tinnitus: A Randomized Controlled Trial. Psychotherapy and psychosomatics 2017;86(6):351-61. BACKGROUND Tinnitus is experienced by up to 15% of the population and can lead to significant disability and distress. There is rarely a medical or surgical target and psychological therapies are recommended. We investigated whether mindfulness-based cognitive therapy (MBCT) could offer an effective new therapy for tinnitus. METHODS This single-site randomized controlled trial compared MBCT to intensive relaxation training (RT) for chronic,
distressing tinnitus in adults. Both treatments involved 8 weekly, 120-min sessions focused on either relaxation (RT) or mindfulness meditation (MBCT). Assessments were completed at baseline and at treatment commencement 8 weeks later. The primary outcomes were tinnitus severity (Tinnitus Questionnaire) and psychological distress (Clinical Outcomes in Routine Evaluation - Non-Risk, CORE-NR), 16 weeks after baseline. The analysis utilized a modified intention-to-treat approach. RESULTS A total of 75 patients were randomly allocated to MBCT (n = 39) or RT (n = 36). Both groups showed significant reductions in tinnitus severity and loudness, psychological distress, anxiety, depression, and disability. MBCT led to a significantly greater reduction in tinnitus severity than RT, with a mean difference of 6.3 (95% CI 1.3-11.4, p = 0.016). Effects persisted 6 months later, with a mean difference of 7.2 (95% CI 2.1-2.3, p = 0.006) and a standardized effect size of 0.56 (95% CI 0.16-0.96). Treatment was effective regardless of initial tinnitus severity, duration, or hearing loss. CONCLUSIONS MBCT is effective in reducing tinnitus severity in chronic tinnitus patients compared to intensive RT. It also reduces psychological distress and disability. Future studies should explore the generalizability of this approach and how outcome relates to different aspects of the intervention.

69. Mahboubi H, Haidar YM, Kiumehr S, et al. Customized Versus Noncustomized Sound Therapy for Treatment of Tinnitus: A Randomized Crossover Clinical Trial. *Annals of Otology, Rhinology & Laryngology* 2017;126(10):681-87. Objectives: To determine the effectiveness of a customized sound therapy and compare its effectiveness to that of masking with broadband noise. Methods: Subjects were randomized to receive either customized sound therapy or broadband noise for 2 hours per day for 3 months and then switched to the other treatment after a washout period. The outcome variables were tinnitus loudness (scored 0-10), Tinnitus Handicap Inventory (THI), Beck Anxiety Inventory (BAI), minimum masking levels (MML), and residual inhibition (RI). Results: Eighteen subjects completed the study. Mean age was 53 ± 11 years, and mean tinnitus duration was 118 ± 99 months. With customized sound therapy, mean loudness decreased from 6.4 ± 2.0 to 4.9 ± 1.9 (P = .001), mean THI decreased from 42.8 ± 21.6 to 31.5 ± 20.3 (P < .001), mean BAI decreased from 10.6 ± 10.9 to 8.3 ± 9.9 (P = .01), and MML decreased from 22.3 ± 11.6 dB SL to 17.2 ± 10.6 dB SL (P = .005). After 3 months of broadband noise therapy, only BAI and, to a lesser degree, MML decreased (P = .003 and .04, respectively). Conclusions: Customized sound therapy can decrease the loudness and THI scores of tinnitus patients, and the results may be superior to broadband noise.

70. Li S-a, Bao L, Chrostowski M. Investigating the Effects of a Personalized, Spectrally Altered Music-Based Sound Therapy on Treating Tinnitus: A Blinded, Randomized Controlled Trial. *Audiology & Neuro-Otology* 2017;21(5):296-304. Objective: This blinded, randomized controlled trial assessed the effectiveness of a personalized, spectrally altered music-based sound therapy over 12 months of use. Method: Two groups of participants (n = 50) were randomized to receive either altered or unaltered classical music. The treatment group received classical music that had been modified based on spectral alterations specific to their tinnitus characteristics. Tinnitus and psychological functioning were assessed at baseline and 3, 6, and 12 months after initial testing using self-reports. Participants, investigators and research assistants were blinded from group assignment. Results: Data from 34 participants were analyzed. The treatment group reported significantly lower levels of tinnitus distress (primary outcome, assessed using the Tinnitus Handicap Inventory) than the control group throughout the follow-up period. Among the treatment group, there were statistically significant and clinically meaningful levels of reduction in tinnitus distress, severity, and functional impairment at 3- and 6-month follow-ups, which was sustained at the 12-
month follow-up. Conclusion: The personalized music therapy was effective in reducing subjective tinnitus and represents a meaningful advancement in tinnitus intervention.

71. Landgrebe M, Hajak G, Wolf S, et al. 1-Hz rTMS in the treatment of tinnitus: A sham-controlled, randomized multicenter trial. *Brain stimulation* 2017;10(6):1112-20. BACKGROUND Chronic tinnitus is a frequent, difficult to treat disease with high morbidity. OBJECTIVE This multicenter randomized, sham-controlled trial investigated the efficacy and safety of 1-Hz repetitive transcranial magnetic stimulation (rTMS) applied to the left temporal cortex in patients with chronic tinnitus. METHOD Tinnitus patients were randomized to receive 10 sessions of either real or sham 1-Hz rTMS (2000 stimuli, 110% motor threshold) to the left temporal cortex. The primary outcome was the change in the sum score of the tinnitus questionnaire (TQ) of Goebel and Hiller from baseline to end of treatment. RESULTSA total of 163 patients were enrolled in the study (real rTMS: 75; sham rTMS: 78). At day 12, the baseline mean of 43.1 TQ points in 71 patients assigned to real rTMS changed by -0.5 points; it changed by 0.5 points from a baseline of 42.1 in 75 patients randomized to sham rTMS (adjusted mean difference between groups: -1.0; 95.19% confidence interval: -3.2 to 1.2; p = 0.36). All secondary outcome measures including measures of depression and quality of life showed no significant differences either (p > 0.11). The number of participants with side-effects or adverse events did not differ between groups. CONCLUSION Real 1-Hz-rTMS over the left temporal cortex was well tolerated but not superior compared with sham rTMS in improving tinnitus severity. These findings are in contrast to results from studies with smaller sample sizes and put the efficacy of this rTMS protocol for treatment of chronic tinnitus into question. TRIAL REGISTRATION Trials: http://www.isrctn.com/ISRCTN89848288.

72. Kreuzer PM, Poepppl TB, Rupprecht R, et al. Individualized repetitive transcranial magnetic stimulation treatment in chronic tinnitus? *Frontiers in Neurology* 2017;8(APR):126. Background: Prefrontal and temporo-parietal repetitive transcranial magnetic stimulation (rTMS) in patients suffering from chronic tinnitus have shown significant but only moderate effectiveness with high interindividual variability in treatment response. This open-label pilot study was designed to examine the general feasibility of an individualized fronto-temporal rTMS protocol and to explore what criteria are needed for a more detailed evaluation in randomized clinical studies. Method(s): During the first session of a 2-week rTMS protocol, we applied different rTMS protocols to the left and right temporo-parietal and dorsolateral prefrontal cortex (DLPFC) in 25 tinnitus patients. Short trains of 1, 5, 10, and 20 Hz and continuous theta burst stimulation were applied, and patients were asked for immediate tinnitus reductions after each train. If a patient reported such improvements, rTMS treatment was applied over nine sessions with a combined protocol consisting of the most effective frontal and the most effective temporo-parietal stimulation protocol. Those patients who did not improve after the test session were treated with a standard prefrontal plus temporo-parietal protocol (20 Hz over left DLPFC + 1 Hz over temporo-parietal cortex). Result(s): Almost half of the patients (12 of 25) reported immediate tinnitus reductions during the test session. In this group, the mean pre- to post-treatment amelioration in the tinnitus questionnaire was higher (medium to high effect sizes) in contrast to the patients who did not respond to the test session. Treatment outcome remained stable over a follow-up period of 10 weeks. Discussion(s): Individualized rTMS was shown to be feasible and effective in chronic tinnitus. The results obtained from this study provide tentative evidence in support of an individualized rTMS treatment approach and might provide a basis for a "tailored" application of rTMS in tinnitus and other neuropsychiatric disorders. Copyright © 2017 Kreuzer, Poepppl, Rupprecht, Vielsmeier, Lehner, Langguth and Schecklmann.

BACKGROUND
Many previous studies of electroacupuncture used combined therapy of electroacupuncture and systemic manual acupuncture, so it was uncertain which treatment was effective. This study evaluated and compared the effects of systemic manual acupuncture, periauricular electroacupuncture and distal electroacupuncture for treating patients with tinnitus.

METHODS
A randomized, parallel, open-labeled exploratory trial was conducted. Subjects aged 20-75 years who had suffered from idiopathic tinnitus for > 2 weeks were recruited from May 2013 to April 2014. The subjects were divided into three groups by systemic manual acupuncture group (MA), periauricular electroacupuncture group (PE), and distal electroacupuncture group (DE). The groups were selected by random drawing. Nine acupoints (TE 17, TE21, SI19, GB2, GB8, ST36, ST37, TE3 and TE9), two periauricular acupoints (TE17 and TE21), and four distal acupoints (TE3, TE9, ST36, and ST37) were selected. The treatment sessions were performed twice weekly for a total of eight sessions over 4 weeks. Outcomes were the tinnitus handicap inventory (THI) score and the loud and uncomfortable visual analogue scales (VAS). Demographic and clinical characteristics of all participants were compared between the groups upon admission using one-way analysis of variance (ANOVA). One-way ANOVA was used to evaluate the THI, VAS loud, and VAS uncomfortable scores. The least significant difference test was used as a post-hoc test.

RESULTS
Thirty-nine subjects were eligible and their data were analyzed. No difference in THI and VAS loudness scores was observed in between groups. The VAS uncomfortable scores decreased significantly in MA and DE compared with those in PE. Within the group, all three treatments showed some effect on THI, VAS loudness scores and VAS uncomfortable scores after treatment except DE in THI.

CONCLUSION
There was no statistically significant difference between systemic manual acupuncture, periauricular electroacupuncture and distal electroacupuncture in tinnitus. However, all three treatments had some effect on tinnitus within the group before and after treatment. Systemic manual acupuncture and distal electroacupuncture have some effect on VAS.

TRIAL REGISTRATION
KCT0001991 by CRIS (Clinical Research Information Service), 2016-8-1, retrospectively registered.


Importance: Individuals with tinnitus have poorer working memory, slower processing speeds and reaction times, and deficiencies in selective attention, all of which interfere with readiness and performance. Brain Fitness Program-Tinnitus (BFP-T) is a cognitive training program specially designed to exploit neuroplasticity for preservation and expansion of cognitive health in adults with tinnitus.

Objective: To evaluate the effect of the BFP-T on tinnitus.

Design, Setting, and Participants: This open-label, intention-to-treat randomized clinical trial prescreened 191 patients with tinnitus and 64 healthy controls (HCs) from June 1, 2012, through October 31, 2013. Participants were 40 adults with bothersome tinnitus for more than 6 months and 20 age-matched HCs. Patients with tinnitus were randomized to a BFP-T or non-BFP-T control group. The BFP-T was completed online, and assessments were completed at Washington University School of Medicine.

Interventions: Participants in the intervention group were required to complete the BFP-T online 1 hour per day 5 days per week for 8 weeks. Tinnitus assessment, neuroimaging, and cognitive testing were completed at baseline and 8 weeks later. The HCs underwent neuroimaging and cognitive assessments.

Main Outcomes and Measures: The primary outcome measure was the
change in Tinnitus Handicap Inventory (THI) score. Behavioral measures, neuroimaging, and cognitive tests were performed before and after the intervention. Results: A total of 40 patients with tinnitus and 20 HCs participated in the study (median [range] age, 56 [35-64] years in the BFP-T group, 52 [24-64] years in the non-BFP-T group, and 50 [30-64] years in the HC group; 13 [65%] in the BFP-T group, 14 [70%] in the non-BFP-T group, and 13 [65%] in the HC group were males; and 16 [80%] in the BFP-T group, 16 [80%] in the non-BFP-T group, and 15 [75%] in the HC group were white). There was a reduction in the THI score in the BFP-T group (median, 7; range, -16 to 64) and non-BFP-T group (median, 11; range, -6 to 26), but this reduction was not significantly different between the 2 groups (median difference, 0; 95% CI, -10 to 8). There was no difference in cognitive test scores and other behavioral measures. There was a significant difference between baseline and follow-up in functional connectivity in cognitive control regions in the BFP-T group but not in HCs or individuals with untreated tinnitus. Of the 20 patients in the BFP-T group, 10 (50%) self-reported improvement attributable to the intervention, and 6 (30%) reported to be much improved in the domains of tinnitus, memory, attention, and concentration. Conclusions and Relevance: These findings suggest that the computer-based cognitive training program is associated with self-reported changes in attention, memory, and perception of tinnitus. A possible mechanistic explanation for these changes could be neuroplastic changes in key brain systems involved in cognitive control. Cognitive training programs might have a role in the future treatment of patients with tinnitus. Trial Registration: clinicaltrials.gov Identifier: NCT01458821.

75. Henry JA, Thielman EJ, Zaugg TL, et al. Randomized Controlled Trial in Clinical Settings to Evaluate Effectiveness of Coping Skills Education Used With Progressive Tinnitus Management. *Journal of speech, language, and hearing research : JSLHR* 2017;60(5):1378-97. Purpose This randomized controlled trial evaluated, within clinical settings, the effectiveness of coping skills education that is provided with progressive tinnitus management (PTM). Method At 2 Veterans Affairs medical centers, N = 300 veterans were randomized to either PTM intervention or 6-month wait-list control. The PTM intervention involved 5 group workshops: 2 led by an audiologist (teaching how to use sound as therapy) and 3 by a psychologist (teaching coping skills derived from cognitive behavioral therapy). It was hypothesized that PTM would be more effective than wait-list control in reducing functional effects of tinnitus and that there would be no differences in effectiveness between sites. Results At both sites, a statistically significant improvement in mean Tinnitus Functional Index scores was seen at 6 months for the PTM group. Combined data across sites revealed a statistically significant improvement in Tinnitus Functional Index relative to wait-list control. The effect size for PTM using the Tinnitus Functional Index was 0.36 (small). Conclusions Results suggest that PTM is effective at reducing tinnitus-related functional distress in clinical settings. Although effect sizes were small, they provide evidence of clinical effectiveness of PTM in the absence of stringent research-related inclusion criteria and with a relatively small number of sessions of cognitive behavioral therapy.

76. Henry JA, McMillan G, Dann S, et al. Tinnitus Management: Randomized Controlled Trial Comparing Extended-Wear Hearing Aids, Conventional Hearing Aids, and Combination Instruments. *Journal of the American Academy of Audiology* 2017;28(6):546-61. Background Whereas hearing aids have long been considered effective for providing relief from tinnitus, controlled clinical studies evaluating this premise have been very limited. Purpose The purpose of this study was to systematically determine the relative efficacy of conventional receiver-in-the-canal hearing aids (HA), the same hearing aids with a sound generator (HA+SG), and
extended-wear, deep fit hearing aids (EWHA), to provide relief from tinnitus through a randomized controlled trial. Each of these ear-level devices was a product of Phonak, LLC.

**RESEARCH DESIGN** Participants were randomized to HA, HA+SG, or EWHA and wore bilaterally fit devices for about 4 months. Fittings, adjustments, and follow-up appointments were conducted to comply with company guidelines and to ensure that all participants attended appointments on the same schedule. At 4-5 months, participants returned to complete final outcome measures, which concluded their study participation.

**STUDY SAMPLE** Participants were 55 individuals (mean age: 63.1 years) with mild to moderately-severe hearing loss who: (a) did not currently use hearing aids; (b) reported tinnitus that was sufficiently bothersome to warrant intervention; and (c) were suitable candidates for each of the study devices.

**DATA COLLECTION AND ANALYSIS** The primary outcome measure was the Tinnitus Functional Index (TFI). Secondary outcome measures included hearing-specific questionnaires and the Quick Speech in Noise test (QuickSIN). The goal of the analysis was to evaluate efficacy of the EWHA and HA+SG devices versus the HA standard device.

**RESULTS** There were 18 participants in each of the HA and EWHA groups and 19 in the HA+SG group. Gender, age, and baseline TFI severity were balanced across treatment groups. Nearly all participants had a reduction in tinnitus symptoms during the study. The average TFI change (improvement) from baseline was 21 points in the HA group, 31 points in the EWHA group, and 33 points in the HA+SG group. A “clinically significant” improvement in reaction to tinnitus (at least 13-point reduction in TFI score) was seen by 67% of HA, 82% of EWHA, and 79% of HA+SG participants. There were no statistically significant differences in the extent to which the devices reduced TFI scores. Likewise, the hearing-specific questionnaires and QuickSIN showed improvements following use of the hearing aids but these improvements did not differ across device groups.

**CONCLUSION** There is insufficient evidence to conclude that any of these devices offers greater relief from tinnitus than any other one tested. However, all devices appear to offer some improvement in the functional effects of tinnitus.


**Purpose** Loudness is a major auditory dimension of tinnitus and is used to diagnose severity, counsel patients, or as a measure of clinical efficacy in audiological research. There is no standard test for tinnitus loudness, but matching and rating methods are popular. This article provides important new knowledge about the reliability and validity of an audiologist-administered tinnitus loudness matching test and a patient-reported tinnitus loudness rating.

**Method** Retrospective analysis of loudness data for 91 participants with stable subjective tinnitus enrolled in a randomized controlled trial of a novel drug for tinnitus. There were two baseline assessments (screening, Day 1) and a posttreatment assessment (Day 28).

**Results** About 66%-70% of the variability from screening to Day 1 was attributable to the true score. But measurement error, indicated by the smallest detectable change, was high for both tinnitus loudness matching (20 dB) and tinnitus loudness rating (3.5 units). Only loudness rating captured a sensation that was meaningful to people who lived with the experience of tinnitus.

**Conclusions** The tinnitus loudness rating performed better against acceptability criteria for reliability and validity than did the tinnitus loudness matching test administered by an audiologist. But the rating question is still limited because it is a single-item instrument and is probably able to detect only large changes (at least 3.5 points).

Objectives: A randomized cross-over trial in 18 participants tested the hypothesis that nature sounds, with unpredictable temporal characteristics and high valence would yield greater improvement in tinnitus than constant, emotionally neutral broadband noise. Study Design: The primary outcome measure was the Tinnitus Functional Index (TFI). Secondary measures were: loudness and annoyance ratings, loudness level matches, minimum masking levels, positive and negative emotionality, attention reaction and discrimination time, anxiety, depression and stress. Each sound was administered using MP3 players with earbuds for 8 continuous weeks, with a 3 week wash-out period before crossing over to the other treatment sound. Measurements were undertaken for each arm at sound fitting, 4 and 8 weeks after administration. Qualitative interviews were conducted at each of these appointments.

Result(s): From a baseline TFI score of 41.3, sound therapy resulted in TFI scores at 8 weeks of 35.6; broadband noise resulted in significantly greater reduction (8.2 points) after 8 weeks of sound therapy use than nature sounds (3.2 points). The positive effect of sound on tinnitus was supported by secondary outcome measures of tinnitus, emotion, attention, and psychological state, but not interviews. Tinnitus loudness level match was higher for BBN at 8 weeks; while there was little change in loudness level matches for nature sounds. There was no change in minimum masking levels following sound therapy administration. Self-reported preference for one sound over another did not correlate with changes in tinnitus. Conclusion(s): Modeled under an adaptation level theory framework of tinnitus perception, the results indicate that the introduction of broadband noise shifts internal adaptation level weighting away from the tinnitus signal, reducing tinnitus magnitude. Nature sounds may modify the affective components of tinnitus via a secondary, residual pathway, but this appears to be less important for sound effectiveness. The different rates of adaptation to broadband noise and nature sound by the auditory system may explain the different tinnitus loudness level matches. In addition to group effects there also appears to be a great deal of individual variation. A sound therapy framework based on adaptation level theory is proposed that accounts for individual variation in preference and response to sound. Copyright © 2017 Durai and Searchfield.


**INTRODUCTION** Tinnitus is the perception of sound in the absence of a corresponding external acoustic stimulus. Bimodal neuromodulation is emerging as a promising treatment for this condition. The main objectives of this study are to investigate the relevance of interstimulus timing and the choices of acoustic and tongue stimuli for a proprietary bimodal (auditory and somatosensory) neuromodulation device, as well as to explore whether specific subtypes of patients are differentially responsive to this novel intervention for reducing the symptoms of chronic tinnitus.

**METHODS AND ANALYSIS** This is a two-site, randomised, triple-blind, exploratory study of a proprietary neuromodulation device with a pre-post and 12-month follow-up design. Three different bimodal stimulation parameter sets will be examined. The study will enrol 342 patients, split 80:20 between two sites (Dublin, Ireland and Regensburg, Germany), to complete 12 weeks of treatment with the device. Patients will be allocated to one of three arms using a stepwise stratification according to four binary categories: tinnitus tonality, sound level tolerance (using loudness discomfort level of <60 dB SL as an indicator for hyperacusis), hearing thresholds and...
presence of a noise-induced audiometric profile. The main indicators of relative clinical efficacy for the three different parameter sets are two patient-reported outcomes measures, the Tinnitus Handicap Inventory and the Tinnitus Functional Index, after 12 weeks of intervention. Clinical efficacy will be further explored in a series of patient subtypes, split by the stratification variables and by presence of a somatic tinnitus. Evidence for sustained effects on the psychological and functional impact of tinnitus will be followed up for 12 months. Safety data will be collected and reported. A number of feasibility measures to inform future trial design include: reasons for exclusion, completeness of data collection, attrition rates, patient’s adherence to the device usage as per manufacturer's instructions and evaluation of alternative methods for estimating tinnitus impact and tinnitus loudness.ETHICS AND DISSEMINATIONThis study protocol is approved by the Tallaght Hospital/St. James’s Hospital Joint Research Ethics Committee in Dublin, Ireland, and by the Ethics Committee of the University Clinic Regensburg, Germany. Findings will be disseminated to relevant research, clinical, health service and patient communities through publications in peer-reviewed and popular science journals and presentations at scientific and clinical conferences.TRIAL REGISTRATION NUMBERThe trial is registered on ClinicalTrials.gov (NCT02669069) Pre-results.

80. Cai Y, Zhou Q, Yang H, et al. Logistic regression analysis of factors influencing the effectiveness of intensive sound masking therapy in patients with tinnitus. BMJ open 2017;7(11):e018050.OBJECTIVESTo investigate factors influencing the effectiveness of intensive sound masking therapy on tinnitus using logistic regression analysis.DESIGNThe study used a retrospective cross-section analysis.PARTICIPANTS102 patients with tinnitus were recruited at the Sun Yat-sen Memorial Hospital of Sun Yat-sen University, China.INTERVENTIONIntensive sound masking therapy was used as an intervention approach for patients with tinnitus.PRIMARY AND SECONDARY OUTCOME MEASURESParticipants underwent audiological investigations and tinnitus pitch and loudness matching measurements, followed by intensive sound masking therapy. The Tinnitus Handicap Inventory (THI) was used as the outcome measure pre and post treatment. Multivariate logistic regression was performed to investigate the association of demographic and audiological factors with effective therapy.RESULTSAccording to the THI score changes pre and post sound masking intervention, 51 participants were categorised into an effective group, the remaining 51 participants were placed in a non-effective group. Those in the effective group were significantly younger than those in the non-effective group (P=0.012). Significantly more participants had flat audiogram configurations in the effective group (P=0.04). Multivariable logistic regression analysis showed that age (OR=0.96, 95% CI 0.93 to 0.99, P=0.007), audiometric configuration (P=0.027) and THI score pre treatment (OR=1.04, 95% CI 1.02 to 1.07, P<0.001) were significantly associated with therapeutic effectiveness. Further analysis showed that patients with flat audiometric configurations were 5.45 times more likely to respond to intervention than those with high-frequency steeply sloping audiograms (OR=5.45, 95% CI 1.67 to 17.86, P=0.005).CONCLUSIONAudometric configuration, age and THI scores appear to be predictive of the effectiveness of sound masking treatment. Gender, tinnitus characteristics and hearing threshold measures do not seem to be related to treatment effectiveness. A further randomised control study is needed to provide evidence of the effectiveness of prognostic factors in tinnitus interventions.

therapy of electroacupuncture and systemic manual acupuncture, so it was uncertain which treatment was effective. This study evaluated and compared the effects of systemic manual acupuncture, periauricular electroacupuncture and distal electroacupuncture for treating patients with tinnitus. Methods: A randomized, parallel, open-labeled exploratory trial was conducted. Subjects aged 20-75 years who had suffered from idiopathic tinnitus for > 2 weeks were recruited from May 2013 to April 2014. The subjects were divided into three groups by systemic manual acupuncture group (MA), periauricular electroacupuncture group (PE), and distal electroacupuncture group (DE). The groups were selected by random drawing. Nine acupoints (TE 17, TE21, SI19, GB2, GB8, ST36, ST37, TE3 and TE9), two periauricular acupoints (TE17 and TE21), and four distal acupoints (TE3, TE9, ST36, and ST37) were selected. The treatment sessions were performed twice weekly for a total of eight sessions over 4 weeks. Outcomes were the tinnitus handicap inventory (THI) score and the loud and uncomfortable visual analogue scales (VAS). Demographic and clinical characteristics of all participants were compared between the groups upon admission using one-way analysis of variance (ANOVA). One-way ANOVA was used to evaluate the THI, VASloud, and VASuncomfortable scores. The least significant difference test was used as a post-hoc test. Results: Thirty-nine subjects were eligible and their data were analyzed. No difference in THI and VASloudness scores was observed in between groups. The VAS uncomfortable scores decreased significantly in MA and DE compared with those in PE. Within the group, all three treatments showed some effect on THI, VAS loudness scores and VASuncomfortable scores after treatment except DE in THI. Conclusions: There was no statistically significant difference between systemic manual acupuncture, periauricular electroacupuncture and distal electroacupuncture in tinnitus. However, all three treatments had some effect on tinnitus within the group before and after treatment. Systemic manual acupuncture and distal electroacupuncture have some effect on VAS.

Trial registration: KCT0001991 by CRIS (Clinical Research Information Service), 2016-8-1, retrospectively registered.

82. Beukes EW, Baguley DM, Allen PM, et al. Guided Internet-based versus face-to-face clinical care in the management of tinnitus: study protocol for a multi-centre randomised controlled trial. Trials 2017;18:1-11. Background: Innovative strategies are required to improve access to evidence-based tinnitus interventions. A guided Internet-based cognitive behavioural therapy (iCBT) intervention for tinnitus was therefore developed for a U.K. Population: Initial clinical trials indicated efficacy of iCBT at reducing tinnitus severity and associated comorbidities such as insomnia and depression. The aim of this phase III randomised controlled trial is to compare this new iCBT intervention with an established intervention, namely face-to-face clinical care for tinnitus. Methods/design: This will be a multi-centre study undertaken across three hospitals in the East of England. The design is a randomised, two-arm, parallel-group, non-inferiority trial with a 2-month follow-up. The experimental group will receive the guided iCBT intervention, whereas the active control group will receive the usual face-to-face clinical care. An independent researcher will randomly assign participants, using a computer-generated randomisation schedule, after stratification for tinnitus severity. There will be 46 participants in each group. The primary assessment measure will be the Tinnitus Functional Index. Data analysis will establish whether non-inferiority is achieved using a pre-defined non-inferiority margin. Discussion: This protocol outlines phase III of a clinical trial comparing a new iCBT with established face-to-face care for tinnitus. If guided iCBT for tinnitus proves to be as effective as the usual tinnitus care, it may be a viable additional management route for individuals with tinnitus. This could increase access to evidence-
based effective tinnitus care and reduce the pressures on existing health care systems. Trial Registration: ClinicalTrials.gov identifier: NCT02665975. Registered on 22 January 2016.

83. Beukes EW, Baguley DM, Allen PM, et al. Audiologist-Guided Internet-Based Cognitive Behavior Therapy for Adults With Tinnitus in the United Kingdom: A Randomized Controlled Trial. *Ear and hearing* 2017;39(3):423-33. OBJECTIVES Specialist tinnitus services are in high demand as a result of the negative effect tinnitus may have on quality of life. Additional clinically and cost-effective tinnitus management routes are needed. One potential route is providing Cognitive Behavioural Therapy for tinnitus via the Internet (iCBT). This study aimed to determine the efficacy of guided iCBT, using audiological support, on tinnitus distress and tinnitus-related comorbidities, in the United Kingdom. A further aim was to establish the stability of intervention effects 2-months postintervention. The hypothesis was that iCBT for tinnitus would be more effective at reducing tinnitus distress than weekly monitoring. DESIGN A randomized, delayed intervention efficacy trial, with a 2-month follow-up was implemented to evaluate the efficacy of iCBT in the United Kingdom. Participants were randomly assigned to the experimental (n = 73) or weekly monitoring control group (n = 73) after being stratified for tinnitus severity and age. After the experimental group completed the 8-week long iCBT intervention, the control group undertook the same intervention. Intervention effects were, therefore, evaluated in two independent groups at two time points. The primary outcome was a change in tinnitus distress between the groups as assessed by the Tinnitus Functional Index. Secondary assessment measures were included for insomnia, anxiety, depression, hearing disability, hyperacusis, cognitive failures, and satisfaction with life. These were completed at baseline, postintervention, and at a 2-month postintervention follow-up. RESULTS After undertaking the iCBT intervention, the experimental group had a greater reduction in tinnitus distress when compared with the control group. This reduction was statistically significant (Cohen's d = 0.7) and was clinically significant for 51% of the experimental group and 5% of the control group. This reduction was evident 4 weeks after commencing the iCBT intervention. Furthermore, the experimental group had a greater reduction in insomnia, depression, hyperacusis, cognitive failures, and a greater improvement in quality of life, as evidenced by the significant differences in these assessment measures postintervention. Results were maintained 2 months postintervention. CONCLUSIONS Guided (using audiological support) iCBT for tinnitus resulted in statistically significant reductions in tinnitus distress and comorbidities (insomnia, depression, hyperacusis, cognitive failures) and a significant increase in quality of life. These effects remained stable at 2-months postintervention. Further trials to determine the longer term efficacy of iCBT to investigate predictors of outcome and to compare iCBT with standard clinical care in the United Kingdom are required. Registered at clinicaltrials.gov: NCT02370810 on 5/03/2015.

84. Beukes EW, Allen PM, Manchaiah V, et al. Internet-Based Intervention for Tinnitus: Outcome of a Single-Group Open Trial. *Journal of the American Academy of Audiology* 2017;28(4):340-51. BACKGROUND Managing chronic tinnitus is challenging, and innovative ways to address the resulting health-care burden are required. Internet-based cognitive behavioral therapy (iCBT) for tinnitus shows promise as a cost-effective treatment option. The feasibility and effectiveness of iCBT in the United Kingdom are yet to be explored. Furthermore, it is not known if iCBT can be supported by an audiologist rather than a psychologist. PURPOSE This study aimed to determine the feasibility of guided iCBT using audiological support on tinnitus distress and tinnitus-related comorbidities. Furthermore, it aimed to establish the feasibility of iCBT for tinnitus distress in the United Kingdom, by determining recruitment, attrition, and compliance rates. Finally, it aimed to identify which
aspects of the protocol require refinement for subsequent clinical trials. RESEARCH DESIGN A single-group open trial design was implemented. This study would serve as a prerequisite study, to identify barriers, before undertaking effectiveness trials. STUDY SAMPLE Participants consisted of 37 adults (18 males, 19 females), with an age range of between 50 and 59 yr. The mean preintervention tinnitus severity rating was 56.15 (standard deviation = 18.35), which is categorized as "severe tinnitus" as measured by the Tinnitus Functional Index (TFI). Five participants withdrew during the study, and 29 of the remaining participants completed the postintervention questionnaire. INTERVENTION The guided iCBT intervention ran over an eight-week period and consisted of 16 obligatory modules and five optional modules. The intervention was designed to be interactive, interesting, and stimulating. A key element was the provision of support from an audiologist throughout the program. DATA COLLECTION AND ANALYSIS Online questionnaires were used throughout the study. These were administered at baseline and postintervention to determine attrition and compliance rates and to facilitate sample size estimates for further clinical trials. Outcome measures for tinnitus severity, hearing handicap, insomnia, cognitive functioning, hyperacusis, anxiety, depression, and life satisfaction were used to investigate the effects of iCBT with audiological support. In addition, a weekly questionnaire was incorporated to monitor change in tinnitus distress while undertaking the intervention. RESULTS Feasibility was established using an audiologist to support this guided iCBT intervention, as a significant change postintervention was found for tinnitus severity, as measured by the TFI and the Tinnitus Handicap Inventory, Screening version. The attrition rate was 22% and compliance was variable. Although these results were based on a small sample, they provide encouraging evidence for the feasibility of delivering iCBT treatment for tinnitus symptoms with audiology support in the United Kingdom. CONCLUSIONS An Internet-based intervention of tinnitus appears to be feasible in the United Kingdom when using audiological support. Randomized controlled trials to further investigate the effectiveness of iCBT for tinnitus in the United Kingdom are required.

85. Bauer CA, Berry JL, Brozoski TJ. The effect of tinnitus retraining therapy on chronic tinnitus: A controlled trial. Laryngoscope Investigative Otolaryngology 2017;2(4):166-77. Objectives: The goal of this study was to compare treatment outcomes for chronic bothersome tinnitus after Tinnitus Retraining Therapy (TRT) versus standard of care treatment (SC) and to determine the longevity of the effect over an 18-month period. Study Design: A randomized controlled trial comparing TRT to SC for chronic tinnitus. Method(s): Adults with subjective, stable, bothersome chronic tinnitus associated with hearing loss amenable to aural rehabilitation with hearing aids were recruited. The Tinnitus Handicap Inventory (THI) was the primary outcome measure and the Tinnitus Functional Index (TFI) the secondary outcome measure of tinnitus severity and impact. Data were collected at screening, entry (0 months), and 6, 12, and 18 months after the beginning of treatment, using an integrated digitized suite of evaluation modules. TRT consisted of directive counseling and acoustic enrichment using combination hearing aids and sound generators; SC consisted of general aural rehabilitation counseling and hearing aids. Result(s): Significant improvement in tinnitus impact occurred after both TRT and SC therapy, with a larger treatment effect obtained in the TRT group. Lasting therapeutic benefit was evident at 18 months in both groups. THI initial scores were unstable in 10% of enrolled participants, showing moderate bidirectional fluctuation between screening and baseline (0 month) assessment. Conclusion(s): Adults with moderate to severe tinnitus and hearing loss amenable to amplification, benefit from either TRT or SC treatment when combined with hearing aid use. TRT benefit may exceed that of SC. The global improvement in tinnitus severity that
accrued over an 18-month period appeared to be robust and clinically significant. Level of Evidence: I. Copyright © 2017 Authors Laryngoscope Investigative Otolaryngology published by Wiley Periodicals, Inc. on behalf of The Triological Society.

86. Arif M, Sadlier M, Rajendrkumar D, et al. A randomised controlled study of mindfulness meditation versus relaxation therapy in the management of tinnitus. The Journal of laryngology and otology 2017;131(6):501-07. OBJECTIVE Psychotherapeutic interventions have been adopted effectively in the management of tinnitus for a long time. This study compared mindfulness meditation and relaxation therapy for management of tinnitus. METHODS In this randomised controlled trial, patients were recruited for five sessions of mindfulness meditation or five sessions of relaxation therapy. Patients’ responses were evaluated using the Tinnitus Reaction Questionnaire as a primary outcome measure, and the Hospital Anxiety and Depression Scale, visual analogue scale and a health status indicator as secondary outcome measures. RESULTS A total of 86 patients were recruited. Thirty-four patients completed mindfulness meditation and 27 patients completed relaxation therapy. Statistically significant improvement was seen in all outcome measures except the health status indicator in both treatment groups. The change in treatment scores was greater in the mindfulness meditation group than in the relaxation therapy group. CONCLUSION This study suggests that although both mindfulness meditation and relaxation therapy are effective in the management of tinnitus, mindfulness meditation is superior to relaxation therapy.

87. Ahnblad P, Nordkvist A. A Randomized, Placebo-Controlled, Double-Blind, Parallel Groups Study Evaluating the Performance and Safety of a Steady State Coherent Biomodulator Patch in the Treatment of Subjective Tinnitus. The international tinnitus journal 2017;21(2):157-67. OBJECTIVE The objectives of this study were to evaluate the performance and safety of an innovative passive light photon driven microscopic biomodulator patch as an alternative medical device for tinnitus relief. MATERIALS AND METHODSEighty-two (82) patients were randomized to receive either an active (biomodulator) patch or a placebo patch, for a 3-week treatment period. Patch performance (evaluated with questionnaires related to tinnitus and quality-of-life) and safety were assessed after 3 weeks of treatment (Week 3) and at a follow-up visit 4-weeks after end of treatment (Week 7). RESULTS The biomodulator patch was safe and well-tolerated and was efficacious, with significant difference (p < 0.05) between the groups at Week 7; active patch had 30% responders compared to 10% for placebo, measured as a decrease from baseline in at least 2 points in tinnitus annoyance visual analogue scale (VAS, 0-10). Tinnitus handicap inventory (THI, 0-100) improved by mean -16 points significantly (p = 0.0005) for the active responder group, but with no statistically significant changes for the placebo group or between the groups. Well-being questionnaire also improved for the active responder group, but not statistically significant. The placebo responder group did not improve in well-being. Other tinnitus related symptoms did not show significant changes. There was no statistically significant difference in performance between the active (biomodulator) and placebo groups directly at the end of treatment (Week 3). CONCLUSION In a cost-risk-benefit rationale according to this study it can be reasonable to recommend the biomodulator patch for treatment of tinnitus. Improvements were shown at Week 7 (4 weeks after the end of treatment period).

motivational interviewing (MI) program as an adjunct to hearing aid rehabilitation for patients with tinnitus and sensorineural hearing loss. Research Design: This was a pilot randomized controlled trial. Study Sample: The sample consisted of 50 patients aged between 40 and 82 yr with both tinnitus and sensorineural hearing loss and a pure-tone average (0.5, 1, 2, and 4 kHz) < 70 dB HL. All patients were first-time hearing aid users. Intervention: A brief MI program was used during hearing aid fitting in 25 patients, whereas the remainder received standard practice (SP), with conventional hearing rehabilitation. Data Collection and Analysis: A total of 46 patients (N = 23 + 23) with tinnitus were included for further analysis. The Tinnitus Handicap Inventory (THI) and the International Outcome Inventory for Hearing Aids (IOI-HA) were administered before and after rehabilitation. THI was used to investigate changes in tinnitus annoyance, and the IOI-HA was used to determine the effect of hearing aid treatment. Results: Self-reported tinnitus disability (THI) decreased significantly in the MI group (p< 0.001) and in the SP group (p < 0.006). However, there was greater improvement in the MI group (p < 0.013). Furthermore, the findings showed a significant improvement in patients' satisfaction concerning the hearing aids (IOI-HA, within both groups; MI group, p < 0.038; and SP group, p < 0.026), with no difference between the groups (p < 0.99). Conclusion: Tinnitus handicap scores decrease to a greater extent following brief MI than following SP. Future research on the value of incorporating MI into audiological rehabilitation using randomized controlled designs is required.

89. Wise K, Ma E. Clinical Presentation of Tinnitus and a Review of, and Evidence Base for, Tinnitus Applications. Perspectives of the ASHA Special Interest Groups 2016;1(7):43-56. A lack of evidence base presently exists, to validate the efficacy of mobile technology applications (apps) for tinnitus—highlighting a need for research. We reviewed tinnitus apps available via two popular smartphone operating systems: the Apple iOS and Google Android platforms. A March (2016) search using platforms available in the Austral-Asia region yielded over 260 tinnitus-related apps. Search parameters required apps to employ an English language format and feature the keyword "tinnitus" in the app name or description. Those apps retained for consideration (257) enabled 4 primary themes to emerge, featuring apps offering: (1) sound therapy approaches, (2) information, tips or assessment, (3) health promotion or alternative approaches, and (4) miscellaneous, nontherapeutic apps. Themes enabled further organization of related app characteristics into sub-groups. Numerous apps (44.3%) presented sound menus, ordered into a virtual library of presumably beneficial listening options. To place tinnitus apps in the context of current therapeutic considerations, an overview of the clinical presentation of tinnitus, and approaches aimed at mediating the perception of tinnitus and affective responses, precedes the review. We suggest future research addresses: the relative benefit(s) of one app over another, efficacy of tinnitus apps as a therapeutic option, long-term outcomes, and generalizability across populations.

90. Weise C, Kleinstäuber M, Andersson G. Internet-Delivered Cognitive-Behavior Therapy for Tinnitus: A Randomized Controlled Trial. Psychosomatic medicine 2016;78(4):501-10. OBJECTIVES Tinnitus has a substantially negative impact on quality of life in up to 5% of the general population. Internet-based cognitive-behavioral treatment (iCBT) has been shown to be effective in a few trials. The aim of our study was to investigate iCBT for tinnitus by using a randomized controlled trial. METHODS Patients with severe tinnitus-related distress were randomly assigned to therapist-guided iCBT (n = 62) or to a moderated online discussion forum (n = 62). Standardized self-report measures for tinnitus-related distress (Tinnitus Handicap Inventory, Mini-Tinnitus Questionnaire) and associated symptoms (tinnitus acceptance, anxiety, depression, and
insomnia) were assessed at pretreatment and posttreatment, 6-month-, and 1-year follow-up. Clinical significance was assessed with the Reliable Change Index.

RESULTS Multivariate analyses of variance revealed significant main effects for time, group, and interaction in favor of the iCBT group. With regard to tinnitus-related distress, the significant univariate interaction effects (time by group) were supported by large effect sizes (Tinnitus Handicap Inventory: $g = 0.83$, 95% confidence interval = 0.47-1.20; Mini-Tinnitus Questionnaire: $g = 1.08$, 95% confidence interval = 0.71-1.64). For the secondary outcomes, significant interactions with small to medium effect sizes were found. Within-group effects for the iCBT, from pretreatment to follow-up, were substantial in regard to tinnitus-related distress ($1.38 \leq d \leq 1.81$) and small to large for secondary outcomes ($0.39 \leq d \leq 1.04$).

CONCLUSIONS Using a randomized controlled trial design, we replicated prior findings regarding positive effects of Internet-delivered CBT on tinnitus-related distress and associated symptoms. Implementing iCBT for tinnitus into regular health care will be an important next step to increase access to treatment for patients with tinnitus. TRIAL REGISTRATION ClinicalTrials.gov, Identifier: NCT01205919.

91. Tegg-Quinn S, Bennett RJ, Eikelboom RH, et al. The impact of tinnitus upon cognition in adults: A systematic review. International Journal of Audiology 2016;55(10):533-40. Objective: To systematically review and analyze experimental outcomes of studies exploring the impact of tinnitus upon cognitive function and their implications for clinical management of invasive tinnitus. Design: A systematic and descriptive review. Study sample: Eighteen studies were identified investigating the impact of tinnitus on cognitive function. Results: The 18 studies evaluated cognitive function using 24 different objective behavioural tests, nine electrophysiological recordings, one oculomotor test, and one self-report questionnaire. The studies spanned 18 years and revealed numerous interactions potentially contributing to the cognitive difficulties frequently reported by people with invasive tinnitus. The studies indicate a clear association between tinnitus and aspects of cognitive function, specifically the executive control of attention. Conclusions: Tinnitus impairs cognitive function by way of impact upon executive control of attention. Clinical management of patients reporting tinnitus and cognitive difficulties requires an understanding of the reciprocal relationship between tinnitus and cognitive function, with additive effects of anxiety, depression, and somatic cognitive bias. Further study is required to establish the impact of advancing age, hearing loss, anxiety, depression tinnitus duration, and distress upon cognitive function in people with invasive tinnitus.

92. Stein A, Wunderlich R, Lau P, et al. Clinical trial on tonal tinnitus with tailor-made notched music training. BMC neurology 2016;16:1-17. Background: Tinnitus is a result of hyper-activity/hyper-synchrony of auditory neurons coding the tinnitus frequency, which has developed due to synchronous mass activity owing to the lack of inhibition. We assume that removal of exactly these frequencies from a complex auditory stimulus will cause the brain to reorganize around tonotopic regions coding the tinnitus frequency through inhibition-induced plasticity. Based on this assumption, a novel treatment for tonal tinnitus--tailor-made notched music training (TMNMT)--has been introduced and was tested in this clinical trial. Methods: A randomized controlled trial in parallel group design was performed in a double-blinded manner. We included 100 participants with chronic, tonal tinnitus who listened to tailor-made notched music for two hours a day for three consecutive months. Our primary outcome measures were the Tinnitus Handicap Questionnaire and Visual Analog Scales measuring perceived tinnitus loudness, awareness, distress and handicap. Participants rated their tinnitus before and after the training as well as one month after cessation of the training. Results: While no effect was found for the primary outcome measures, tinnitus distress,
as measured by the Tinnitus Questionnaire, a secondary outcome measure, developed differently in the two groups. The treatment group showed higher distress scores while the placebo group revealed lower distress scores after the training. However, this effect did not reach significance in post-hoc analysis and disappeared at follow-up measurements. At follow-up, tinnitus loudness in the treatment group was significantly reduced as compared to the control group. Post-hoc analysis, accounting for low reliability scores in the Visual Analog Scales, showed a significant reduction of the overall Visual Analog Scale mean score in the treatment group even at the post measurement. Conclusion: This is the first study on TMNMT that was planned and conducted following the CONSORT statement standards for clinical trials. The current work is one more step towards a final evaluation of TMNMT. Already after three months the effect of training with tailor-made notched music is observable in the most direct rating of tinnitus perception - the tinnitus loudness, while more global measures of tinnitus distress do not show relevant changes. Trial Registration: Current Controlled Trials ISRCTN04840953; Trial registration date: 17.07.2013.

93. Stark D, Rosenberg AR, Johnston D, et al. Patient-Reported Measures of Hearing Loss and Tinnitus in Pediatric Cancer and Hematopoietic Stem Cell Transplantation: A Systematic Review. Journal of speech, language, and hearing research : JSLHR 2016;59(5):1247-52. Purpose: We identified studies that described use of any patient-reported outcome scale for hearing loss or tinnitus among children and adolescents and young adults (AYAs) with cancer or hematopoietic stem cell transplantation (HSCT) recipients. Method: In this systematic review, we performed electronic searches of OvidSP MEDLINE, EMBASE, and PsycINFO to August 2015. We included studies if they used any patient-reported scale of hearing loss or tinnitus among children and AYAs with cancer or HSCT recipients. Only English language publications were included. Two reviewers identified studies and abstracted data. Results: There were 953 studies screened; 6 met eligibility criteria. All studies administered hearing patient-reported outcomes only once, after therapy completion. None of the studies described the psychometric properties of the hearing-specific component. Three instruments (among 6 studies) were used: Health Utilities Index (Barr et al., 2000; Fu et al., 2006; Kennedy et al., 2014), Hearing Measurement Scales (Einar-Jon et al., 2011; Einarsson et al., 2011), and the Tinnitus Questionnaire for Auditory Brainstem Implant (Soussi & Otto, 1994). All had limitations, precluding routine use for hearing assessment in this population. Conclusions: We identified few studies that included hearing patient-reported measures for children and AYA cancer and HSCT patients. None are ideal to take forward into future studies. Future work should focus on the creation of a new psychometrically sound instrument for hearing outcomes in this population.

94. Soleimani R, Jalali MM, Hasandokht T. Therapeutic impact of repetitive transcranial magnetic stimulation (rTMS) on tinnitus: a systematic review and meta-analysis. European archives of otorhinolaryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery 2016;273(7):1663-75. In this study, we conducted a systematic literature review and meta-analysis on the effect of repetitive transcranial magnetic stimulation (rTMS) compared with sham in chronic tinnitus patients. We searched databases, from their onset up to August 2014, for randomized controlled trials (RCT) in English that assessed the effectiveness of rTMS for chronic tinnitus. RCTs were selected according to inclusion/exclusion criteria before data were extracted. For the meta-analysis weighted mean differences (and standard deviations) of Tinnitus Questionnaire (TQ) and Tinnitus Handicap Inventory (THI) scores were determined. Therapeutic success was defined as difference of at least 7 points in the THI score between baseline and the follow-up
assessment after treatment. The odds ratio (OR) for this variable was assessed. Results from 15 RCTs were analyzed. The mean difference for TQ score at 1 week after intervention was 3.42. For THI, the data of mean difference score in two groups, 1 and 6 month after intervention, was 6.71 and 12.89, respectively. The all comparisons indicated a significant medium to large effect size in follow-up which is in favor of the rTMS. The pooled OR of therapeutic success of the studies which used THI at 1 month after intervention was 15.75. These data underscore the clinical effect of rTMS in the treatment of tinnitus. However, there is high variability of studies design and reported outcomes. Replication of data in multicenter trials with a large number of patients and long-term follow-up is needed before further conclusions can be drawn.

95. Slengerik-Hansen J, Ovesen T. Botulinum Toxin Treatment of Objective Tinnitus Because of Essential Palatal Tremor: A Systematic Review. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2016;37(7):820-28.INTRODUCTION In contrast to subjective tinnitus, objective tinnitus can be heard by the examiner as well as by the patient. It can be triggered by, among many other etiologies, idiopathic muscular tremor in the soft palate, the essential palatal tremor (EPT). Many treatment modalities have been investigated, of which only Botulinum toxin (BT) injections have shown promising results.GOAL The aim of this study was to evaluate the effect of BT treatment on objective tinnitus due to EPT by a systematic review of the literature.METHODS In accordance with PRISMA guideline a systematic literature search in three databases was performed. RESULTS Twenty-two studies fulfilled the inclusion criteria, mainly case reports and case series. A total of 51 BT treated patients diagnosed with EPT were identified in the literature. The studies were evaluated with focus on diagnostics, injection technique and BT dose, follow-up, effect on objective tinnitus, complications, and adverse effects.CONCLUSION The included studies suffer from an extremely low evidence level with several sources of bias. When optimally injected, BT seems to be an effective treatment of objective tinnitus due to EPT, with few adverse effects and complications. We suggest BT injections as first choice in case of EPT and present a guideline regarding diagnostics, treatment, and follow-up.

96. Singh C, Kawatra R, Gupta J, et al. Therapeutic role of Vitamin B12 in patients of chronic tinnitus: A pilot study. *Noise & health* 2016;18(81):93-97. True tinnitus is a phantom auditory perception arising from a source or trigger in the cochlea, brainstem, or at higher centers and has no detectable acoustic generator. The most accepted is the famous neurophysiologic model of Jastreboff, which stresses that tinnitus, is a subcortical perception and results from the processing of weak neural activity in the periphery. The aim of this study is to determine the role of Vitamin B12 in treatment of chronic tinnitus. In this randomized, double-blind pilot study, total 40 patients were enrolled, of which 20 in Group A (cases) received intramuscular therapy of 1 ml Vitamin B12 (2500 mcg) weekly for a period of 6 weeks and Group B (20) patients received placebo isotonic saline 01 ml intramuscular. The patients were subjected to Vitamin B12 assay and audiometry pre- and post-therapy. Of the total patients of tinnitus, 17 were Vitamin B12 deficient that is 42.5% showed deficiency when the normal levels were considered to be 250 pg/ml. A paired t-test showed that in Group A, patients with Vitamin B12 deficiency showed significant improvement in mean tinnitus severity index score and visual analog scale (VAS) after Vitamin B12 therapy. This pilot study highlights the significant prevalence of Vitamin B12 deficiency in North Indian population and improvement in tinnitus severity scores and VAS in cobalamin-deficient patients receiving intramuscular Vitamin B12 weekly for 6 weeks further provides a link between cobalamin deficiency
and tinnitus thereby suggestive of a therapeutic role of B12 in cobalamin-deficient patients of tinnitus.


**BACKGROUND AND OBJECTIVE**
Tinnitus is the perception of a phantom sound.

The aim of this study was to compare current intensity (center anode 1 mA and 2 mA), duration (10 minutes and 20 minutes), and location (left temporoparietal area [LTA] and dorsolateral prefrontal cortex [DLPFC]) using 4 × 1 high-definition transcranial direct current stimulation (HD-tDCS) for tinnitus reduction.

**METHOD**
Twenty-seven participants with chronic tinnitus (>2 years) and mean age of 53.5 years underwent 2 sessions of HD-tDCS of the LTA and DLPFC in a randomized order with a 1 week gap between site of stimulation. During each session, a combination of 4 different settings were used in increasing dose (1 mA, 10 minutes; 1 mA, 20 minutes; 2 mA, 10 minutes; and 2 mA, 20 minutes). The impact of different settings on tinnitus loudness and annoyance was documented.

**RESULT**
Twenty-one participants (77.78%) reported a minimum of 1 point reduction on tinnitus loudness or annoyance scales. There were significant changes in loudness and annoyance for duration of stimulation, F(1, 26) = 10.08, P < .005, and current intensity, F(1, 26) = 14.24, P = .001. There was no interaction between the location, intensity, and duration of stimulation. Higher intensity (2 mA) and longer duration (20 minutes) of stimulation were more effective.

**CONCLUSION**
A current intensity of 2 mA for 20-minute duration was the most effective setting used for tinnitus relief. The stimulation of the LTA and DLPFC were equally effective for suppressing tinnitus loudness and annoyance.


**PURPOSE**
Clinical effects of repetitive transcranial magnetic stimulation (rTMS) in chronic tinnitus are moderate. More precise coil localisation strategies, innovative stimulation protocols, and identification of predictors for treatment response were proposed as promising attempts to enhance treatment efficacy. In this pilot study we investigated neuronavigated continuous theta burst TMS (cTBS).

**METHOD**
Twenty-three patients received neuronavigated cTBS over the left primary auditory cortex in a randomized sham-controlled trial (verum = 12; sham = 11). Treatment response was evaluated with tinnitus questionnaires and numeric rating scales. Immediate change in numeric rating scales during the first session was used as predictor for treatment response.

**RESULT**
Tinnitus was significantly reduced after treatment, but there were no superior effects between verum vs. sham treatment. Immediate change in the first treatment session predicted the response to treatment only in the verum group.

**CONCLUSION**
In our study, verum cTBS was not superior to sham which highlights the persistent need for improving non-invasive brain stimulation techniques for the treatment of tinnitus. Future research should focus on the transfer of positive single session effects to daily treatment trials.


**OBJECTIVE**
To systematically review studies of the epidemiology of tinnitus and hyperacusis in children and young people, in order to determine the methodological differences implicated in the variability of prevalence estimates and the influence of population characteristics on childhood tinnitus and hyperacusis.

**DATA SOURCES**
Articles were retrieved from PubMed, EMBASE and Scopus databases.
and from the relevant reference lists using the methods described in the study protocol, which has previously been published. Reporting Items for Systematic Review (PRISMA) guidelines were followed.

**ELIGIBILITY CRITERIA**

Studies addressing childhood prevalence, for example, children and young people aged 5–19 years.

**DATA SELECTION**

2 reviewers independently assessed the studies for eligibility, extracted data and assessed study consistency. Owing to the heterogeneity in the methodologies among the reported studies, only narrative synthesis of the results was carried out.

**RESULTS**

Having identified 1032 publications, 131 articles were selected and 25 articles met the inclusion criteria and had sufficient methodological consistency to be included. Prevalence estimates of tinnitus range from 4.7% to 46% in the general paediatric population and among children with normal hearing, and from 23.5% to 62.2% of population of children with hearing loss. Reported prevalence ranged from 6% to 41.9% when children with hearing loss and normal hearing were both included. The prevalence of hyperacusis varied from 3.2% to 17.1%.

**CONCLUSIONS**

Data on prevalence vary considerably according to the study design, study population and the research question posed. The age range of children studied was varied and a marked degree of variation between definitions (tinnitus, hyperacusis) and measures (severity, perception, annoyance) was observed. The lack of consistency among studies indicates the necessity of examining the epidemiology of tinnitus and hyperacusis in children and adolescents with a set of standardised criteria.

**TRIAL REGISTRATION NUMBER** CRD42014013456.


Objectives/hypothesis: To explore neural connectivity changes associated with repetitive transcranial magnetic stimulation (rTMS) to the temporoparietal junction for patients with bothersome tinnitus.

Study Design: Randomized, double-blind, controlled clinical trial.

Methods: Thirty patients with subjective, nonpulsatile tinnitus for 6 months duration or longer and a score of 36 or greater on the Tinnitus Handicap Inventory completed the study. Participants were randomized to receive either sham or active treatment with rTMS to the temporoparietal junction for either 2 or 4 weeks of therapy. Participants underwent resting state functional connectivity magnetic resonance imaging before therapy and immediately following treatment. Functional connectivity changes between active and sham treatment groups were compared using regions of interest in auditory, default mode, ventral attention, and executive attention networks.

Results: Sixteen patients received active rTMS treatment; 14 patients received sham treatment. There were no differences between the active and sham groups in baseline functional connectivity. Neither treatment with rTMS nor sham therapy resulted in statistically significant functional connectivity changes in the examined brain networks.

Conclusions: The analysis did not identify any changes in neural connectivity following treatment in patients with bothersome tinnitus. These results are consistent with our findings of lack of symptom changes previously reported in the same group of patients. Measures of neural connectivity may inform future work using rTMS to better understand the possible benefits of neural stimulation for tinnitus.

Level Of Evidence: 1b.


Objectives To analyze existing tinnitus treatment trials with regard to eligibility criteria, outcome measures, study quality, and external validity and to recognize the effect of patient demographics, symptom duration, severity, and otologic comorbidity on research findings to help practitioners
apply them to patient encounters.

**DATA SOURCES**
Systematic literature search conducted by an information specialist for development of the American Academy of Otolaryngology-Head and Neck Surgery Foundation’s tinnitus clinical practice guideline.

**REVIEW METHODS**
Articles were assessed for eligibility with the PRISMA protocol (Preferred Reporting Items for Systematic Reviews and Meta-analyses) and data extracted by 2 independent investigators. Studies were assessed for methodological quality, inclusion and exclusion criteria, patient demographics, and outcome measures.

**RESULTS**
A total of 147 randomized trials met inclusion criteria. Nearly all studies took place in a specialist setting. More than 50% did not explicitly define tinnitus, and 44% used a subjective severity threshold, such as "severely disturbing." Fifty-four percent required symptom duration of at least 6 months for study eligibility, and up to 33% excluded patients with "organic" hearing loss or otologic conditions. Mean age was 52.2 years, and median follow-up was 3 months. Only 20% had a low risk of bias.

**CONCLUSION**
Randomized trials of tinnitus interventions are most applicable to older adults with tinnitus lasting ≥ 6 months who are evaluated in specialty settings. High risk of bias, short follow-up, and outcome reporting raise concerns about the validity of findings and may influence how clinicians apply trial results to individual patients and establish treatment expectations, thus demonstrating the need for further quality research in this field.


Tinnitus is a perception of sound that can occur in the absence of an external stimulus. A brief review of electroencephalography (EEG) and magnetoencephalography (MEG) literature demonstrates that there is no clear relationship between tinnitus presence and frequency band power in whole scalp or source oscillatory activity. Yet a preconception persists that such a relationship exists and that resting state EEG could be utilised as an outcome measure for clinical trials of tinnitus interventions, e.g. as a neurophysiological marker of therapeutic benefit. To address this issue, we first examined the test-retest correlation of EEG band power measures in tinnitus patients (n = 42). Second we examined the evidence for a parametric relationship between numerous commonly used tinnitus variables (psychoacoustic and psychosocial) and whole scalp EEG power spectra, directly and after applying factor reduction techniques. Test-retest correlation for both EEG band power measures and tinnitus variables were high. Yet we found no relationship between whole scalp EEG band powers and psychoacoustic or psychosocial variables. We conclude from these data that resting state whole scalp EEG should not be used as a biomarker for tinnitus and that greater caution should be exercised in regard to reporting of findings to avoid confirmation bias. The data was collected during a randomised controlled trial registered at ClinicalTrials.gov (Identifier: NCT01541969).


**BACKGROUND**
Tinnitus is the perception of sound without external acoustic stimuli. Patients with severe tinnitus may have physical and psychological complaints and their tinnitus can cause deterioration in their quality of life. At present no specific therapy for tinnitus has been found to be satisfactory in all patients. In recent decades, a number of reports have suggested that oral zinc supplementation may be effective in the management of tinnitus. Since zinc has a role in cochlear physiology and in the synapses of the auditory system, there is a plausible mechanism of action for this treatment.

**OBJECTIVE**
To evaluate the effectiveness and safety of oral zinc supplementation in the management of patients with tinnitus.

**SEARCH METHODS**
The Cochrane ENT Information Specialist searched the ENT Trials...
Register; Central Register of Controlled Trials (CENTRAL 2016, Issue 6); PubMed; EMBASE; CINAHL; Web of Science; ClinicalTrials.gov; ICTRP and additional sources for published and unpublished trials. The date of the search was 14 July 2016.

**SELECTION CRITERIA**
Randomised controlled trials comparing zinc supplementation versus placebo in adults (18 years and over) with tinnitus.

**DATA COLLECTION AND ANALYSIS**
We used the standard methodological procedures recommended by Cochrane. Our primary outcome measures were improvement in tinnitus severity and disability, measured by a validated tinnitus-specific questionnaire, and adverse effects. Secondary outcomes were quality of life, change in socioeconomic impact associated with work, change in anxiety and depression disorders, change in psychoacoustic parameters, change in tinnitus loudness, change in overall severity of tinnitus and change in thresholds on pure tone audiometry. We used GRADE to assess the quality of the evidence for each outcome; this is indicated in italics.

**MAIN RESULTS**
We included three trials involving a total of 209 participants. The studies were at moderate to high risk of bias. All included studies had differences in participant selection criteria, length of follow-up and outcome measurement, precluding a meta-analysis. The participants were all adults over 18 years with subjective tinnitus, but one study conducted in 2013 (n = 109) included only elderly patients.

**Improvement in tinnitus severity and disability**
Only the study in elderly patients used a validated instrument (Tinnitus Handicap Questionnaire) for this primary outcome. The authors of this cross-over study did not report the results of the two phases separately and found no significant differences in the proportion of patients reporting tinnitus improvement at four months of follow-up: 5% (5/93) versus 2% (2/94) in the zinc and placebo groups, respectively (risk ratio (RR) 2.53, 95% confidence interval (CI) 0.50 to 12.70; very low-quality evidence). None of the included studies reported any significant adverse effects.

**Secondary outcomes**
For the secondary outcome change in tinnitus loudness, one study reported no significant difference between the zinc and placebo groups after eight weeks: mean difference in tinnitus loudness -9.71 dB (95% CI -25.53 to 6.11; very low-quality evidence). Another study also measured tinnitus loudness but used a 0- to 100-point scale. The authors of this second study reported no significant difference between the zinc and placebo groups after four months: mean difference in tinnitus loudness rating scores 0.50 (95% CI -5.08 to 6.08; very low-quality evidence). Two studies used unvalidated instruments to assess tinnitus severity. One (with 50 participants) reported the severity of tinnitus using a non-validated scale (0 to 7 points) and found no significant difference in subjective tinnitus scores between the zinc and placebo groups at the end of eight weeks of follow-up (mean difference (MD) -1.41, 95% CI -2.97 to 0.15; very low-quality evidence). A third trial (n = 50) also evaluated the improvement of tinnitus using a non-validated instrument (a 0 to 10 scale: 10 = severe and unbearable tinnitus). In this study, after eight weeks there was no difference in the proportion of patients with improvement in their tinnitus, 8.7% (2/23) treated with zinc versus 8% (2/25) of those who received a placebo (RR 1.09, 95% CI 0.17 to 7.10, very low-quality evidence). None of the included studies reported any of our other secondary outcomes (quality of life, change in socioeconomic impact associated with work, change in anxiety and depression disorders, change in psychoacoustic parameters or change in thresholds on pure tone audiometry).

**AUTHORS’ CONCLUSIONS**
We found no evidence that the use of oral zinc supplementation improves symptoms in adults with tinnitus.

104. Peker S, Sirin A. Parallels between phantom pain and tinnitus. Medical hypotheses 2016;91:95-97. Phantom pain and tinnitus are diseases that cause patients great discomfort. Both are phantom sensations that have many connections with cerebral structures, but their underlying mechanisms are not fully understood. Several therapies have been suggested for these conditions.
over the years, but there is still no consensus on how to treat either one. Comparison of these two phenomena reveals many similarities, including what is known about their underlying mechanisms, associated brain areas, and responses to therapeutic agents and methods. These similarities need to be evaluated in greater depth, as this could improve our understanding of tinnitus and phantom pain, and thereby improve management strategies for these conditions.


Objective: To evaluate the characteristics and spontaneous recovery of tinnitus related to idiopathic sudden sensorineural hearing loss (ISSNHL).

Study Design: Retrospective analysis from two randomized placebo-controlled clinical trials for treatment of ISSNHL within 48 hours from onset (Study A), or of tinnitus related to ISSNHL within 3 months from onset (Study B).

Setting: Forty-eight European sites (academic tertiary referral centers, private ENT practices).

Patients: One hundred thirteen adult patients of which 65 with hearing loss ≥30 dB (Study A) and 48 with persistent acute tinnitus (Study B) at baseline.

Interventions: Intratympanic (i.t.) injection of placebo gel in single dose or in triple dose during 3 consecutive days.

Main Outcome Measures: Frequency of tinnitus, subjective tinnitus loudness, rates of complete tinnitus remission, and complete hearing recovery during 3 months follow-up.

Results: In acute ISSNHL, tinnitus loudness decreased rapidly in cases of mild-moderate hearing loss, and tinnitus had completely resolved in two-thirds of patients after 3 months. Hearing recovery preceded tinnitus resolution. When associated with severe-profound hearing loss, tinnitus improved significantly less. Complete hearing recovery and full tinnitus remission were both about three times more frequent in mild-moderate hearing loss patients than in severe-profound cases. Improvement in tinnitus loudness over time can be approximated by a negative exponential function.

Conclusions: Prognosis for ISSNHL-related tinnitus is relatively poor in case of severe-profound hearing loss and the longer it has persisted. Alleviation or management of tinnitus should be a key therapeutic objective especially in pronounced ISSNHL cases.


Background: Tinnitus can be related to many different aetiologies such as hearing loss or a noise trauma, but it can also be related to the somatosensory system of the cervical spine, called cervicogenic somatic tinnitus (CST). Case studies suggest a positive effect of cervical spine treatment on tinnitus complaints in patients with CST, but no experimental studies are available.

Objective: To investigate the effect of a multimodal cervical physical therapy treatment on tinnitus complaints in patients with CST.

Design: Randomized controlled trial.

Patients: Patients with a combination of severe subjective tinnitus (Tinnitus Functional Index (TFI): 25–90 points) and neck complaints (Neck Bournemouth Questionnaire (NBQ) > 14 points).

Intervention: All patients received cervical physical therapy for 6 weeks (12 sessions). Patients were randomized in an immediate-start therapy group (n = 19) and a 6-week delayed-start therapy group (n = 19).

Measurements: TFI and NBQ-scores were documented at baseline, after the wait-and-see period in the delayed-start group, after treatment and after 6 weeks follow-up. The Global Perceived Effect (GPE) was documented at all measuring moments, except at baseline. Results: In all patients (n = 38) TFI and NBQ-scores decreased significantly after treatment (p = 0.04 and p < 0.001). NBQ-scores remained significantly lower after follow-up (p = 0.001). Immediately after treatment, 53% (n = 38) experienced substantial improvement of tinnitus. This effect was maintained in 24% of patients after follow-up at six weeks.

Conclusion: Cervical physical therapy can have a positive effect on subjective tinnitus complaints in
patients with a combination of tinnitus and neck complaints. Larger studies, using more responsive outcome measures, are however necessary to prove this effect. Trial registration NCT02016313.

107. Michiels S, Naessens S, Van de Heyning P, et al. The effect of physical therapy treatment in patients with subjective tinnitus: A systematic review. *Frontiers in Neuroscience* 2016;10(NOV):545. Background: Tinnitus is a very common symptom that often causes distress and decreases the patient’s quality of life. Apart from the well-known causes, tinnitus can in some cases be elicited by dysfunctions of the cervical spine or the temporomandibular joint (TMJ). To date however, it is unclear whether alleviation of these dysfunctions, by physical therapy treatment, also decreases the tinnitus complaints. Such physical therapy could be an interesting treatment option for patients that are now often left without treatment. Objective(s): The aim of this review was to investigate the current evidence regarding physical therapy treatment in patients with tinnitus. Data sources: The online databases Pubmed, Web of Science, Cochrane, and Embase were searched up to March 2016. Two independent reviewers conducted the data extraction and methodological quality assessment. Study eligibility criteria: Only randomized controlled trials and quasi-experimental trials were included in the review. Studies had to be written in English, French, Dutch, or German. Participants and interventions: The included studies investigated the effect of physical therapy treatment modalities on tinnitus severity in patients suffering from subjective tinnitus. Result(s): Six studies were included in this review, four investigating cervical spine treatment and two investigating TMJ treatment. These studies show positive effects of cervical spine treatment (manipulations, exercises, triggerpoint treatment) on tinnitus severity. Additionally, decrease in tinnitus severity and intensity was demonstrated after TMJ treatment, following splints, occlusal adjustments as well as jaw exercises. Limitation(s): The risk of bias in the included studies was high, mainly due to lack of randomization, lack of blinding of subjects, therapists, and/or investigators. Additionally, risk of bias is present due to incomplete presentation of the data and selective reporting. A major issue of the reviewed papers is the heterogeneity of the included study populations, treatments and outcome measures, which inhibit data pooling and meta-analysis. Conclusion(s): Despite the methodological issues in the included studies and the consequent low quality evidence, it is noteworthy that all included studies show positive treatment effects. Before recommendations can be made, these results need to be confirmed in larger, high quality studies, using unambiguous inclusion criteria, state-of-the-art treatment, and high quality outcome measures. Copyright © 2016 Michiels, Naessens, Van de Heyning, Braem, Visscher, Gilles and De Hertogh.

108. McCormack A, Edmondson-Jones M, Somerset S, et al. A systematic review of the reporting of tinnitus prevalence and severity. *Hearing research* 2016;337:70-79. INTRODUCTION There is no standard diagnostic criterion for tinnitus, although some clinical assessment instruments do exist for identifying patient complaints. Within epidemiological studies the presence of tinnitus is determined primarily by self-report, typically in response to a single question. Using these methods prevalence figures vary widely. Given the variety of published estimates worldwide, we assessed and collated published prevalence estimates of tinnitus and tinnitus severity, creating a narrative synthesis of the data. The variability between prevalence estimates was investigated in order to determine any barriers to data synthesis and to identify reasons for heterogeneity. METHODS and analysis: A systematic review included all adult population studies reporting the prevalence of tinnitus from January 1980 to July 2015. We searched five databases (Embase, Medline, PsychInfo, CINAHL and Web Of Science), using a combination of medical subject headings (MeSH) and relevant text words.
Observational studies including cross-sectional studies were included, but studies estimating the incidence of tinnitus (e.g. cohort studies) were outside the scope of this systematic review.

**RESULTS**

The databases identified 875 papers and a further 16 were identified through manual searching. After duplicates were removed, 515 remained. On the basis of the title, abstract and full-text screening, 400, 48 and 27 papers respectively were removed. This left 40 papers, reporting 39 different studies, for data extraction. Sixteen countries were represented, with the majority of the studies from the European region (38.5%). Publications since 2010 represented half of all included studies (48.7%). Overall prevalence figures for each study ranged from 5.1% to 42.7%. For the 12 studies that used the same definition of tinnitus, prevalence ranged from 11.9% to 30.3%. Twenty-six studies (66.7%) reported tinnitus prevalence by different age groups, and generally showed an increase in prevalence as age increases. Half the studies reported tinnitus prevalence by gender. The pattern generally showed higher tinnitus prevalence among males than females. There were 8 different types of definitions of tinnitus, the most common being “tinnitus lasting for more than five minutes at a time” (34.3%). Only seven studies gave any justification for the question that was used, or acknowledged the lack of standard questions for tinnitus. There is widespread inconsistency in defining and reporting tinnitus, leading to variability in prevalence estimates among studies. Nearly half of the included studies had a high risk of bias and this limits the generalisability of prevalence estimates. In addition, the available prevalence data is heterogeneous thereby preventing the ability to pool the data and perform meta-analyses. Sources of heterogeneity include different diagnostic criteria, different age groups, different study focus and differences in reporting and analysis of the results. Heterogeneity thus made comparison across studies impracticable.

**CONCLUSION**

Deriving global estimates of the prevalence of tinnitus involves combining results from studies which are consistent in their definition and measurement of tinnitus, survey methodology and in the reporting and analysis of the results. Ultimately comparison among studies is unachievable without such consistency. The strength of this systematic review is in providing a record of all the available, recent epidemiological data in each global region and in making recommendations for promoting standardisation.


**BACKGROUND**

Subjective tinnitus (ST) is a frequent audiologic condition that still requires effective treatment. This study aimed at evaluating two therapeutic approaches: Virtual Reality (VR) immersion in auditory and visual 3D environments and Cognitive Behaviour Therapy (CBT).

**METHODS**

This open, randomized and therapeutic equivalence trial used bilateral testing of VR versus CBT. Adult patients displaying unilateral or predominantly unilateral ST, and fulfilling inclusion criteria were included after giving their written informed consent. We measured the different therapeutic effect by comparing the mean scores of validated questionnaires and visual analog scales, pre and post protocol. Equivalence was established if both strategies did not differ for more than a predetermined limit. We used univariate and multivariate analysis adjusted on baseline values to assess treatment efficacy. In addition of this trial, purely exploratory comparison to a waiting list group (WL) was provided.

**RESULTS**

Between August, 2009 and November, 2011, 148 of 162 screened patients were enrolled (VR n = 61, CBT n = 58, WL n = 29). These groups did not differ at baseline for demographic data. Three month after the end of the treatment, we didn’t find any difference between VR and CBT groups either for tinnitus severity (p = 0.99) or tinnitus handicap (p = 0.36).

**CONCLUSION**

VR appears to be at least as effective as CBT in unilateral ST patients.
110. Liu F, Han X, Li Y, et al. Acupuncture in the treatment of tinnitus: a systematic review and meta-analysis. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2016;273(2):285-94. This study aimed at a systematic review and meta-analysis of all available randomized controlled trials (RCTs) using acupuncture to treat tinnitus. Five electronic databases, in both English and Chinese, were searched. All studies in our review and meta-analysis included parallel RCTs of tinnitus patients which compared subjects receiving acupuncture (or its other forms, such as electroacupuncture) to subjects receiving no treatment, sham treatment, drugs or basic medical therapy. Data from the articles were validated and extracted using a predefined data extraction form. Nearly all of Chinese studies reported positive results, while most of English studies reported negative results. Analysis of the combined data found that the acupuncture treatments seemed to provide some advantages over conventional therapies for tinnitus. It had difference in acupuncture points and sessions between Chinese studies and English studies. Methodological flaws were also found in many of the RCTs, especially in Chinese studies. The results of this review suggest that acupuncture therapy may offer subjective benefit to some tinnitus patients. Acupuncture points and sessions used in Chinese studies may be more appropriate, whereas these studies have many methodological flaws and risk bias, which prevents us making a definitive conclusion.

111. Lehner A, Schecklmann M, Greenlee MW, et al. *Triple-site rTMS for the treatment of chronic tinnitus: a randomized controlled trial.* *Scientific reports* 2016;6:22302. Recent research indicates that tinnitus is related to alterations of neural networks including temporal, parietal, and prefrontal brain regions. The current study examines a rTMS protocol which targets three central nodes of these networks in a two-arm randomized parallel group trial. Overall, 49 patients with chronic tinnitus were randomized to receive either triple-site stimulation (left dorsolateral prefrontal stimulation, 1000 pulses, 20 Hz plus left and right temporoparietal stimulation, 1000 pulses each, 1 Hz) or single-site stimulation (left temporoparietal stimulation, 3000 pulses, 1 Hz). Both groups were treated in ten sessions. Tinnitus severity as measured by the tinnitus questionnaire was assessed before rTMS (day1), after rTMS (day12) and at two follow-up visits (day 90 and day 180). The triple-site protocol was well tolerated. There was a significant reduction in tinnitus severity for both treatment groups. The triple-site group tended to show a more pronounced treatment effect at day 90. However, the measurement time point x group interaction effect was not significant. The current results confirm former studies that indicated a significant reduction of tinnitus severity after rTMS treatment. No significant superiority of the multisite protocol was observed. Future approaches for the enhancement of treatment effects are discussed.

112. Laureano M, Onishi E, Bressan R, et al. The effectiveness of acupuncture as a treatment for tinnitus: a randomized controlled trial using (99m)Tc-ECD SPECT. *European Radiology* 2016;26(9):3234-42. Objective: Investigate the effect of acupuncture on brain perfusion using ethyl cysteinate dimer single-photon emission computed tomography ((99m)Tc-ECD SPECT) in patients with tinnitus. Methods: This randomized, single-blind, sham-control study examined patients (18-60 years old) with normal hearing and chronic, idiopathic, continuous tinnitus. Fifty-seven subjects were randomly assigned to true (n = 30) or sham (n = 27) acupuncture (ACP); (99m)Tc-ECD SPECT examinations were performed before and after 12 twice-weekly ACP sessions. Secondary outcomes included changes in the Tinnitus Handicap Inventory (THI), Visual Analog Scale (VAS), Hamilton Anxiety Scale (HAS) and Beck Depression Inventory (BDI). Imaging data were analysed using
Statistical Parametric Mapping (SPM8) software. Regression models were used to examine secondary outcomes via two paradigms: intention-to-treat (ITT; where multiple imputations were conducted because of study attrition) and complete cases. Results: No between-group brain perfusion differences were observed. However, a significant improvement in THI scores was observed at the end of true ACP treatment for all domains (all p values < 0.01) except the catastrophic scale. Conclusions: ACP might reduce the effects of tinnitus on daily life; however, additional studies should be conducted to verify the effects of ACP on the neural architecture and brain function of tinnitus patients. Key Points: • Efficacy of acupuncture on brain perfusion and symptoms of tinnitus patients. • Acupuncture improved the Tinnitus Handicap Inventory scores in tinnitus patients. • No significant changes in brain perfusion were observed after 12 twice-weekly sessions. • Perfusion changes would reflect changes in neuronal function.

113. Hyvärinen P, Mäkitie A, Aarnisalo AA. Self-Administered Domiciliary tDCS Treatment for Tinnitus: A Double-Blind Sham-Controlled Study. PloS one 2016;11(4):e0154286. Transcranial direct current stimulation (tDCS) has shown potential for providing tinnitus relief, although positive effects have usually been observed only during a short time period after treatment. In recent studies the focus has turned from one-session experiments towards multi-session treatment studies investigating long-term outcomes with double-blinded and sham-controlled study designs. Traditionally, tDCS has been administered in a clinical setting by a healthcare professional but in studies involving multiple treatment sessions, often a trade-off has to be made between sample size and the amount of labor needed to run the trial. Also, as the number of required visits to the clinic increases, the dropout rate is likely to rise proportionally. The aim of the current study was to find out if tDCS treatment for tinnitus could be patient-administered in a domiciliary setting and whether the results would be comparable to those from in-hospital treatment studies. Forty-three patients with chronic (> 6 months) tinnitus were involved in the study, and data on 35 out of these patients were included in final analysis. Patients received 20 minutes of left temporal area anodal (LTA) or bifrontal tDCS stimulation (2 mA) or sham stimulation (0.3 mA) for ten consecutive days. An overall reduction in the main outcome measure, Tinnitus Handicap Inventory (THI), was found (mean change -5.0 points, p < 0.05), but there was no significant difference between active and sham treatment outcomes. Patients found the tDCS treatment easy to administer and they all tolerated it well. In conclusion, self-administered domiciliary tDCS treatment for tinnitus was found safe and feasible and gave outcome results similar to recent randomized controlled long-term treatment trials. The results suggest better overall treatment response—as measured by THI—with domiciliary treatment than with in-hospital treatment, but this advantage is not related to the tDCS variant. The study protocol demonstrated in the current study is not restricted to tinnitus only.

114. Hui FK, Abruzzo T, Ansari SA. Endovascular Interventions for Idiopathic Intracranial Hypertension and Venous Tinnitus: New Horizons. Neuroimaging clinics of North America 2016;26(2):289-99. Pulsatile tinnitus from intracranial venous abnormalities is an uncommon cause of pulse synchronous tinnitus. Endovascular therapies may have applications in many of these disease conditions. They have the advantage of being minimally invasive and may selectively eliminate the site of turbulence. Venous stenting has been used successfully to treat venous stenoses with low complication rates and high success rates in patients with idiopathic intracranial hypertension though randomized controlled data are lacking. Careful exclusion of other causes of tinnitus should be performed before consideration for surgical or endovascular treatment of presumed causative lesions of venous tinnitus.
Tinnitus is defined as the perception of sound in the absence of an external source. It is often associated with hearing loss and is thought to result from abnormal neural activity at some point or points in the auditory pathway, which is incorrectly interpreted by the brain as an actual sound. Neurostimulation therapies therefore, which interfere on some level with that abnormal activity, are a logical approach to treatment. For tinnitus, where the pathological neuronal activity might be associated with auditory and other areas of the brain, interventions using electromagnetic, electrical, or acoustic stimuli separately, or paired electrical and acoustic stimuli, have been proposed as treatments. Neurostimulation therapies should modulate neural activity to deliver a permanent reduction in tinnitus percept by driving the neuroplastic changes necessary to interrupt abnormal levels of oscillatory cortical activity and restore typical levels of activity. This change in activity should alter or interrupt the tinnitus percept (reduction or extinction) making it less bothersome. Here we review developments in therapies involving electrical stimulation of the ear, head, cranial nerve, or cortex in the treatment of tinnitus which demonstrably, or are hypothesised to, interrupt pathological neuronal activity in the cortex associated with tinnitus.

Objectives: In this four-site clinical trial, we evaluated whether tinnitus masking (TM) and tinnitus retraining therapy (TRT) decreased tinnitus severity more than the two control groups: an attention-control group that received tinnitus educational counseling (and hearing aids if needed; TED), and a 6-month-wait-list control (WLC) group. The authors hypothesized that, over the first 6 months of treatment, TM and TRT would decrease tinnitus severity in Veterans relative to TED and WLC, and that TED would decrease tinnitus severity relative to WLC. The authors also hypothesized that, over 18 months of treatment, TM and TRT would decrease tinnitus severity relative to TED. Treatment effectiveness was hypothesized not to be different across the four sites.

Design: Across four Veterans affairs medical center sites, N = 148 qualifying Veterans who experienced sufficiently bothersome tinnitus were randomized into one of the four groups. The 115 Veterans assigned to TM (n = 42), TRT (n = 34), and TED (n = 39) were considered immediate-treatment subjects; they received comparable time and attention from audiologists. The 33 Veterans assigned to WLC were, after 6 months, randomized to receive delayed treatment in TM, TRT, or TED. Assessment of outcomes took place using the Tinnitus Handicap Inventory (THI) at 0, 3, 6, 12, and 18 months.

Results: Results of a repeated measures analysis of variance using an intention-to-treat approach showed that the tinnitus severity of Veterans receiving TM, TRT, and TED significantly decreased (p < 0.05) relative to Veterans in the WLC group at 3 months (effect sizes = 0.44, 0.52, and 0.27, respectively) and at 6 months (effect sizes = 0.52, 0.56, and 0.40, respectively). Analyses comparing effectiveness of TM, TRT, and TED over 18 months revealed that the three conditions were not significantly different, but that tinnitus severity in the combined groups significantly decreased (p < 0.01) from baseline to 3 months (5.6 THI points) and from 3 to 6 months (3.7 THI points). With respect to clinically significant change, about half of Veterans who received TM (55%), TRT (59%), or TED (46%) showed strong or modest improvement on the THI by 18 months. Without treatment, the WLC group did not show significant change. Treatment effectiveness did not differ by study site. Conclusions: Audiologists who provided interventions to Veterans with bothersome tinnitus in the regular clinic setting were able to significantly reduce tinnitus severity over 18 months.
using TM, TRT, and TED approaches. These results suggest that TM, TRT, and TED, when implemented as in this trial, will provide effectiveness that is relatively similar by 6 months and beyond.

117. Henry JA, Griest S, Thielman E, et al. Tinnitus Functional Index: Development, validation, outcomes research, and clinical application. Hearing research 2016;334:58-64. The Tinnitus Research Consortium (TRC) issued a Request for Proposals in 2003 to develop a new tinnitus outcome measure that would: (1) be highly sensitive to treatment effects (validated for "responsiveness"); (2) address all major dimensions of tinnitus impact; and (3) be validated for scaling the negative impact of tinnitus. A grant was received by M. Meikle to conduct the study. In that observational study, all of the TRC objectives were met, with the final 25-item Tinnitus Functional Index (TFI) containing eight subscales. The study was published in 2012, and since then the TFI has received increasing international use and is being translated into at least 14 languages. The present study utilized data from a randomized controlled trial (RCT) that involved testing the efficacy of "telephone tinnitus education" as intervention for bothersome tinnitus. These data were used to confirm results from the original TFI study. Overall, the TFI performed well in the RCT with Cohen’s d being 1.23. There were large differences between the eight different subscales, ranging from a mean 13.2-point reduction (for the Auditory subscale) to a mean 26.7-point reduction (for the Relaxation subscale). Comparison of TFI performance was made with the Tinnitus Handicap Inventory. All of the results confirmed sensitivity of the TFI along with its subscales. This article is part of a Special Issue entitled <Tinnitus>.

118. Henin S, Fein D, Smouha E, et al. The Effects of Compensatory Auditory Stimulation and High-Definition Transcranial Direct Current Stimulation (HD-tDCS) on Tinnitus Perception - A Randomized Pilot Study. PloS one 2016;11(11):e0166208. BACKGROUND Tinnitus correlates with elevated hearing thresholds and reduced cochlear compression. We hypothesized that reduced peripheral input leads to elevated neuronal gain resulting in the perception of a phantom sound. OBJECTIVE The purpose of this pilot study was to test whether compensating for this peripheral deficit could reduce the tinnitus percept acutely using customized auditory stimulation. To further enhance the effects of auditory stimulation, this intervention was paired with high-definition transcranial direct current stimulation (HD-tDCS). METHODSA randomized sham-controlled, single blind study was conducted in a clinical setting on adult participants with chronic tinnitus (n = 14). Compensatory auditory stimulation (CAS) and HD-tDCS were administered either individually or in combination in order to access the effects of both interventions on tinnitus perception. CAS consisted of sound exposure typical to daily living (20-minute sound-track of a TV show), which was adapted with compressive gain to compensate for deficits in each subject’s individual audiograms. Minimum masking levels and the visual analog scale were used to assess the strength of the tinnitus percept immediately before and after the treatment intervention. RESULTS CAS reduced minimum masking levels, and visual analog scale trended towards improvement. Effects of HD-tDCS could not be resolved with the current sample size. CONCLUSION The results of this pilot study suggest that providing tailored auditory stimulation with frequency-specific gain and compression may alleviate tinnitus in a clinical population. Further experimentation with longer interventions is warranted in order to optimize effect sizes.

evidence-based guidance to facilitate design decisions for confirmatory trials or systematic reviews investigating treatment efficacy for adults with tinnitus. This systematic review therefore seeks to ascertain the current status of trial designs by identifying and evaluating the reporting of outcome domains and instruments in the treatment of adults with tinnitus.

Methods: Records were identified by searching PubMed, EMBASE CINAHL, EBSCO, and CENTRAL clinical trial registries (ClinicalTrials.gov, ISRCTN, ICTRP) and the Cochrane Database of Systematic Reviews. Eligible records were those published from 1 July 2006 to 12 March 2015. Included studies were those reporting adults aged 18 years or older who reported tinnitus as a primary complaint, and who were enrolled into a randomised controlled trial, a before and after study, a non-randomised controlled trial, a case-controlled study or a cohort study, and written in English. Studies with fewer than 20 participants were excluded.

Results: Two hundred and twenty-eight studies were included. Thirty-five different primary outcome domains were identified spanning seven categories (tinnitus percept, impact of tinnitus, co-occurring complaints, quality of life, body structures and function, treatment-related outcomes and unclear or not specified). Over half the studies (55%) did not clearly define the complaint of interest. Tinnitus loudness was the domain most often reported (14%), followed by tinnitus distress (7%). Seventy-eight different primary outcome instruments were identified. Instruments assessing multiple attributes of the impact of tinnitus were most common (34%). Overall, 24 different patient-reported tools were used, predominantly the Tinnitus Handicap Inventory (15%). Loudness was measured in diverse ways including a numerical rating scale (8%), loudness matching (4%), minimum masking level (1%) and loudness discomfort level (1%). Ten percent of studies did not clearly report the instrument used.

Conclusions: Our findings indicate poor appreciation of the basic principles of good trial design, particularly the importance of specifying what aspect of therapeutic benefit is the main outcome. No single outcome was reported in all studies and there was a broad diversity of outcome instruments.

Prospero Registration: The systematic review protocol is registered on PROSPERO (International Prospective Register of Systematic Reviews): CRD42015017525. Registered on 12 March 2015 revised on 15 March 2016.


INTRODUCTION

Over 70 million people in Europe and >50 million people in the USA are reported to experience tinnitus (the sensation of noise in the absence of any corresponding sound source). Tinnitus is a multidimensional concept. Individual patients may report different profiles of tinnitus-related symptoms which may each require a tailored management approach and an appropriate measure of therapeutic benefit. This systematic review concerns the patient perspective and has the purpose to find what symptoms are reported by people who experience tinnitus and by their significant others.

METHODS AND ANALYSIS

This protocol lays out the methodology to define what dimensions of tinnitus-related symptoms patients and their significant others report as being a problem. Methods are defined according to the Preferred Reporting Items for Systematic reviews and Meta-analyses for Protocols (PRISMA-P) 2015 and data will be collated in a narrative synthesis. Findings will contribute to the eventual establishment of a Core Domain Set for clinical trials of tinnitus.

ETHICS AND DISSEMINATION

No ethical issues are foreseen. Findings will be reported at national and international ENT and audiology conferences and in a peer-reviewed journal.

TRIAL REGISTRATION NUMBER

CRD42015020629.

OBJECTIVESelf-help interventions are followed by people independently with minimal or no therapist contact. This review aims to assess the effectiveness of self-help interventions for adults with chronic tinnitus and systematically identify the self-help techniques used. DESIGN Systematic review and application of health psychology taxonomies. Electronic database searches were conducted, supplemented by citation searching and hand-searching of key journals. Prospective controlled trials, which used measures of tinnitus distress, functional management, anxiety, depression, and quality of life, were included. Michie et al’s behaviour change techniques (BCTs) taxonomy and Taylor et al’s PRISMS taxonomy of self-management components were applied to describe interventions. STUDY SAMPLE Five studies were included, providing low-to-moderate levels of evidence. RESULTS Randomized controlled trial studies were too few and heterogeneous for meta-analysis to be performed. Studies comparing self-help interventions to therapist-guided interventions and assessing non tinnitus-specific psychosocial outcomes and functional management were lacking. Fifteen BCTs and eight self-management components were identified across interventions. CONCLUSION A lack of high-quality and homogeneous studies meant that confident conclusions could not be drawn regarding the efficacy of self-help interventions for tinnitus. Better reporting and categorization of intervention techniques is needed for replication in research and practice and to facilitate understanding of intervention mechanisms.

122. Forogh B, Mirshaki Z, Raissi GR, et al. Repeated sessions of transcranial direct current stimulation for treatment of chronic subjective tinnitus: a pilot randomized controlled trial. *Neurological sciences : official journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology* 2016;37(2):253-59. Subjective tinnitus is an auditory phantom sensation characterized by the perception of sound in the absence of an identifiable external source. This distressing audiological symptom can severely affect the quality of life. Transcranial direct current stimulation (tDCS) is a noninvasive technique that can induce short-term relief in tinnitus in some patients. The purpose of this pilot double-blind randomized controlled trial was to investigate whether repeated application of anodal tDCS over left temporoparietal area could induce long-lasting relief in patients with chronic tinnitus. Twenty-two patients with chronic tinnitus for at least 6 months were randomly allocated into two groups and received five sessions of anodal (N = 11) or sham (N = 11) stimulation in five consecutive days. A current intensity of 2 mA for 20 min was used for anodal stimulation. Outcomes were assessed using Persian version of tinnitus handicap inventory (THI), loudness and distress visual analog scale (VAS) scores and clinical global impression (CGI) scale. The trial is registered at the Iranian Registry of Clinical Trials (IRCT) with the reference ID of IRCT2014082018871N1. No statistically significant difference was found between anodal and sham stimulation regarding either immediate or long-lasting effects over the 2 weeks follow-up period. Deterioration of symptoms and alteration in tinnitus characteristics were reported by a few patients. There were no significant long-term beneficial effects following tDCS of the left temporoparietal area.

123. Doi MY, Tano SS, Schultz AR, et al. Effectiveness of acupuncture therapy as treatment for tinnitus: a randomized controlled trial. *Brazilian journal of otorhinolaryngology* 2016;82(4):458-65. INTRODUCTION Tinnitus is a subjective sensation of hearing a sound in the absence of an external stimulus, which significantly worsens the quality of life in 15-25% of affected individuals. OBJECTIVE To assess the effectiveness of acupuncture therapy for tinnitus. METHODS Randomized clinical trial (REBEC2T9T7Q) with 50 participants with tinnitus,
divided into two groups: 25 participants in the acupuncture group and 25 participants in the control group. The acupuncture group received acupuncture treatment and the control group received no treatment. After a period of 5 weeks, they were called to perform the final evaluation and the control group received acupuncture treatment for ethical reasons. RESULTSA statistically significant result was found for the primary outcome, reducing the intensity of tinnitus, with p=0.0001 and the secondary endpoint, showing improvement in quality of life, with p=0.0001. CONCLUSION Chinese scalp acupuncture associated with bilateral electroacupuncture demonstrated, in the short term, a statistically significant improvement by reducing the level of tinnitus intensity, as well as improving the quality of life of individuals with tinnitus.


INTRODUCTION Cochlear implantation is an increasingly common procedure in the treatment of severe to profound sensorineural hearing loss (SNHL) in children and adults. It is often performed as a day-case procedure. The major drive towards day-case surgery has been from a logistical, economical and societal perspective, but we also speculate that the patient’s quality of life (QoL) is at least equal to inpatient surgery if not increased as a result of rapid discharge and rehabilitation. Even though cochlear implantation seems well suited to a day-case approach and this even seems to be common practice in some countries, evidence is scarce and of low quality to guide us towards the preferred treatment option.

METHODS AND ANALYSIS A single-centre, non-blinded, randomised, controlled trial was designed to (primarily) investigate the effect on general QoL of day-case cochlear implantation compared to inpatient cochlear implantation and (secondarily) the effect of both methods on (subjective) hearing improvement, disease-specific QoL, tinnitus, vertigo and cost-effectiveness. 30 adult patients with severe to profound bilateral postlingual SNHL who are eligible for unilateral cochlear implantation will be randomly assigned to either the day-case or inpatient treatment group. The outcome measures will be assessed using auditory evaluations, questionnaires (preoperatively, at 1-week, 3-week, 3-month and 1-year follow-up) and costs diaries (weekly during the first month postoperatively, after which once in a month until 1-year follow-up). Preoperative and postoperative outcomes will be compared. The difference in costs and benefit will be represented using the incremental cost utility/effectiveness ratio. The analyses will be carried out on an intention-to-treat basis.

ETHICS AND DISSEMINATION This research protocol was approved by the Institutional Review Board of the UMC Utrecht (NL45590.041.13; V.5, November 2015). The trial results will be disseminated through peer-reviewed medical journals and presented at scientific conferences.

TRIAL REGISTRATION NUMBER NTR4464; Pre-results.


INTRODUCTION Earlier studies show that a Cochlear Implant (CI), capable of providing intracochlear electrical stimulation independent of environmental sounds, appears to suppress tinnitus at least for minutes. The current main objective is to compare the long-term suppressive effects of looped (i.e. repeated) electrical stimulation (without environmental sound perception) with the standard stimulation pattern of a CI (with environmental sound perception). This could open new possibilities for the development of a "Tinnitus Implant" (TI), an intracochlear pulse generator for the suppression of tinnitus.

MATERIALS AND METHODS Ten patients with single sided deafness suffering from unilateral tinnitus in the deaf ear are fitted with a CI (MED-EL...
Corporation, Innsbruck, Austria). Stimulation patterns are optimized for each individual patient, after which they are compared using a randomized crossover design, with a follow-up of six months, followed by a 3 month period using the modality of patient’s choice. RESULTS Results show that tinnitus can be suppressed with intracochlear electrical stimulation independent of environmental sounds, even long term. No significant difference in tinnitus suppression was found between the standard clinical CI and the TI. CONCLUSION It can be concluded that coding of environmental sounds is no requirement for tinnitus suppression with intracochlear electrical stimulation. It is therefore plausible that tinnitus suppression by CI is not solely caused by an attention shift from the tinnitus to environmental sounds. Both the standard clinical CI and the experimental TI are potential treatment options for tinnitus. These findings offer perspectives for a successful clinical application of the TI, possibly even in patients with significant residual hearing. TRIAL REGISTRATION TrialRegister.nl NTR3374.

126. Ahmed AO. Repetitive transcranial magnetic stimulation: Review of the novel technique for the treatment of tinnitus. Indian Journal of Otology 2016;22(2):77-80. Tinnitus remains a huge burden worldwide. It is said to affect one third of persons at some point in their lives. Various therapeutic approaches have been tried without a seemingly appreciable result. This article reviews the role of repetitive transcranial magnetic stimulation (rTMS) as a novel method of treating patients with tinnitus. To review the literature on rTMS in the management of tinnitus. Literature search using a systematic review of available databases such as PubMed, EMBASE, Cochrane library, Web of science and Science Direct was used. The efficacy of this new method of treating tinnitus is yet to be fully documented. Long-term effects such as induction of metaplastic change, genetic mutation from the magnetic fields surrounding the underlying tissues are all possible. To improve and strengthen acceptability in its efficacy, some of these adverse effects have to be adequately controlled. Copyright © 2016 Indian Journal of Otology Published by Wolters Kluwer - Medknow.

127. Wolever RQ, Price R, Hazelton AG, et al. Complementary therapies for significant dysfunction from tinnitus: Treatment review and potential for integrative medicine. Evidence-based Complementary and Alternative Medicine 2015;2015:931418. Tinnitus is a prevalent and costly chronic condition; no universally effective treatment exists. Only 20% of patients who report tinnitus actually seek treatment, and when treated, most patients commonly receive sound-based and educational (SBE) therapy. Additional treatment options are necessary, however, for nonauditory aspects of tinnitus (e.g., anxiety, depression, and significant interference with daily life) and when SBE therapy is inefficacious or inappropriate. This paper provides a comprehensive review of (1) conventional tinnitus treatments and (2) promising complementary therapies that have demonstrated some benefit for severe dysfunction from tinnitus. While there has been no systematic study of the benefits of an Integrative Medicine approach for severe tinnitus, the current paper reviews emerging evidence suggesting that synergistic combinations of complementary therapies provided within a whole-person framework may augment SBE therapy and empower patients to exert control over their tinnitus symptoms without the use of medications, expensive devices, or extended programs. Copyright © 2015 Ruth Q. Wolever et al.

practice over a 22- to 26-week period as part of an open label, non-randomized, non-controlled observational study. Method(s): Sixty-six patients with subjective tonal tinnitus were treated with acoustic CR neuromodulation with a retrospective review of patient records being performed in order to identify changes of visual analog scale (VAS, \( n = 66 \)) and in the score of the tinnitus handicap questionnaire (THQ, \( n = 51 \)). Patients had their tinnitus severity recorded prior to the initiation of therapy using the tinnitus handicap inventory in order to categorize patients into slight up to catastrophic impact categories. THQ and VAS for tinnitus loudness/annoyance were obtained at the patient’s initial visit, at 10-14 and 22-26 weeks. Result(s): Visual analog scale scores were significantly improved, demonstrating a 25.8% mean reduction in tinnitus loudness and a 32% mean reduction in tinnitus annoyance with a clinically significant reduction in percept loudness and annoyance being recorded in 59.1 and 72.7% of the patient group. THQ scores were significantly improved by 19.4% after 22-26 weeks of therapy compared to baseline. Conclusion(s): Acoustic CR neuromodulation therapy appears to be a practical and promising treatment for subjective tonal tinnitus. However, due to the lack of a control group it is difficult to reach an absolute conclusion regarding to what extent the observed effects are related directly to the acoustic CR neuromodulation therapy. Also, as the observed patient group was made up of paying clients it is unknown as to whether this could have caused any additional placebo like effects to influence the final results.

129. Theodoroff SM, Lewis MS, Folmer RL, et al. Hearing impairment and tinnitus: prevalence, risk factors, and outcomes in US service members and veterans deployed to the Iraq and Afghanistan wars. Epidemiologic reviews 2015;37:71-85. Hearing loss and tinnitus are the 2 most prevalent service-connected disabilities among veterans in the United States. Veterans of Operations Enduring Freedom, Iraqi Freedom, and New Dawn have been exposed to multiple hazards associated with these conditions, such as blasts/explosions, ototoxic chemicals, and most notably high levels of noise. We conducted a systematic literature review of evidence on 1) prevalence of, 2) risk and protective factors for, and 3) functional and quality-of-life outcomes of hearing impairment and tinnitus in US Operations Enduring Freedom, Iraqi Freedom, and New Dawn veterans and military personnel. We identified studies published from 2001 through 2013 using PubMed, PsycINFO, REHABDATA, Cochrane Library, pearlring, and expert recommendation. Peer-reviewed English language articles describing studies of 30 or more adults were included if they informed one or more key questions. A total of 839 titles/abstracts were reviewed for relevance by investigators trained in critical analysis of literature; 14 studies met inclusion criteria. Of these, 13 studies presented data on prevalence and 4 on risk/protective factors, respectively. There were no included studies reporting on outcomes. Findings from this systematic review will help inform clinicians, researchers, and policy makers on future resource and research needs pertaining to hearing impairment and tinnitus in this newest generation of veterans.

130. Thabit MN, Fouad N, Shahat B, et al. Combined central and peripheral stimulation for treatment of chronic tinnitus: a randomized pilot study. Neurorehabilitation and neural repair 2015;29(3):224-33. BACKGROUND Tinnitus is a common untreatable condition that originates from central maladaptive plasticity initiated by peripheral injury. Repetitive transcranial magnetic stimulation (rTMS), direct cochlear low-level laser therapy (LLLT), and acupuncture were tried for tinnitus treatment, but the results of these methods were clinically unsatisfactory. OBJECTIVE This study aimed to test the combined effect of the 3 methods targeting both peripheral and central auditory areas as a new therapeutic strategy for tinnitus. METHODS For this, 30 patients were
randomized to 3 equal groups receiving 3 different interventions: inhibitory rTMS to the left auditory cortex, LLLT (which includes a combination of direct cochlear LLLT and laser acupuncture) to the affected ear(s), and finally, a combination of rTMS and LLLT. The Tinnitus Handicap Inventory (THI) and Visual Analogue Scale (VAS) were assessed before, immediately after, and at 2 weeks and 4 weeks after 10 consecutive every-other-day sessions for each intervention type. RESULTS We found that combined stimulation was effective in tinnitus treatment. This effect remained for 4 weeks after the end of the treatment. However, each of rTMS and LLLT alone had no significant effect. Repeated-measures ANOVA showed a significant effect of Time and Time × Intervention interaction for THI and VAS scores. The post hoc t test for different time points per intervention revealed a significant difference between baseline and all postintervention measurements of both THI and VAS for the combination intervention. CONCLUSION Combined central rTMS and peripheral LLLT is more beneficial as a new method for management of tinnitus rather than these two used separately.

131. Spiegel DP, Linford T, Thompson B, et al. Multisensory attention training for treatment of tinnitus. *Scientific reports* 2015;5:10802. Tinnitus is the conscious perception of sound with no physical sound source. Some models of tinnitus pathophysiology suggest that networks associated with attention, memory, distress and multisensory experience are involved in tinnitus perception. The aim of this study was to evaluate whether a multisensory attention training paradigm which used audio, visual, and somatosensory stimulation would reduce tinnitus. Eighteen participants with predominantly unilateral chronic tinnitus were randomized between two groups receiving 20 daily sessions of either integration (attempting to reduce salience to tinnitus by binding with multisensory stimuli) or attention diversion (multisensory stimuli opposite side to tinnitus) training. The training resulted in small but statistically significant reductions in Tinnitus Functional Index and Tinnitus Severity Numeric Scale scores and improved attentional abilities. No statistically significant improvements in tinnitus were found between the training groups. This study demonstrated that a short period of multisensory attention training reduced unilateral tinnitus, but directing attention toward or away from the tinnitus side did not differentiate this effect.

132. Simonetti P, Oiticica J. Tinnitus neural mechanisms and structural changes in the brain: The contribution of neuroimaging research. *International Archives of Otorhinolaryngology* 2015;19(3):259–65. Introduction Tinnitus is an abnormal perception of sound in the absence of an external stimulus. Chronic tinnitus usually has a high impact in many aspects of patients' lives, such as emotional stress, sleep disturbance, concentration difficulties, and so on. These strong reactions are usually attributed to central nervous system involvement. Neuroimaging has revealed the implication of brain structures in the auditory system. Objective This systematic review points out neuroimaging studies that contribute to identifying the structures involved in the pathophysiological mechanism of generation and persistence of various forms of tinnitus. Data Synthesis Functional imaging research reveals that tinnitus perception is associated with the involvement of the nonauditory brain areas, including the front parietal area; the limbic system, which consists of the anterior cingulate cortex, anterior insula, and amygdala; and the hippocampal and parahippocampal area. Conclusion The neuroimaging research confirms the involvement of the mechanisms of memory and cognition in the persistence of perception, anxiety, distress, and suffering associated with tinnitus. Copyright © 2015 by Thieme Publicaes Ltda, Rio de Janeiro, Brazil.

Background. Tinnitus is the phantom perception of sound and can have negative effect on the quality of life. Transcranial direct current stimulation (tDCS) is a noninvasive neuromodulation technique, which can increase or decrease the cortical excitability in the brain region to which it is applied. tDCS has been used for tinnitus research since 2006. Objective. To investigate whether tDCS affects tinnitus perception, related emotion, or both, and the potential implications for tinnitus management. Methods. A scoping review was undertaken using the methods proposed by Arksey and O’Malley. After initial consideration of title relevance and reading abstracts, 15 studies were included in this review. The data from these studies were charted to investigate the impact of tDCS on tinnitus perception and emotions. Results. tDCS results in transient suppression of tinnitus loudness and annoyance; however, it does not lead to long-term impact on tinnitus related emotion. Local stimulation of different sites of stimulation (left temporoparietal area, dorsolateral prefrontal cortex, and auditory cortex) might modulate tinnitus perception (loudness) and emotions differently; however, further research is needed to explore this hypothesis. This review has identified aspects of methodologies that require attention in upcoming tinnitus and tDCS trials to offer better insights. Conclusions. tDCS is an effective research tool for transient tinnitus neuromodulation. However, efforts should be invested in designing clinical trials using local and multiple sites of stimulation, optimized parameters, and objective outcome measures before it can be translated into a clinical tool for tinnitus management.

134. Riga M, Katotomichelakis M, Danielides V. The potential role of the medial olivocochlear bundle in the generation of tinnitus: controversies and weaknesses in the existing clinical studies. *Otology & Neurotology* 2015;36(2):201-08. Objective: The physiology of the efferent cochlear innervation and the pathophysiology of tinnitus are 2 important but rather obscure chapters of neuro-otology. The possible interference of the medial olivocochlear bundle (MOCB) in the pathophysiology of tinnitus is not only a matter of strong controversy but also a field with possible important clinical and therapeutic implications. The aim of this study was to reveal the differences in study population, design, and methodology that may have attributed the conflicting results in the existing clinical trials. Data Sources A review of the relevant literature published between January 1990 and June 2013 was conducted via the PubMed database with the search terms “tinnitus” and “otoacoustic emissions and suppression or efferent.” Study Selection: Clinical studies on patients with additional pathologic abnormalities that may implicate the MOCB, such as hyperacousis or auditory neuropathy, were excluded. Data Extraction: The 15 relevant studies were reviewed for critical differences in the recruitment of their study population and control group, as well as their methods of testing and evaluating the results. Data Synthesis: The different methods and study parameters are compared to each other. Factors known to attribute different MOCB responses, possibly responsible for the controversial results, are highlighted. Conclusion: The remarkable heterogeneity of the existing studies does not allow for safe conclusions. Insufficient knowledge on the physiology of the MOCB reflex seems to preclude the formation of a consensus on the optimal protocol for the evaluation of its function. Further research is definitely needed.

135. Rheker J, Andersson G, Weise C. The role of “on demand” therapist guidance vs. no support in the treatment of tinnitus via the internet: A randomized controlled trial. *Internet Interventions* 2015;2(2):189-99. Objective: Internet-based cognitive behavioral self-help treatments (iCBT) have been shown to successfully reduce the distress associated with tinnitus. Despite this success, little is known about the mechanisms that make iCBT for tinnitus sufferers work. Availability of minimal therapeutic support is assumed to positively influence treatment outcome in iCBT, but the lower
limit of required support is not known. In face-to-face therapy, patients' positive outcome expectations have demonstrated an advantageous effect on outcome. The first aim of our study was thus to investigate the role of 'on demand' therapeutic guidance vs. no therapeutic support on treatment outcome in an iCBT for tinnitus sufferers. Our second aim was to investigate whether positive outcome expectations can predict treatment outcome. Method(s): A total of 112 tinnitus patients were randomly assigned to one of two groups (support-on-demand or non-support). Both groups received an established iCBT treatment for tinnitus. While participants in the support group (n = 56) could ask a therapist for additional support, those in the other (n = 56) received no therapeutic guidance. Tinnitus distress was assessed pre- and post-treatment via the Tinnitus Handicap Inventory (THI) and the Mini-Tinnitus Questionnaire (Mini-TQ). Pre-treatment outcome expectations were assessed using the Patient Questionnaire on Therapy Expectation and Evaluation (PATHEV). Result(s): We observed significantly less tinnitus distress in the THI (support: t(55) = 7.51, p <= .001; non-support: t(55) = 7.68, p <= .001) and Mini-TQ (support: t(55) = 8.24, p <= .001; non-support: t(55) = 8.46, p <= .001) in both groups from pre- to post-treatment, but no significant differences between the groups or interactions. The PATHEV subscale "Hope of Improvement" significantly predicted treatment outcome as measured by the THI (beta = 0.28, p = .027). Conclusion(s): The iCBT self-help program is a good treatment option for tinnitus sufferers whether or not support-on-demand is provided. Furthermore, our results show the importance of outcome expectations to the efficacy of iCBT in tinnitus patients. Future research should focus on discovering further predictors of treatment outcome.

136. Rabau S, Van Rompaey V, Van de Heyning P. The effect of Transcranial Direct Current Stimulation in addition to Tinnitus Retraining Therapy for treatment of chronic tinnitus patients: a study protocol for a double-blind controlled randomised trial. Trials 2015;16:514. BACKGROUND: Currently, there still is no treatment that eliminates tinnitus in all patients. Recent studies have shown that Tinnitus Retraining Therapy (TRT) significantly improves quality of life for tinnitus patients. Also, several studies have reported that transcranial Direct Current Stimulation (tDCS) has a positive effect on attention, working memory, long-term memory and other cognitive processes. The aim of this randomised placebo-controlled double-blind study is to evaluate the added effect of tDCS to TRT in chronic tinnitus patients. To our knowledge, this is the first study to combine both methods. METHODS: Patients with chronic, non-pulsatile tinnitus will be randomised in two treatment groups: TRT and real tDCS versus TRT and sham tDCS. Evaluations will take place at baseline before therapy starts, at the end of the TRT and 3 months after therapy starts. The Tinnitus Functional Index will be used as the primary outcome measurement. Secondary outcome measurements will be the Visual Analogue Scale of Loudness, Hospital Anxiety and Depression Scale (HADS), Hyperacusis Questionnaire, psychoacoustic measurements and Event-related potential (ERP). DISCUSSION: To our knowledge this is the first study to combine TRT and tDCS. The objective is to evaluate whether tDCS can provide faster and/or more relief from the annoyance experienced in chronic tinnitus patients' daily lives. The advantage of the study is that it is double-blind and placebo-controlled. TRIAL REGISTRATION: The present study protocol was registered on 31 October 2014 at Clinicaltrials.gov: NCT02285803.

137. Pal N, Maire R, Stephan MA, et al. Transcranial Direct Current Stimulation for the Treatment of Chronic Tinnitus: A Randomized Controlled Study. Brain stimulation 2015;8(6):1101-07. BACKGROUND: Tinnitus is an often disabling condition for which there is no effective therapy. Current research suggests that tinnitus may develop due to maladaptive plastic changes and altered
activity in the auditory and prefrontal cortex. Transcranial direct current stimulation (tDCS) modulates brain activity and has been shown to transiently suppress tinnitus in trials.

OBJECTIVE To investigate the efficacy and safety of tDCS in the treatment of chronic subjective tinnitus.

METHODS In a randomized, parallel, double-blind, sham-controlled study, the efficacy and safety of cathodal tDCS to the auditory cortex with anode over the prefrontal cortex was investigated in five sessions over five consecutive days. Tinnitus was assessed after the last session on day 5, and at follow-up visits 1 and 3 months post-stimulation using the Tinnitus Handicap Inventory (THI, primary outcome measure), Subjective Tinnitus Severity Scale, Hospital Anxiety and Depression scale, Visual Analogue Scale, and Clinical Global Impression scale.

RESULTS 42 patients were investigated, 21 received tDCS and 21 sham stimulation. There were no beneficial effects of tDCS on tinnitus as assessed by primary and secondary outcome measures. Effect size assessed with Cohen’s d amounted to 0.08 (95% CI: -0.52 to 0.69) at 1 month and 0.18 (95% CI: -0.43 to 0.78) at 3 months for the THI.

CONCLUSION tDCS of the auditory and prefrontal cortices is safe, but does not improve tinnitus. Different tDCS protocols might be beneficial.


INTRODUCTION There is some debate as to what extent epidemiological data for the prevalence of childhood tinnitus can be relied on. While indications are that the prevalence is relatively high, referral numbers for children with tinnitus are reported to be low and many of the studies have a number of methodological difficulties. We describe the protocol of a systematic review aimed at assessing the prevalence of tinnitus and/or hyperacusis in children and young people.

METHODS AND ANALYSIS We will include studies of any design (except case reports or case series) comparing the prevalence of tinnitus and/or hyperacusis in children and young people with and without hearing loss, any known external exposure and psychological disorders. We will search the following databases: PubMed, EMBASE and Scopus. No restrictions of language will be applied in the search strategy but during the article selection language is limited to English, German and Scandinavian languages. Primary and additional outcomes will be the prevalence of tinnitus/hyperacusis and the severity, respectively.

ETHICS AND DISSEMINATION No ethical issues are foreseen. The results will be published in a peer-reviewed journal and presented at national and international conferences of audiology and paediatrics.

TRAIL REGISTRATION NUMBER This review protocol is registered in the PROSPERO International Prospective Register of Systematic Reviews, registration number CRD42014013456.


Neuromodulation is an increasingly accepted treatment for neurological and psychiatric disorders but is limited by its invasiveness or its inability to target deep brain structures using noninvasive techniques. We propose a new concept called Multimodal Synchronization Therapy (mSync) for achieving targeted activation of the brain via noninvasive and precisely timed activation of auditory, visual, somatosensory, motor, cognitive, and limbic pathways. In this initial study in guinea pigs, we investigated mSync using combined activation of just the auditory and somatosensory pathways, which induced differential and timing dependent plasticity in neural firing within deep brain and cortical regions of the auditory system. Furthermore, by varying the location of somatosensory stimulation across the body, we increased or decreased spiking activity across different neurons. These encouraging results demonstrate the feasibility of systematically
modulating the brain using mSync. Considering that hearing disorders such as tinnitus and hyperacusis have been linked to abnormal and hyperactive firing patterns within the auditory system, these results open up the possibility for using mSync to decrease this pathological activity by varying stimulation parameters. Incorporating multiple types of pathways beyond just auditory and somatosensory inputs and using other activation patterns may enable treatment of various brain disorders.

140. Mahmoudian S, Farhadi M, Mohebbi M, et al. Alterations in auditory change detection associated with tinnitus residual inhibition induced by auditory electrical stimulation. *Journal of the American Academy of Audiology* 2015;26(4):408-22. BACKGROUND Residual inhibition (RI) is a temporary phenomenon that happens following offset of appropriate complete or partial acoustical and electrical masking stimulations in people who experience tinnitus. The biologic mechanisms associated with RI are not yet fully understood. Few studies have been focused on RI. Auditory mismatch negativity (MMN) as a change-detection tool may be an appropriate tool to explore the processing changes because of tinnitus and RI. PURPOSE The purpose of this study was to investigate alterations in auditory change detection and auditory sensory memory related to RI induced by auditory electrical stimulation (AES) using MMN brain mapping in participants with tinnitus. RESEARCH DESIGN This investigation was a single-blind randomized controlled clinical trial study. Participants were randomly assigned into two groups: AES and placebo electrical stimulation (PES). STUDY SAMPLE Twenty-eight participants with chronic subjective tinnitus aged 22- to 45-yr-old participated in the study. INTERVENTION After randomization, all participants received both AES and PES for 1 min in different sessions. DATA COLLECTION AND ANALYSIS Brain mapping of multifeature MMN paradigm was recorded from 29 scalp electrodes pre- and post-AES and PES. Following AES, participants were categorized into two groups: RI and nonresidual inhibition (NRI). The grand average MMN waveforms and isopotential topographic maps were obtained in RI, NRI, and PES groups. RESULTS Three MMN parameters for five deviants of frequency, intensity, duration, location, and silent gap were compared among three groups of RI, NRI, and PES. Statistical analyses revealed significant between-subject effects for AES on MMN amplitude of frequency and duration deviant, MMN area under the curve of frequency, intensity, and duration deviants. CONCLUSION Presence of RI can reestablish change-detection mechanisms in the central auditory pathways. It is suggested that MMN is reliable for assessment of change-detection system in people with tinnitus. It can be a useful technique in monitoring effects of treatments and rehabilitation.

141. Liu W, Liu Z, Zheng N, et al. Temporal Bone Pneumatization and Pulsatile Tinnitus Caused by Sigmoid Sinus Diverticulum and/or Dehiscence. *BioMed Research International* 2015;2015:1-4. Background. Although air cells within temporal bone may play an important role in the transmission of pulsatile tinnitus (PT) noise, it has not been studied systematically. Purpose. To evaluate the difference in temporal bone pneumatization between PT patients with sigmoid sinus diverticulum and/or dehiscence (SSDD) and healthy people. Material and Methods. A total of 199 unilateral persistent PT patients with SSDD and 302 control subjects underwent dual-phase contrast-enhanced CT (DP-CECT), to assess the grade of temporal bone pneumatization in each ear. Results. In the bilateral temporal bone of 302 controls, 16 ears were grade I, 53 were grade II, 141 were grade III, and 394 were grade IV. Among the affected ears of 199 PT cases, 1 ear was grade I, 18 were grade II, 53 were grade III, and 127 were grade IV. There was no significant difference in the pneumatization grade between the affected PT ear and either ear in the healthy subjects (p > 0.05).
Conclusion. Although air cells within the temporal bone are an important factor in the occurrence of PT, its severity does not differ significantly from the pneumatization of healthy people.

142. Li T-T, Wang Z-J, Yang S-B, et al. Transcutaneous electrical stimulation at auricular acupoints innervated by auricular branch of vagus nerve pairing tone for tinnitus: study protocol for a randomized controlled clinical trial. *Trials* 2015;16:101. BACKGROUND Subjective tinnitus is a phantom sensation experienced in the absence of any source of sound. Its mechanism remains unclear, and no approved drugs are available. Vagus nerve stimulation (VNS) is an exciting new method to treat tinnitus, but direct electrical stimulation of the cervical vagus has disadvantages. This randomized controlled clinical trial aims to overcome these limitations by stimulating the auricular branch of vagus nerve (ABVN) on the outer ear. Since the ABVN is the only peripheral branch of the vagus nerve distributed on the ear's surface, it should be possible to achieve analogous efficacy to VNS by activating the central vagal pathways. However, researches have indicated that the curative effect lies in a combination of auditory and vagal nerve stimulation. Moreover, from traditional Chinese theory, auricular acupoints used to treat tinnitus are mainly in the regions supplied by the ABVN. Whether stimulation at the auricular acupoints is due to unintentional stimulation of vagal afferent fibers also needs evidence. METHODS/DESIGN A total of 120 subjects with subjective tinnitus are randomized equally into four groups: (1) electrical stimulation at auricular acupoints (CO10, CO11, CO12, and TF4) innervated by the ABVN; (2) electrical stimulation at auricular acupoints (CO10, CO11, CO12, and TF4) innervated by ABVN pairing tones; (3) electrical stimulation at auricular acupoints innervated by non-ABVN pairing tones; (4) electrical acupuncture. Patients will be treated for 30 minutes every other day for 8 weeks. The primary outcome measure is the Tinnitus Handicap Inventory. The secondary outcome measure combines a visual analogue scale to measure tinnitus disturbance and loudness with the Hospital Anxiety and Depression Scale. Assessment is planned at baseline (before treatment) and in the 4th and 8th week, with further follow-up visits after termination of the treatment at the 12th week. Any adverse events will be promptly documented. DISCUSSION Completion of this trial will help to confirm whether ABVN or the combination of ABVN and sound stimulus plays a more important role in treating tinnitus. Moreover, the result of this clinical trial will enhance our understanding of specific auricular acupoints. TRIAL REGISTRATION Chinese Clinical Trials Register ChiCTR-TRC-14004940.

143. Krings JG, Wineland A, Kallogjeri D, et al. A novel treatment for tinnitus and tinnitus-related cognitive difficulties using computer-based cognitive training and D-cycloserine. *JAMA Otolaryngology-Head & Neck Surgery* 2015;141(1):18-26. Importance: Tinnitus affects more than 40 million people in the United States, and cognitive difficulties are among the most commonly associated symptoms. Objective: To test the feasibility and preliminarily the effectiveness of using a putative neuroplasticity-enhancing drug, D-cycloserine, to facilitate a computer-assisted CT program for improving tinnitus bother and related cognitive difficulties. Design, Setting, and Participants: Double-blind, randomized clinical trial at an outpatient academic medical center of 34 participants aged 35 to 65 years with subjective, unilateral or bilateral, nonpulsatile tinnitus of at least 6 months’ duration. Interventions: Five weeks of twice-weekly computer-based CT with either 250 mg D-cycloserine or placebo orally prior to computer CT sessions. Main Outcomes and Measures: Difference in the change in Tinnitus Functional Index (TFI) score between the 2 groups. Results: After excluding 1 participant lost to follow-up, 1 who withdrew, 1 who did not complete 90% of sessions, and 1 outlier, 30 participants were included in the analysis. The D-cycloserine plus CT group showed
a significant improvement in median TFI score (-5.8 [95% CI, -9.4 to -1.1]) and self-reported cognitive deficits (-4.5 [95% CI, -11.5 to -1.0]), but the placebo group did not (-1.0 [95% CI, -11.7 to 4.9] and -2.0 [95% CI, -5.1 to 2.0], respectively). After controlling for age and duration of tinnitus, there was no significant difference in TFI score change between the 2 groups (P = .41). After confounders were controlled for, the D-cycloserine group demonstrated a significantly greater improvement in self-reported cognitive deficits as compared with the placebo group (P = .03). No serious adverse events were reported.

Conclusions and Relevance: Use of a computer-based CT program with a putative neuroplasticity-sensitizing drug, D-cycloserine, was feasible and well tolerated. With the limited sample size, the adjuvant use of D-cycloserine was no more effective than placebo at improving tinnitus bother. The finding that D-cycloserine use was more effective than placebo at improving self-reported cognitive difficulties could be important given the high rate of concern for cognitive deficits in patients with tinnitus. D-cycloserine and other putative neuroplasticity-facilitating agents could be investigated in the future as a strategy to enhance neuroplasticity-based tinnitus treatments.

Trial Registration: clinicaltrials.gov Identifier: NCT01550796.

144. Kreuzer PM, Lehner A, Schlee W, et al. Combined rTMS treatment targeting the Anterior Cingulate and the Temporal Cortex for the Treatment of Chronic Tinnitus. Scientific reports 2015;5:18028. Repetitive transcranial magnetic stimulation (rTMS) has been proposed as a tinnitus treatment option. Promising results have been obtained by consecutive stimulation of lateral frontal and auditory brain regions. We investigated a combined stimulation paradigm targeting the anterior cingulate cortex (ACC) with double cone coil rTMS, followed by stimulation of the tempo-parietal junction area with a figure-of-eight coil. The study was conducted as a randomized, double-blind pilot trial in 40 patients suffering from chronic tinnitus. We compared mediofrontal stimulation with double-cone-coil, (2000 stimuli, 10 Hz) followed by left temporo-parietal stimulation with figure-of-eight-coil (2000 stimuli, 1 Hz) to left dorsolateral-prefrontal-cortex stimulation with figure-of-eight-coil (2000 stimuli, 10 Hz) followed by temporo-parietal stimulation with figure-of-eight-coil (2000 stimuli, 1 Hz). The stimulation was feasible with comparable dropout rates in both study arms; no severe adverse events were registered. Responder rates did not differ in both study arms. There was a significant main effect of time for the change in the TQ score, but no significant time x group interaction. This pilot study demonstrated the feasibility of combined mediofrontal/temporoparietal-rTMS-stimulation with double cone coil in tinnitus patients but failed to show better outcome compared to an actively rTMS treated control group.

145. Henry JA, Frederick M, Sell S, et al. Validation of a novel combination hearing aid and tinnitus therapy device. Ear & Hearing (01960202) 2015;36(1):42-52. Objectives: Most patients with tinnitus also have hearing loss. Hearing aids have been well-documented to provide amelioration for both hearing and tinnitus problems. Some hearing aids have built-in noise/sound generators that are intended to provide added benefit to patients with tinnitus. It has not been proven, however, whether these "combination instruments" are more effective for tinnitus management than hearing aids alone. The purpose of this study was to collect initial data addressing this question. Design: Thirty individuals meeting study requirements (bothersome tinnitus, hearing aid candidate, and no use of hearing aids for the previous 12 months) were enrolled. All participants initially completed the primary outcome questionnaire (Tinnitus Functional Index [TFI]) and then returned to be fitted with combination instruments. The hearing aid portion of the devices was adjusted to optimize hearing ability. Participants were then randomized to either the experimental group (n = 15) or the control group (n = 15). The experimental group had the noise feature of the instruments activated and
adjusted to achieve optimal relief from tinnitus. The control group did not have the noise portion activated. Following the hearing aid fitting, all study participants also received brief tinnitus counseling. Participants returned 1 to 2 weeks later for a follow-up appointment to confirm proper fit of the instruments and to make any necessary programming adjustments. Additionally, they returned 3 months after the fitting to complete the TFI, which also concluded their participation in the study.

Results: Both groups revealed significant improvement, as indicated by reductions in mean TFI index scores. Differences between groups at 3 months were not statistically significant. However, the experimental group showed a mean reduction in the TFI score that was 6.4 points greater than that for the control group. The difference approached significance (p = 0.09), suggesting that a larger group of participants may have resulted in a significant difference between groups. This possibility is tempered by the fact that effect sizes, which control for variation, were very similar between groups.

Conclusions: Results of this study suggest that the use of hearing aids alone or hearing aids plus the use of sound generators both provide significant benefit with respect to alleviating effects of tinnitus. A larger controlled clinical trial is needed to obtain more definitive results regarding the two configurations of hearing aids.


INTRODUCTION
In Europe alone, over 70 million people experience tinnitus. Despite its considerable socioeconomic relevance, progress in developing successful treatments has been limited. Clinical effectiveness is judged according to change in primary outcome measures, but because tinnitus is a subjective condition, the definition of outcomes is challenging and it remains unclear which distinct aspects of tinnitus (ie, ‘domains’) are most relevant for assessment. The development of a minimum outcome reporting standard would go a long way towards addressing these problems. In 2006, a consensus meeting recommended using 1 of 4 questionnaires for tinnitus severity as an outcome in clinical trials, in part because of availability in different language translations. Our initiative takes an approach motivated by clinimetrics, first by determining what to measure before seeking to determine how to measure it. Agreeing on the domains that contribute to tinnitus severity (ie, ‘what’) is the first step towards achieving a minimum outcome reporting standard for tinnitus that has been reached via a methodologically rigorous and transparent process.

METHODS AND ANALYSIS
Deciding what should be the core set of outcomes requires a great deal of discussion and so lends itself well to international effort. This protocol lays out the first-step methodology in defining a Core Domain Set for clinical trials of tinnitus by establishing existing knowledge and practice with respect to which outcome domains have been measured and which instruments used in recent registered and published clinical trials. ETHICS AND DISSEMINATION
No ethical issues are foreseen. Findings will be reported at national and international ear, nose and throat (ENT) and audiology conferences and in a peer-reviewed journal, using PRISMA (Preferred Reporting Items for Systematic reviews and Meta-analysis) guidelines. TRIAL REGISTRATION NUMBER
The systematic review protocol is registered on PROSPERO (International Prospective Register of Systematic Reviews): CRD42015017525.


IMPORTANCE
Chronic tinnitus negatively affects the quality of life for millions of people. This clinical trial assesses a potential treatment for tinnitus.

OBJECTIVES
To determine if repetitive transcranial magnetic stimulation (rTMS) can reduce the perception or
severity of tinnitus and to test the hypothesis that rTMS will result in a statistically significantly greater percentage of responders to treatment in an active rTMS group compared with a placebo rTMS group.

**DESIGN, SETTING, AND PARTICIPANTS**
A randomized, participant and clinician or observer-blinded, placebo-controlled clinical trial of rTMS involving individuals who experience chronic tinnitus. Follow-up assessments were conducted at 1, 2, 4, 13, and 26 weeks after the last treatment session. The trial was conducted between April 2011 and December 2014 at Portland Veterans Affairs Medical Center among 348 individuals with chronic tinnitus who were initially screened for participation. Of those, 92 provided informed consent and underwent more detailed assessments. Seventy individuals met criteria for inclusion and were randomized to receive active or placebo rTMS. Sixty-four participants (51 men and 13 women, with a mean [SD] age of 60.6 [8.9] years) were included in the data analyses. No participants withdrew because of adverse effects of rTMS.

**INTERVENTIONS**
Participants received 2000 pulses per session of active or placebo rTMS at a rate of 1-Hz rTMS daily on 10 consecutive workdays.

**MAIN OUTCOMES AND MEASURES**
The Tinnitus Functional Index (TFI) was the main study outcome. Our hypothesis was tested by comparing baseline and posttreatment TFIs for each participant and group.

**RESULTS**
Overall, 18 of 32 participants (56%) in the active rTMS group and 7 of 32 participants (22%) in the placebo rTMS group were responders to rTMS treatment. The difference in the percentage of responders to treatment in each group was statistically significant ($\chi^2(1)(2) = 7.94, \ P < .005$).

**CONCLUSIONS AND RELEVANCE**
Application of 1-Hz rTMS daily for 10 consecutive workdays resulted in a statistically significantly greater percentage of responders to treatment in the active rTMS group compared with the placebo rTMS group. Improvements in tinnitus severity experienced by responders were sustained during the 26-week follow-up period. Before this procedure can be implemented clinically, larger studies should be conducted to refine treatment protocols.

**TRIAL REGISTRATION**
clinicaltrials.gov Identifier: NCT01104207.

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148. Figueiredo RR, de Azevedo AA, Penido NdO. Tinnitus and arterial hypertension: a systematic review. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272(11):3089-94. Tinnitus is considered a multi-factorial symptom. Arterial hypertension has been cited as a tinnitus etiological factor. To assess the scientific evidence on the associations between arterial hypertension and tinnitus. A systematic review was performed using PubMed, ISI Web, Lilacs and SciELO scientific databases. This review included articles published in Portuguese, Spanish, French and English correlating tinnitus with hypertension. Letters to editors and case reports were excluded. A total of 424 articles were identified, of which only 20 met the inclusion criteria. Studies that analyzed the incidence of hypertension in tinnitus patients tended to show an association, while those that evaluated the incidence of tinnitus in hypertensive patients did not. There is evidence of an association between tinnitus and hypertension, although a cause and effect relationship is uncertain. Changes in the cochlear microcirculation, resulting in hearing loss, may be an adjuvant factor in tinnitus pathophysiology.

149. Dehkordi MA, Einolghozati S, Ghasemi SM, et al. Effect of low-level laser therapy in the treatment of cochlear tinnitus: A double-blind, placebo-controlled study. *ENT: Ear, Nose & Throat Journal* 2015;94(1):32-36. Many treatments for chronic tinnitus have been attempted, but the condition remains difficult to cure, especially in the case of cochlear tinnitus. We conducted a prospective, double-blind, placebo-controlled study to assess the effect of low-dose laser therapy on chronic cochlear tinnitus. Our study population was made up of 66 patients--33 who received active
laser treatment (case group) and 33 who received inactive dummy treatment (control group). Patients in the laser group received 5 mV with a wave length of 650 nm for 20 minutes a day, 5 days a week, for 4 weeks. The controls followed the same schedule, but they were ‘treated’ with an inactive device. The degree of tinnitus was evaluated before and after treatment in each group in three ways: (1) the Tinnitus Severity Index (TSI), (2) a subjective 10-point self-assessment scale for tinnitus loudness, and (3) the Tinnitus Evaluation Test (TET). A study's end, we found no statistically significant difference, between the case and control groups in the number of patients who experienced a reduction in TSI values (p = 0.589) or a reduction in subjective self-assessment scores (p = 0.475). Nor did we find any significant reductions in the loudness (p = 0.665) and frequency (p = 0.396) of tinnitus as determined by the TET. We conclude that 5-mV laser therapy with a wavelength of 650 nm is no better than placebo for improving hearing thresholds overall or for treating tinnitus with regard to age, sex, environmental noise level, and the duration of tinnitus.

150. Conrad I, Kleinstäuber M, Jasper K, et al. The Changeability and Predictive Value of Dysfunctional Cognitions in Cognitive Behavior Therapy for Chronic Tinnitus. *International Journal of Behavioral Medicine* 2015;22(2):239-50. Background: Multidimensional tinnitus models describe dysfunctional cognitions as a complicating factor in the process of tinnitus habituation. However, this concept has rarely been investigated in previous research. Purpose: The present study investigated the effects of two cognitive-behavioral treatments on dysfunctional tinnitus-related cognitions in patients with chronic tinnitus. Furthermore, dysfunctional cognitions were examined as possible predictors of the therapeutic effect on tinnitus distress. Method: A total of 128 patients with chronic tinnitus were randomly assigned to either an Internet-delivered guided self-help treatment (Internet-based cognitive-behavioral therapy, ICBT), a conventional face-to-face group therapy (cognitive-behavioral group therapy, GCBT), or an active control group in the form of a web-based discussion forum (DF). To assess tinnitus-related dysfunctional thoughts, the Tinnitus Cognitions Scale (T-Cog) was used at pre- and post-assessment, as well as at the 6- and 12-month follow-up. Results: Multivariate ANOVAs with post hoc tests revealed significant and comparable reductions of dysfunctional tinnitus-related cognitions for both treatments (GCBT and ICBT), which remained stable over a 6- and 12-month period. Negative correlations were found between the catastrophic subscale of the T-Cog and therapy outcome for ICBT, but not for GCBT. This means a higher degree of catastrophic thinking at baseline was associated with lower benefit from ICBT directly after the treatment. Hierarchical regression analysis confirmed catastrophizing as a predictor of poorer therapy outcome regarding emotional tinnitus distress in ICBT. No associations were detected in the follow-up assessments. Conclusion: Both forms of CBT are successful in reducing dysfunctional tinnitus-related cognitions. Catastrophizing significantly predicted a less favorable outcome regarding emotional tinnitus distress in ICBT. Clinical implications of these results are described. Dysfunctional cognitions could be targeted more intensively in therapy and in future research on tinnitus.

151. Bilici S, Yigit O, Taskin U, et al. Medium-term results of combined treatment with transcranial magnetic stimulation and antidepressant drug for chronic tinnitus. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272(2):337-43. We compared the effects of repetitive transcranial magnetic stimulation (rTMS) and paroxetine [a selective serotonin reuptake inhibitor (SSRI)] on tinnitus in terms of effectiveness and medium-term results. This is a randomised, double-blind, placebo-controlled study. Seventy-five
patients with moderate tinnitus were divided into five equal groups. Each group was treated for 1 month as follows: group 1 received rTMS alone at 1 Hz frequency; group 2 received rTMS alone at 10 Hz frequency; group 3 received rTMS at 1 Hz frequency combined with paroxetine; group 4 received paroxetine alone; and group 5 received a placebo (sham rTMS). Participants were tested using the Tinnitus Handicap Inventory (THI), Tinnitus Severity Index (TSI), the Beck Anxiety Scoring (BAS), and Psychiatric Sign Screening (PSS) tests. THI, TSI, BAS, and PSS were measured prior to treatment, and at the first and sixth month post-treatment. The THI and TSI scores improved after treatment in all groups, except the placebo group. The THI scores in groups 1 and 2 showed a statistically significant improvement after the first and sixth month compared to pretreatment scores, whereas a significant improvement in THI scores occurred only after the sixth month in groups 3 and 4. The TSI scores in group 3 showed a significant improvement at the first and sixth month marks after treatment. The rTMS and SSRI play potential roles in the reduction of tinnitus severity, but without cumulative or synergistic effects when a combination of treatment regimens is applied. These positive effects might be due to the relationship between the auditory cortex areas related to emotions and tinnitus.

152. Basura GJ, Koehler SD, Shore SE. Bimodal stimulus timing-dependent plasticity in primary auditory cortex is altered after noise exposure with and without tinnitus. Journal of neurophysiology 2015;114(6):3064-75. Central auditory circuits are influenced by the somatosensory system, a relationship that may underlie tinnitus generation. In the guinea pig dorsal cochlear nucleus (DCN), pairing spinal trigeminal nucleus (Sp5) stimulation with tones at specific intervals and orders facilitated or suppressed subsequent tone-evoked neural responses, reflecting spike timing-dependent plasticity (STDP). Furthermore, after noise-induced tinnitus, bimodal responses in DCN were shifted from Hebbian to anti-Hebbian timing rules with less discrete temporal windows, suggesting a role for bimodal plasticity in tinnitus. Here, we aimed to determine if multisensory STDP principles like those in DCN also exist in primary auditory cortex (A1), and whether they change following noise-induced tinnitus. Tone-evoked and spontaneous neural responses were recorded before and 15 min after bimodal stimulation in which the intervals and orders of auditory-somatosensory stimuli were randomized. Tone-evoked and spontaneous firing rates were influenced by the interval and order of the bimodal stimuli, and in sham-controls Hebbian-like timing rules predominated as was seen in DCN. In noise-exposed animals with and without tinnitus, timing rules shifted away from those found in sham-controls to more anti-Hebbian rules. Only those animals with evidence of tinnitus showed increased spontaneous firing rates, a purported neurophysiological correlate of tinnitus in A1. Together, these findings suggest that bimodal plasticity is also evident in A1 following noise damage and may have implications for tinnitus generation and therapeutic intervention across the central auditory circuit.

153. Bagger-Sjöbäck D, Strömbäck K, Hultcrantz M, et al. High-frequency hearing, tinnitus, and patient satisfaction with stapedotomy: A randomized prospective study. Scientific reports 2015;5:13341. Otosclerosis is a common disorder that leads to conductive hearing loss. Most patients with otosclerosis also have tinnitus, and surgical treatment is known to improve hearing as well as tinnitus. Some patients however experience worsening of tinnitus after the operation, but there are no known factors that allow surgeons to predict who will be at risk. In this prospective observational study on 133 patients undergoing stapedotomy, we show that postoperative air conduction thresholds at very high stimulus frequencies predict improvement of tinnitus, as assessed with proportional odds logistic regression models. Young patients were significantly more likely to experience reduction of tinnitus and patients whose tinnitus became better were also more
satisfied with the outcome of the operation. These findings have practical importance for patients and their surgeons. Young patients can be advised that surgery is likely to be beneficial for their tinnitus, but a less positive message should be conveyed to older patients.

154. Arts RAGJ, George ELJ, Chenault MN, et al. Optimizing intracochlear electrical stimulation to suppress tinnitus. *Ear and hearing* 2015;36(1):125-35. OBJECTIVES Research on tinnitus suppression by intracochlear electrical stimulation has gained interest over the past few decades and it has become easier to apply since the introduction of cochlear implants (CI). This study attempted to gain more insight into optimal stimulation characteristics for tinnitus suppression. DESIGN Eleven subjects with unilateral CI and tinnitus were recruited from our CI clinic. Electrical stimulation, independent of acoustic sounds, was generated using their CI. The current prospective (single blinded) experimental study systematically assessed two stimulation parameters, namely current level and the anatomical stimulation site inside the cochlea and their short-term effect on tinnitus. RESULTS Approximately one-third of the tested conditions were successful in which case tinnitus loudness was reduced by at least 30%. At least one successful condition was achieved for nine subjects (82%). Complete suppression was achieved in 6 out of 107 tested conditions (6%). The effect of subthreshold electrical stimulation on tinnitus suppression did not differ significantly from above threshold electrical stimulation. However, a positive relation between mean percentage tinnitus suppression and current level was observed. Pitch-matched electrical stimulation did not appear to suppress tinnitus better than other tested conditions. CONCLUSIONS The majority of the subjects were able to experience tinnitus reduction through intracochlear electrical stimulation independent of acoustic sounds. Tinnitus can be reduced with audible or even inaudible, subthreshold stimuli. Clear trends in optimal stimulation characteristics were not found. Optimal stimulus characteristics for tinnitus reduction therefore appear to be highly subject-specific.

155. Andersson G. Clinician-Supported Internet-Delivered Psychological Treatment of Tinnitus. *American Journal of Audiology* 2015;24(3):299-301. PURPOSE: Internet-delivered psychological treatments for tinnitus distress have existed for more than 15 years, and there are a slowly growing number of studies. The aim of this brief report is to review the evidence and to comment on the future potentials of Internet treatments for tinnitus. METHOD: Studies were retrieved, and in total 6 controlled studies were included in the review with 9 different comparisons (6 in which the treatment was compared against a control group and 3 in which Internet treatment was compared against group treatment). Moreover, 2 open studies based on clinical samples in regular care were also included in the review. The outcomes for the 2 controlled sets of studies were analyzed using meta-analytic methods. RESULTS: For the 6 studies comparing Internet treatment against a no-treatment control condition, a moderate effect size was found (Hedges’s g = 0.58). The 3 studies comparing Internet treatment against face-to-face group treatments showed a small difference of Hedges’s g = 0.13. Conclusions: Internet-delivered psychological treatment holds promise as a treatment alternative to other standard forms of treatment delivery, including group treatment. Larger studies are needed as well as ways to blend information technology with regular services.

156. Xie H, Li X, Lai J, et al. Effectiveness of De Qi during acupuncture for the treatment of tinnitus: study protocol for a randomized controlled trial. *Trials* 2014;15:397. BACKGROUND: Acupuncture has been used in China to treat tinnitus for a long time. There is debate as to whether or not De Qi is a key factor in achieving the efficacy of acupuncture. However, there is no sufficient evidence obtained from randomized controlled trials to confirm the role of De Qi in the treatment of
acupuncture for tinnitus. This study aims to identify the effect of De Qi for patients who receive acupuncture to alleviate tinnitus by a prospective, double-blind, randomized, sham-controlled trial.

METHODS AND DESIGN

This study compares two acupuncture groups (with or without manipulation) in 292 patients with a history of subjective tinnitus. The trial will be conducted in the Teaching Hospital of Chengdu University of Traditional Chinese Medicine. In the study, the patients will be randomly assigned into two groups according to a computer-generated randomization list and assessed prior to treatment. Then, they will receive 5 daily sessions of 30 minutes each time for 4 consecutive weeks and undergo a 12-week follow-up phase. The administration of acupuncture follows the guidelines for clinical research on acupuncture (WHO Regional Publication, Western Pacific Series Number 15, 1995), and is performed double-blind by physicians well-trained in acupuncture. The measures of outcome include the subjective symptoms scores and quantitative sensations of De Qi evaluated by Visual Analog Scales (VAS) and the Chinese version of the 'modified' Massachusetts General Hospital Acupuncture Sensation Scale (C-MMASS). Furthermore, adverse events are recorded and analyzed. If any subjects are withdrawn from the trial, intention-to-treat (ITT) and per-protocol (PP) analysis will be performed.

DISCUSSION

The key features of this trial include the randomization procedures, large sample and the standardized protocol to evaluate De Qi qualitatively and quantitatively in the treatment of acupuncture for tinnitus. The trial will be the first study with a high evidence level in China to assess the efficacy of De Qi in the treatment of tinnitus in a randomized, double-blind, sham-controlled manner.

TRIAL REGISTRATION

Chinese Clinical Trial Registry: ChiCTR-TRC-14004720 (6 May 2014).


Background: Little is known about patient factors that might influence outcomes of tinnitus interventions. Determining such factors would offer insights into why some individuals benefit from tinnitus intervention whereas others do not. Purpose: The purpose of this study was to evaluate selected patient factors that may be associated with outcomes of tinnitus intervention. Factors studied include demographics, tinnitus characteristics, psychoacoustic tinnitus measures, audiometric data, and overall physical/emotional health status. Research Design: A retrospective analysis was performed on data obtained from a controlled clinical study that compared factors associated with tinnitus relief after tinnitus masking and tinnitus retraining therapy. Study Sample: A total of 126 military veterans participated in this controlled clinical study. Of these, 89 completed outcome measures at both baseline and 12 mo and were included in the present analysis. Data Collection and Analysis: A "responder" to intervention was identified as having a decrease (improvement) of 20 or more points on the Tinnitus Handicap Inventory between baseline and 12 mo. A "nonresponder" did not achieve a 20-point improvement on the Tinnitus Handicap Inventory. Individual patient factors were examined using independent t-tests or χ2 analysis. A logistic regression model was used to determine how well each factor predicted treatment outcome (responder or nonresponder) while controlling for each of the other factors. Results: Five patient factors were significantly different (p ≤ 0.05) between responders and nonresponders. Responders tended to (1) be younger in age; (2) have better low-frequency hearing sensitivity; (3) have greater problems with overall hearing; (4) be more likely to have tinnitus for shorter durations; and (5) perceive their tinnitus to be located "in the head" versus "in the ears." A logistic regression was then performed to determine how well each factor predicted the treatment outcome (responder versus nonresponder) while controlling for each of the other factors. Results from the logistic regression
revealed two of the five factors, localization of tinnitus and self-report of hearing problems, to be statistically significant. Conclusions: Examining the association of individual patient factors to a specific tinnitus intervention yielded several significant findings. Although these findings are not definitive, they reveal the capability that exists to perform these kinds of analyses to investigate relationships between individual patient characteristics and outcomes of intervention for tinnitus. Prospective research using systematic approaches is needed to identify these relationships that would contribute toward the ability to differentially predict outcomes of various tinnitus interventions. Obtaining this information would lead to more targeted therapy and ultimately more effective intervention.

158. Shekhawat GS, Searchfield GD, Stinear CM. Randomized Trial of Transcranial Direct Current Stimulation and Hearing Aids for Tinnitus Management. *Neurorehabilitation and neural repair* 2014;28(5):410-19. Background The perception of sound in the absence of an external sound is tinnitus. Tinnitus can have a severe negative impact on quality of life. Objective This trial investigated whether multisession anodal transcranial direct current stimulation (tDCS) of the left temporoparietal area would enhance sound therapy from hearing aids. Methods Forty participants (mean age = 54 years) experiencing chronic tinnitus (minimum 2 years) completed a 7-month long double-blind randomized clinical trial. Participants were randomized into 2 groups: control receiving sham tDCS and experimental receiving tDCS. Each group underwent multisession (5 consecutive sessions with 24-hour gap) anodal tDCS (2 mA intensity and 20 minutes duration) of the left temporoparietal area, followed by hearing aid use for 6 months. The impact of tDCS and hearing aid use on tinnitus was assessed using questionnaires (primary measure: Tinnitus Functional Index) and minimum masking level measurement. Results There was a significant reduction in the overall Tinnitus Functional Index score with time, F(2, 37) = 11.9, P = .0001, for both the groups. Similar patterns were seen for secondary measures. tDCS appeared to have a positive effect on minimum masking levels but not questionnaire responses. Conclusions After 3 months of hearing aid use, there were significant improvements in tinnitus, which were sustained at 6 months of use. The hearing aid effects appeared independent of tDCS. Further investigations of tDCS or other neuromodulators priming the auditory system for sound therapy based tinnitus treatments are warranted.

159. Schilder AGM, Burton MJ, Eby TL, et al. Cochrane Corner: Amplification with Hearing Aids for Patients with Tinnitus and Co-existing Hearing Loss. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2014;150(6):915-18. The "Cochrane Corner" is a section in the journal that highlights systematic reviews relevant to otolaryngology-head and neck surgery, with invited commentary to aid clinical decision making. This installment features a Cochrane review, "Amplification with Hearing Aids for Patients with Tinnitus and Co-existing Hearing Loss," which identified only 1 randomized controlled trial and concluded that current evidence for use of hearing aids is limited.

160. Scherer RW, Formby C, Gold S, et al. The Tinnitus Retraining Therapy Trial (TRTT): study protocol for a randomized controlled trial. *Trials* 2014;15:396. Background Subjective tinnitus is the perception of sound in the absence of a corresponding external sound for which there is no known medical etiology. For a minority of individuals with tinnitus, the condition impacts their ability to lead a normal lifestyle and is severely debilitating. There is no known cure for tinnitus, so current therapy focuses on reducing the effect of tinnitus on the patient’s quality of life. Tinnitus retraining
therapy (TRT) uses nonpsychiatric tinnitus-specific educational counseling and sound therapy in a habituation-based protocol to reduce the patient’s tinnitus-evoked negative reaction to, and awareness of, the tinnitus, with the ultimate goal of reducing the tinnitus impact on the patient’s quality of life. Some studies support the efficacy of TRT, but no trial to date has compared TRT with the current standard of care or evaluated the separate contributions of TRT counseling and sound therapy. The Tinnitus Retraining Therapy Trial (TRTT) is a randomized, double-blind, placebo-controlled, multicenter trial for individuals with intolerable tinnitus.

METHODS/DESIGN The TRTT is enrolling active-duty and retired military personnel and their dependents with functionally adequate hearing sensitivity and severe tinnitus at US Air Force, Navy, and Army medical centers. Eligible study participants are randomized to TRT, partial TRT, or standard care to determine the efficacy of TRT and its components (TRT counseling and sound therapy). The primary outcome is change in score on the Tinnitus Questionnaire assessed longitudinally between baseline and follow-up (3, 6, 12, and 18 months following treatment). Secondary outcomes include subscale score changes in the Tinnitus Questionnaire, overall and subscale score changes in the Tinnitus Functional Index and Tinnitus Handicap Inventory, and change in the visual analog scale of the TRT Interview Form. Audiological outcomes include tinnitus pitch and loudness match and measures of loudness discomfort levels. The incidence of depression as a safety measure is assessed at each visit using the Beck Depression Inventory Fast Screen.

TRIAL REGISTRATION Clinicaltrials.gov NCT01177137.

161. Schecklmann M, Landgrebe M, Kleinjung T, et al. Changes in motor cortex excitability associated with temporal repetitive transcranial magnetic stimulation in tinnitus: hints for cross-modal plasticity? BMC neuroscience 2014;15:71. BACKGROUND Motor cortex excitability was found to be changed after repetitive transcranial magnetic stimulation (rTMS) of the temporal cortex highlighting the occurrence of cross-modal plasticity in non-invasive brain stimulation. Here, we investigated the effects of temporal low-frequency rTMS on motor cortex plasticity in a large sample of tinnitus patients. In 116 patients with chronic tinnitus different parameters of cortical excitability were assessed before and after ten rTMS treatment sessions. Patients received one of three different protocols all including 1 Hz rTMS over the left temporal cortex. Treatment response was defined as improvement by at least five points in the tinnitus questionnaire (TQ). Variables of interest were resting motor threshold (RMT), short-interval intra-cortical inhibition (SICI), intracortical facilitation (ICF), and cortical silent period (CSP). RESULTS After rTMS treatment RMT was decreased by about 1% of stimulator output near-significantly in the whole group of patients. SICI was associated with significant changes with respect to treatment response. The group of treatment responders showed a decrease of SICI over the course of treatment, the group of non-responders the reverse pattern. CONCLUSIONS Minor RMT changes during rTMS treatment do not necessarily suggest the need for systematic re-examination of the RMT for safety and efficacy issues. Treatment response to rTMS was shown to be related to changes in SICI that might reflect modulation of GABAergic mechanisms directly or indirectly related to rTMS treatment effects.

162. Schecklmann M, Giani A, Tupak S, et al. Functional near-infrared spectroscopy to probe state- and trait-like conditions in chronic tinnitus: a proof-of-principle study. Neural plasticity 2014;2014:894203. OBJECTIVE Several neuroscience tools showed the involvement of auditory cortex in chronic tinnitus. In this proof-of-principle study we probed the capability of functional near-infrared spectroscopy (fNIRS) for the measurement of brain oxygenation in auditory cortex in dependence from chronic tinnitus and from intervention with transcranial magnetic stimulation. METHODSTwenty-three patients received continuous theta burst stimulation over the...
left primary auditory cortex in a randomized sham-controlled neuronavigated trial (verum = 12; placebo = 11). Before and after treatment, sound-evoked brain oxygenation in temporal areas was measured with fNIRS. Brain oxygenation was measured once in healthy controls (n = 12).

RESULTS Sound-evoked activity in right temporal areas was increased in the patients in contrast to healthy controls. Left-sided temporal activity under the stimulated area changed over the course of the trial; high baseline oxygenation was reduced and vice versa. CONCLUSIONS By demonstrating that rTMS interacts with auditory evoked brain activity, our results confirm earlier electrophysiological findings and indicate the sensitivity of fNIRS for detecting rTMS induced changes in brain activity. Moreover, our findings of trait- and state-related oxygenation changes indicate the potential of fNIRS for the investigation of tinnitus pathophysiology and treatment response.

163. Savage J, Waddell A. Tinnitus. BMJ clinical evidence 2014;2014 INTRODUCTION Up to 18% of people in industrialised societies are mildly affected by chronic tinnitus, and 0.5% report tinnitus having a severe effect on their daily life. Tinnitus can be associated with hearing loss, acoustic neuromas, drug toxicity, ear diseases, and depression. Tinnitus can last for many years, and can interfere with sleep and concentration. METHODS AND OUTCOMES We conducted a systematic review and aimed to answer the following clinical question: What are the effects of treatments for chronic tinnitus? We searched: Medline, Embase, The Cochrane Library, and other important databases up to November 2013 (Clinical Evidence reviews are updated periodically; please check our website for the most up-to-date version of this review). We included harms alerts from relevant organisations such as the US Food and Drug Administration (FDA) and the UK Medicines and Healthcare products Regulatory Agency (MHRA). RESULTS We found 33 studies that met our inclusion criteria. We performed a GRADE evaluation of the quality of evidence for interventions. CONCLUSIONS In this systematic review, we present information relating to the effectiveness and safety of the following interventions: acamprosate, acupuncture, antidepressant drugs, benzodiazepines, carbamazepine, electromagnetic stimulation, ginkgo biloba, hearing aids, hypnosis, psychotherapy, tinnitus-masking devices, and cognitive behavioural therapy plus tinnitus-masking device (tinnitus retraining therapy).

164. Newman CW, Sandridge SA, Jacobson GP. Assessing outcomes of tinnitus intervention. Journal of the American Academy of Audiology 2014;25(1):76-105. BACKGROUND It has been estimated that as many as 50 million Americans do experience or have experienced tinnitus. For approximately 12 million of these individuals, tinnitus makes it impossible for them to carry out normal everyday activities without limitation. These are the patients that present to audiology clinics for assessment and management. The tinnitus evaluation includes the measurement of acoustical characteristics of tinnitus and the impact that this impairment has on health-related quality of life (HRQoL). Tinnitus is a disorder that often occurs as a result of auditory system impairment. The impairment for some can impart an activity limitation and a participation restriction (i.e., tinnitus-related disability or handicap, respectively). The goal of tinnitus management is to reduce, or eliminate, activity limitations and participation restrictions by reducing or eliminating a patient’s perception of tinnitus or their reaction to tinnitus. Implicit in this statement is the assumption that there exist standardized measures for quantifying the patient’s tinnitus perception and their reaction to it. If there existed stable and responsive standardized tinnitus measures, then it would be possible to compare a patient’s tinnitus experience at different time points (e.g., before and after treatment) to assess, for example, treatment efficacy. PURPOSE The purposes of the current review are to (1) describe psychometric standards used to select outcome measurement tools; (2) discuss
available measurement techniques and their application to tinnitus evaluation and treatment-related assessment within the domains established by the World Health Organization’s International Classification of Functioning, Disability and Health; (3) list and briefly describe self-report tinnitus questionnaires; (4) describe how valuation of tinnitus treatment can be assessed using economic models of treatment effectiveness; and (5) provide future directions including the development of a tinnitus outcomes test battery and treatment-related study designs.RESEARCH DESIGNRetrospective literature reviewCONCLUSIONSAlthough psychometrically robust measures of tinnitus HRQoL do exist, there is no unanimity in, for example, what tests should be included in the tinnitus assessment, and how studies of HRQoL should be conducted. The current authors suggest that future studies employ more rigorous designs and contain (minimally) the following characteristics: (1) utilization of randomized control groups and blinding; (2) appropriate statistical testing including "dropouts" that should be used in an "intention to treat" analysis rather than elimination from the final data set; (3) long-term follow-up assessment to evaluate responsiveness; (4) appropriate inclusion criteria to avoid "ceiling" and "floor" effects; and (5) suitable sample sizes based on the application of power analyses.

165. Myers PJ, Griest S, Kaelin C, et al. Development of a progressive audiologic tinnitus management program for Veterans with tinnitus. Journal of Rehabilitation Research & Development 2014;51(4):609-21. Tinnitus is the most prevalent service-connected disability awarded to Veterans. However, clinical protocols for management of tinnitus have been inconsistent across Department of Veterans Affairs (VA) medical centers. A study was funded to develop and pilot test a protocol to provide tinnitus services consistently across VA audiology clinics. Drawing on a series of prior VA and external research projects, a clinical model was formulated, supporting materials in multimedia were developed, and a pilot study was conducted. Five hierarchical levels of care were defined and labeled the Progressive Audiologic Tinnitus Management (PATM) model. The model facilitates access to medical services for tinnitus and includes detailed protocols for evaluation, education, and counseling of patients. Patients at each level of care have the option to "progress" to the next level of PATM if further services are required. Clinical procedures were defined for each level and materials were produced for audiologists and patients. The PATM model was then piloted with clinical patients at the James A. Haley Veterans’ Hospital (JAHVH) in Tampa, Florida. Throughout the pilot study, feedback from patients and clinicians was carefully noted. Training materials for audiologists, incorporation of the protocol into clinic activities, and patient outcomes were evaluated. The model was implemented within the JAHVH Audiology Clinic and to assist Veterans with tinnitus management. The most notable finding was how little tinnitus-specific intervention was required for the majority of patients. This finding supports a clinical model that offers stepped-care ("progressive") levels of care until tinnitus management is achieved by the patient.

166. Mei ZG, Yang SB, Cai SJ, et al. Treatment of tinnitus with electrical stimulation on acupoint in the distribution area of ear vagus nerve combining with sound masking: Randomized controlled trial. World Journal of Acupuncture - Moxibustion 2014;24(2):30-35. Objective: To observe the efficacy of treating tinnitus with electrical stimulation on acupoint in the distribution area of ear vagus nerve by combining with sound masking. Method(s): Sixty-three volunteers suffering from tinnitus were randomly divided into a treatment group (32 cases) and a control group (31 cases) according to envelope method. The treatment group was given the treatment with electrical stimulation on acupoint in the distribution area of ear vagus nerve by combining with sound masking while the control group was given the treatment by taking flunarizine hydrochloride capsules and
oryzanol orally. The treatment for both groups lasted for eight weeks. The efficacy was evaluated before treatment, 4 weeks and 8 weeks following the treatment respectively according to "Tinnitus Handicap Inventory" and "Tinnitus Dysphoria Inventory". Result(s): It was revealed from the Tinnitus Handicap Inventory that the differences were not statistically significant by comparing the two groups after treatment for 4 weeks (chi²=1.981, P=0.16); After 8 weeks of the treatment, patients with mild tinnitus and severe tinnitus were significantly improved in the treatment group compared with those before treatment (chi²=25.01, P<0.001) while the difference in the control group was not statistically significant before and after treatment (chi²=2.986, P=0.084), and the difference of the ratio of patients with mild tinnitus in the two groups was statistically significant (chi²=9.315, P=0.002). It was revealed from the Tinnitus Dysphoria Inventory that dysphoria of patients in the treatment group was more alleviated than that in the control group after treatment for 4 weeks (chi²=4.661, P=0.03); After 8 weeks of the treatment, the patients with mild dysphoria and severe dysphoria were significantly improved in the two groups (chi²=25.397, P<0.001 and chi²=7.828, P=0.005, respectively), and the efficacy in the treatment group was improved more significantly than that in the control group (chi²=5.857, P=0.016). It was shown from the comprehensive efficacy that after 8 weeks of treatment, the effective rates of the two groups were 90.63% (29/32) and 80.65% (25/31) respectively, and the difference between the two groups was not statistically significant (chi²=0.595, P=0.44). Conclusion Handicap and dysphoria of tinnitus can be improved significantly by treating with electrical stimulation on acupoint in the distribution area of ear vagus nerve and sound masking, and the efficacy was superior to that of western medicines.Copyright © 2014 World Journal of Acupuncture-Moxibustion House.

167. McKenna L, Handscomb L, Hoare DJ, et al. **A scientific cognitive-behavioral model of tinnitus: Novel conceptualizations of tinnitus distress.** *Frontiers in Neurology* 2014;5(OCT):196. The importance of psychological factors in tinnitus distress has been formally recognized for almost three decades. The psychological understanding of why tinnitus can be a distressing condition posits that it becomes problematic when it acquires an emotive significance through cognitive processes. Principle therapeutic efforts are directed at reducing or removing the cognitive (and behavioral) obstacles to habituation. Here, the evidence relevant to a new psychological model of tinnitus is critically reviewed. The model posits that patients' interpretations of tinnitus and the changes in behavior that result are given a central role in creating and maintaining distress. The importance of selective attention and the possibility that this leads to distorted perception of tinnitus is highlighted. From this body of evidence, we propose a coherent cognitive-behavioral model of tinnitus distress that is more in keeping with contemporary psychological theories of clinical problems (particularly that of insomnia) and which postulates a number of behavioral processes that are seen as cognitively mediated. This new model provides testable hypotheses to guide future research to unravel the complex mechanisms underpinning tinnitus distress. It is also well suited to define individual symptomatology and to provide a framework for the delivery of cognitive-behavioral therapy.Copyright © 2014 McKenna, Handscomb, Hoare and Hall.

168. Maudoux A, Lefebvre P. **Tinnitus: Mechanisms induced from human functional neuroimaging studies.** *Seminars in Hearing* 2014;35(2):131-44. The past 15 years has provided an unprecedented collection of discoveries that bear upon our scientific understanding of the pathophysiology of tinnitus. Highlighted among these discoveries is the fact that changes of brain activity accompany tinnitus. All tinnitus theories refer to common concepts. First, peripheral lesions in the cochlea or the auditory nerve produce dysfunctional input to central auditory structures and induce changes in
the auditory system. Associated to plastic changes in central auditory structures, neuroimaging studies show signs of the implication of extra-auditory regions in tinnitus pathophysiology. Collectively, these observations have led to important new insights into the understanding of tinnitus. Here, we review the advances made in this field of research using human functional neuroimaging methods. © 2014 by Thieme Medical Publishers, Inc.

169. Maes IHL, Cima RFF, Anteunis LJC, et al. Cost-effectiveness of specialized treatment based on cognitive behavioral therapy versus usual care for tinnitus. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2014;35(5):787-95. OBJECTIVE To evaluate the cost-effectiveness of specialized multidisciplinary tinnitus treatment based on cognitive behavioral therapy, compared with care as usual. DESIGN Randomized controlled trial including an economic evaluation from a health-care and societal perspective, using a one-year time horizon. SETTING Audiologic center. PATIENTS A referred sample of 626 patients with tinnitus were eligible for participation. Approximately 492 patients were included in the study. Eighty-six (35%) of 247 patients in the usual care group, and 74 (30%) of 245 patients in the specialized care group were lost to follow-up by month 12. MAIN OUTCOME MEASURES Quality adjusted life years (QALYs) as measured with the Health Utilities Index Mark III and cost in US dollars. RESULTs Compared with patients receiving usual care, patients who received specialized care gained on average 0.015 QALYs (95% bootstrapped confidence interval [BCI], -0.03 to 0.06). The incremental costs from a societal perspective are $357 (95% BCI, -$1,034 to $1,785). The incremental cost per QALY from a societal perspective amounted to $24,580. The probability that SC is cost-effective from a societal perspective is 58% for a willingness to pay for a QALY of $45,000. CONCLUSION Specialized multidisciplinary tinnitus treatment based on cognitive behavioral therapy is cost-effective as compared with usual care. Although uncertainty surrounding the incremental costs and effects is considerable, sensitivity analysis indicated that cost-effectiveness results were robust.

170. Langguth B, Landgrebe M, Frank E, et al. Efficacy of different protocols of transcranial magnetic stimulation for the treatment of tinnitus: Pooled analysis of two randomized controlled studies. *The world journal of biological psychiatry : the official journal of the World Federation of Societies of Biological Psychiatry* 2014;15(4):276-85. OBJECTIVE Tinnitus is related to alterations in neuronal activity of auditory and nonauditory brain areas. Targeted modulation of these areas by repetitive transcranial magnetic stimulation (rTMS) has been proposed as a new therapeutic approach for chronic tinnitus. METHODs Two randomized, double-blind, parallel-group, controlled clinical trials were performed subsequently and pooled for analysis. A total of 192 tinnitus patients were randomly allocated to receive 10 stimulation sessions of either sham rTMS, PET-based neuronavigated 1 Hz rTMS, 1 Hz r TMS over the left auditory cortex, or combined 20 Hz rTMS over the left frontal cortex, followed by 1 Hz rTMS over the left auditory cortex. RESULTS rTMS treatment was well tolerated and no severe side effects were observed. All active rTMS treatments resulted in significant reduction of the TQ as compared to baseline. The comparison between treatment groups failed to reach significant differences. The number of treatment responders was higher for temporal rTMS (38%) and combined frontal and temporal rTMS (43%), as compared to sham (6%). CONCLUSIONs This large study demonstrates the safety and tolerability of rTMS treatment in patients with chronic tinnitus. While the overall effect did not prove superior to placebo, secondary outcome parameters argue in favour of the active stimulation groups, and specifically the combined frontal and temporal rTMS protocol.
171. Kreuzer PM, Landgrebe M, Vielsmeier V, et al. Trauma-associated tinnitus. *The Journal of head trauma rehabilitation* 2014;29(5):432-42. BACKGROUND Up to 53% of individuals suffering from traumatic brain injuries develop tinnitus. OBJECTIVE To review the current literature on trauma-associated tinnitus in order to provide orientation for the clinical management of patients with trauma-associated tinnitus. MATERIALS A systematic literature search has been conducted in PubMed database applying the search terms posttraumatic tinnitus and trauma-associated tinnitus. Results have been complemented by related studies, book chapters, and the authors' clinical experience. RESULTS Not only mechanical, pressure-related, or noise-related head traumata but also neck injuries and emotional trauma can cause tinnitus. Exact diagnosis is essential. Disorders such as ossicular chain disruption, traumatic eardrum perforation, or perilymphatic fistula can be surgically treated. It should also be considered that pulsatile tinnitus can be a sign of life-threatening disorders such as carotid cavernous fistulas, arteriovenous malformations, and carotid dissections. Also, posttraumatic stress disorder should be taken into consideration as a potential contributing factor. CONCLUSION There is an evident mismatch between the high incidence of trauma-associated tinnitus and scarce literature on the topic. A consistent and-at best-standardized assessment of tinnitus- and hearing-related sequelae of trauma is recommended both for the improvement of clinical care and for a deeper understanding of the various pathophysiological mechanisms of trauma-associated tinnitus.

172. Kreuzer PM, Landgrebe M, Resch M, et al. Feasibility, safety and efficacy of transcutaneous vagus nerve stimulation in chronic tinnitus: an open pilot study. *Brain stimulation* 2014;7(5):740-47. OBJECTIVES Vagus nerve stimulation represents an established treatment strategy for epilepsy and affective disorders. Recently, positive effects were also shown in animals and humans with tinnitus. Here we report the results of an open pilot study exploring feasibility, safety and efficacy of tVNS in the treatment of chronic tinnitus. STUDY DESIGN Fifty patients with chronic tinnitus underwent tVNS in an open single-armed pilot study which was conducted in two phases applying two different stimulating devices (Cerbomed CM02 and NEMOS). Clinical assessment was based on Tinnitus Questionnaire (TQ), Tinnitus Handicap Inventory (THI), Beck Depression Inventory (BDI), WHO Quality of Life, and various numeric rating scales. Primary outcome was defined as change in TQ (baseline vs. final visit in week 24). The study has been registered with clinicaltrials.gov (NCT01176734). RESULTS Primary analysis indicated mean TQ reductions of 3.7 points (phase 1) and 2.8 points (phase 2) significant for the first study phase. Secondary analyses indicated a significant BDI reduction for phase 1 (uncorrected for multiple testing), but no further systematic or significant effects. Adverse events included twitching and pressure at electrode placement site. The occurrence of one hospitalization because of palpations and the development of a left bundle branch block were considered as unrelated to the intervention. Cognitive testing revealed no significant changes. CONCLUSION Our data demonstrate the feasibility of tVNS over a period of 6 months. There was no clinically relevant improvement of tinnitus complaints. Our data suggest tVNS to be considered safe in patients without a history of cardiac disease.

173. Kim HJ, Kim DY, Kim HI, et al. Long-term effects of repetitive transcranial magnetic stimulation in unilateral tinnitus. *Laryngoscope* 2014;124(9):2155-60. Objectives/Hypothesis We investigated the long-term effects of repetitive transcranial magnetic stimulation (rTMS) delivered to the temporoparietal junction and compared contralateral and ipsilateral application in patients with unilateral tinnitus. Study Design: Prospective study. Methods: A total of 61 patients with asymmetric hearing loss and nonpulsatile chronic tinnitus localized to the poorer ear who were
refractory to medical treatment were enrolled. Patients were randomly assigned to one of two treatment groups: 1-Hz stimulation applied to the temporoparietal junction either ipsilaterally (n = 30) or contralaterally (n = 31) to the symptomatic ear. Changes in the Tinnitus Handicap Inventory (THI) scores and self-rating visual analog scores (VAS) for loudness, awareness, and annoyance were analyzed before and after treatment for 6 months. Improved patients were defined as those with decreases in their THI scores by >10 points and 20%.

**Results:** There were no major complications or worsening of hearing. When analyzing the THI scores and VAS pre-rTMS and 6 months after rTMS, significant decreases were observed in patients overall ($P < .001$). For the comparison of long-term outcomes between the ipsilateral and contralateral stimulation groups, there were no differences in the degree of decrease in THI scores or VAS ($P > .05$). In addition, there was no significant difference in the rate of patients who improved between the ipsilateral (14 of 30) and contralateral (16 of 31) stimulation groups ($P = .800$). The ipsilateral group showed a more rapid improvement than the contralateral group.

**Conclusions:** Daily application of 1-Hz rTMS to the temporoparietal area is safe and has long-term beneficial effects. The laterality of stimulation is not the decisive factor.


**BACKGROUND** The aim of this randomized controlled trial was to investigate the effects of conventional face-to-face group cognitive behavioral therapy (GCBT) and an Internet-delivered guided self-help treatment (Internet-based CBT, ICBT) on tinnitus distress.

**METHODS** A total of 128 adults with at least mild levels of chronic tinnitus distress were randomly assigned to GCBT (n = 43), ICBT (n = 41), or a web-based discussion forum (DF) that served as a control condition (n = 44). Standardized self-report measures [the Tinnitus Handicap Inventory (THI), Mini-Tinnitus Questionnaire (Mini-TQ), Hospital Anxiety and Depression Scale, Insomnia Severity Index and Tinnitus Acceptance Questionnaire] were completed at the pre- and post-assessments and at the 6-month follow-up.

**RESULTS** Repeated-measures ANOVAs revealed significant time × group interaction effects on the primary outcomes (THI and Mini-TQ scores) in favor of both CBT interventions compared with the DF at post-assessment ($0.56 \leq g \leq 0.93$; all $p \leq 0.001$). There were no significant differences between GCBT and ICBT (all $p > 0.05$) and the treatment effects remained stable at the 6-month follow-up.

**CONCLUSION** This study provides evidence that ICBT might be an equally effective alternative to conventional CBT in the management of chronic tinnitus. Despite encouraging results, further research is necessary to determine the actual potential of ICBT as a viable alternative to CBT, and under which circumstances it is effective.


**BACKGROUND** Previous studies of frequency discrimination training (FDT) for tinnitus used repetitive task-based training programmes relying on extrinsic factors to motivate participation. Studies reported limited improvement in tinnitus symptoms.

**PURPOSE** To evaluate FDT exploiting intrinsic motivations by integrating training with computer-gameplay.

**METHODS** Sixty participants were randomly assigned to train on either a conventional task-based training, or one of two interactive game-based training platforms over six weeks. Outcomes included assessment of motivation, tinnitus handicap, and performance on tests of attention.

**RESULTS** Participants reported greater intrinsic motivation to train on the interactive game-based platforms, yet compliance of all three groups was similar (~ 70%) and changes in self-reported tinnitus severity were not significant.
There was no difference between groups in terms of change in tinnitus severity or performance on measures of attention. CONCLUSION 
FDT can be integrated within an intrinsically motivating game. Whilst this may improve participant experience, in this instance it did not translate to additional compliance or therapeutic benefit. TRIAL REGISTRATION ClinicalTrials.gov NCT02095262.


BACKGROUND The authors reviewed practicable options of sound therapy for tinnitus, the evidence base for each option, and the implications of each option for the patient and for clinical practice.

PURPOSE To provide a general guide to selecting sound therapy options in clinical practice.

INTERVENTION Practicable sound therapy options.

DATA COLLECTION AND ANALYSIS Where available, peer-reviewed empirical studies, conference proceedings, and review studies were examined. Material relevant to the purpose was summarized in a narrative.

RESULTS The number of peer-reviewed publications pertaining to each sound therapy option reviewed varied significantly (from none to over 10). Overall there is currently insufficient evidence to support or refute the routine use of individual sound therapy options. It is likely, however, that sound therapy combined with education and counseling is generally helpful to patients.

CONCLUSIONS Clinicians need to be guided by the patient’s point of care, patient motivation and expectations of sound therapy, and the acceptability of the intervention both in terms of the sound stimuli they are to use and whether they are willing to use sound extensively or intermittently. Clinicians should also clarify to patients the role sound therapy is expected to play in the management plan.


Tinnitus is described as the perception of sound or noise in the absence of real acoustic stimulation. In the current absence of a cure for tinnitus, clinical management typically focuses on reducing the effects of co-morbid symptoms such as distress or hearing loss. Hearing loss is commonly co-morbid with tinnitus and so logic implies that amplification of external sounds by hearing aids will reduce perception of the tinnitus sound and the distress associated with it. To assess the effects of hearing aids specifically in terms of tinnitus benefit in patients with tinnitus and co-existing hearing loss. We searched the Cochrane Ear, Nose and Throat Disorders Group Trials Register; the Cochrane Central Register of Controlled Trials (CENTRAL); PubMed; EMBASE; CINAHL; Web of Science; Cambridge Scientific Abstracts; ICTR and additional sources for published and unpublished trials. The date of the search was 19 August 2013. Randomised controlled trials and non-randomised controlled trials recruiting adults with subjective tinnitus and some degree of hearing loss, where the intervention involves amplification with hearing aids and this is compared to interventions involving other medical devices, other forms of standard or complementary therapy, or combinations of therapies, no intervention or placebo interventions. Three authors independently screened all selected abstracts. Two authors independently extracted data and assessed those potentially suitable studies for risk of bias. For studies meeting the inclusion criteria, we used the mean difference (MD) to compare hearing aids with other interventions and controls. One randomised controlled trial (91 participants) was included in this review. We judged the trial to have a low risk of bias for method of randomisation and outcome reporting, and an unclear risk of bias for other criteria. No non-randomised controlled trials meeting our inclusion criteria were identified. The included study measured change in tinnitus severity (primary measure of interest) using a tinnitus questionnaire measure, and change in tinnitus loudness (secondary measure of interest) on
a visual analogue scale. Other secondary outcome measures of interest, namely change in the psychoacoustic characteristics of tinnitus, change in self reported anxiety, depression and quality of life, and change in neurophysiological measures, were not investigated in this study. The included study compared hearing aid use to sound generator use. The estimated effect on change in tinnitus loudness or severity as measured by the Tinnitus Handicap Inventory score was compatible with benefits for both hearing aids or sound generators but no difference was found between the two alternative treatments (MD -0.90, 95% confidence interval (CI) -7.92 to 6.12) (100-point scale); moderate quality evidence. No negative or adverse events were reported. The current evidence base for hearing aid prescription for tinnitus is limited. To be useful, future studies should make appropriate use of blinding and be consistent in their use of outcome measures. Whilst hearing aids are sometimes prescribed as part of tinnitus management, there is currently no evidence to support or refute their use as a more routine intervention for tinnitus.[CINAHL Note: The Cochrane Collaboration systematic reviews contain interactive software that allows various calculations in the MetaView.].

178. Hoare DJ, Edmondson-Jones M, Gander PE, et al. Agreement and reliability of tinnitus loudness matching and pitch likeness rating. PloS one 2014;9(12):e114553. The ability to reproducibly match tinnitus loudness and pitch is important to research and clinical management. Here we examine agreement and reliability of tinnitus loudness matching and pitch likeness ratings when using a computer-based method to measure the tinnitus spectrum and estimate a dominant tinnitus pitch, using tonal or narrowband sounds. Group level data indicated a significant effect of time between test session 1 and 2 for loudness matching, likely procedural or perceptual learning, which needs to be accounted in study design. Pitch likeness rating across multiple frequencies appeared inherently more variable and with no systematic effect of time. Dominant pitch estimates reached a level of clinical acceptability when sessions were spaced two weeks apart. However when dominant tinnitus pitch assessments were separated by three months, acceptable agreement was achieved only for group mean data, not for individual estimates. This has implications for prescription of some sound-based interventions that rely on accurate measures of individual dominant tinnitus pitch.

179. Grewal R, Spielmann PM, Jones SEM, et al. Clinical efficacy of tinnitus retraining therapy and cognitive behavioural therapy in the treatment of subjective tinnitus: a systematic review. The Journal of laryngology and otology 2014;128(12):1028-33. OBJECTIVEThis study aimed to compare the outcomes of two frequently employed interventions for the management of tinnitus: tinnitus retraining therapy and cognitive behavioural therapy. METHOD A systematic review of literature published up to and including February 2013 was performed. Only randomised control trials and studies involving only human participants were included. RESULTS Nine high-quality studies evaluating the efficacy of tinnitus retraining therapy and cognitive behavioural therapy were identified. Of these, eight assessed cognitive behavioural therapy relative to a no-treatment control and one compared tinnitus retraining therapy to tinnitus masking therapy. Each study used a variety of standardised and validated questionnaires. Outcome measures were heterogeneous, but both therapies resulted in significant improvements in quality of life scores. Depression scores improved with cognitive behavioural therapy. CONCLUSION Both cognitive behavioural therapy and tinnitus retraining therapy are effective for tinnitus, with neither therapy being demonstrably superior. Further research using standardised, validated questionnaires is needed so that objective comparisons can be made.
180. Forogh B, Yazdi-Bahri S-M, Ahadi T, et al. Comparison of two protocols of transcranial magnetic stimulation for treatment of chronic tinnitus: a randomized controlled clinical trial of burst repetitive versus high-frequency repetitive Transcranial Magnetic Stimulation. *Neurological sciences : official journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology* 2014;35(2):227-32. The aim of the study was to compare the effects of two techniques of repetitive Transcranial Magnetic Stimulation (rTMS) to treat chronic tinnitus; continuous Theta Burst Stimulation (cTBS) and high-frequency rTMS. In a controlled randomized clinical trial, 55 patients with chronic tinnitus were randomly divided in two groups. They received four sessions of treatment. cTBS was tested on one group and high-frequency rTMS (10 Hz) was tested on the other. Severity of the tinnitus was assessed before treatment, after the last treatment session and then 1-month later. Both the treatments of high-frequency and cTBS had a suppressive effect on tinnitus. However, cTBS was more effective than high-frequency rTMS (P = 0.001). This study suggests that rTMS even in four sessions is effective in reducing tinnitus severity; moreover, compared to high-frequency TMS better results can be achieved with cTBS.

181. Folmer RL, Theodoroff SM, Hal Martin W, et al. Experimental, Controversial, and Futuristic Treatments for Chronic Tinnitus. *Journal of the American Academy of Audiology* 2014;25(1):106-25. Background: Because chronic tinnitus is a condition that negatively impacts the quality of life of millions of people worldwide, a safe and effective treatment for tinnitus has been sought for millennia. However, effective treatments for tinnitus are greatly outnumbered by ineffective strategies, medications, devices, and surgeries that continue to be developed and promoted for the condition. Purpose: This article describes and critiques experimental, controversial, and potential treatments for chronic tinnitus. The purpose of this review is to provide information that should help patients and clinicians to select tinnitus treatment and management strategies most likely to be effective for each set of symptoms and circumstances. Research Design: PubMed and MEDLINE databases (National Center for Biotechnology Information, U.S. National Library of Medicine) were searched for the term tinnitus in articles published from 1940 to 2012. Other historical documents and publications were also reviewed as needed for particular topics. Study Sample: Studies included in this review were selected to represent a sampling of treatment methodologies that have been used for tinnitus. Data Collection and Analysis: Due to the heterogeneity of the studies reviewed, it was not appropriate to perform a meta-analysis. A selective review of the literature was conducted to summarize and critique published research results. Results: Most invasive treatments for tinnitus should be avoided because (1) at best, there is scant evidence that any of these treatments is effective, and (2) the risk to patients for most invasive procedures is much greater than the risk posed by the tinnitus perception. Effective and noninvasive treatments for tinnitus include acoustic therapy (which includes hearing aids and other types of environmental sound enrichment); cognitive-behavioral therapy; psychological counseling; hypnosis; biofeedback; and relaxation training. Over-the-counter or prescription medications may be used as needed to facilitate sleep and to reduce anxiety, depression, or obsessive-compulsiveness. Conclusions: Patients and clinicians should be especially cautious when considering invasive (and potentially harmful) treatments for tinnitus, which is a non-life-threatening symptom. Unless well-designed clinical trials verify that a tinnitus therapy demonstrates effectiveness above and beyond the placebo effect, consumers should be wary of medications, devices, or procedures promoted as a ‘cure.’ Although a true cure for tinnitus has not yet been found, effective and noninvasive tinnitus management strategies are available now. If progress is made to medically (or genetically) treat sensorineural hearing loss in
humans, this breakthrough should also help to simultaneously reduce the perception of tinnitus for many patients.

182. Fernandes FL, Guimarães AC, de Carvalho GM, et al. Stapedial reflex and recruitment: what is the relationship with tinnitus? *Noise & health* 2014;16(73):422-26. Tinnitus is characterized by an auditory perception of sound, with no stimuli from the external environment. Tinnitus is an increasingly significant complaint, affecting 10-17% of the world population. As a symptom, it should always be considered with pathology in the auditory system. Our study aims to assess the relationship of this symptom with the presence of a stapedial reflex and the phenomenon of recruitment. Medical records of patients complaining of subjective tinnitus during their first consultation in the Outpatient Clinic of the Unicamp Teaching Hospital, in Brazil, between 2011 and 2012 were analyzed. We carried out a study with 65 non-randomized tinnitus individuals using questionnaires, clinical and audiological evaluations. The visual analogue scale was used to characterize the degree of disturbance caused by tinnitus. Statistical tests were performed using the IBM SPSS Statistics 19. No association was found between tinnitus and the presence of acoustic reflex or phenomenon of recruitment. We concluded that there is no relationship between tinnitus, the phenomenon of recruitment or the presence of an acoustic reflex.

183. Engelhardt J, Dauman R, Arné P, et al. Effect of chronic cortical stimulation on chronic severe tinnitus: a prospective randomized double-blind cross-over trial and long-term follow up. *Brain stimulation* 2014;7(5):694-700. BACKGROUND Chronic severe tinnitus can be greatly detrimental to quality of life. Some authors have reported benefit of repetitive transcranial magnetic stimulation, others of electrical cortical stimulation by stimulating the Heschl's gyrus or secondary auditory areas. OBJECTIVE To evaluate the efficacy of chronic electrical epidural stimulation of the auditory cortex on severe and disabling tinnitus. METHOD In this double-blind randomized cross-over, patients with chronic (at least 2 years), severe (Strukturierte Tinnitus-Interview, STI score > 19), unilateral or strongly lateralized tinnitus were included. After open-phase stimulation for 4 months, patients were randomized into 2 groups for double-blind stimulation with cross-over between significant and non-significant phases and wash-out in between. Each of the 3 phases was 2 weeks in duration. Patients were chronically stimulated and followed if not explanted. A decrease of STI score >35% was considered as clinically significant. RESULTS None of the 9 patients included achieved significant improvement during the double-blind phase. Four were explanted, 2 owing to lack of effect, one for breast cancer under the stimulator, and another for psychiatric decompensation. Five are still stimulated. Three felt slight to great subjective effectiveness, the remaining 2 reported benefits and still requested stimulation. CONCLUSION This study did not find an objective efficiency of chronic cortical stimulation for severe and resistant tinnitus. The discordance between the results in double-blind and open evaluations could be related to a placebo effect of surgery, but may also be explained by a poorly defined target, a too short randomized phase, or inappropriate outcome measures. Clinical trial reference: NCT00486577.

184. dos Santos GM, Bento RF, de Medeiros IRT, et al. The influence of sound generator associated with conventional amplification for tinnitus control: randomized blind clinical trial. *Trends in hearing* 2014;18 Hearing aids with an integrated sound generator have been used to enhance the treatment of tinnitus. The main aim of this study was to verify whether the combined use of amplification and sound generator is more effective than conventional amplification alone in reducing tinnitus annoyance by means of the use of a new hearing aid with an integrated sound
generator. A total of 49 patients underwent a blind randomized clinical trial. Tinnitus annoyance was measured by Tinnitus Handicap Inventory and numerical scales, and psychoacoustic measures of tinnitus were also performed. The sound generator was set at the lowest intensity capable of providing relief from tinnitus. Results showed that 62.5% of the patients presented a reduction in tinnitus annoyance in the combined fitting group and in the group with amplification alone, 78% showed a reduction. This difference between the groups was not statistically significant.

185. Claes L, Stamberger H, Van de Heyning P, et al. Auditory cortex tACS and tRNS for tinnitus: single versus multiple sessions. *Neural plasticity* 2014;2014:436713. Tinnitus is the perception of a sound in the absence of an external acoustic source, which often exerts a significant impact on the quality of life. Currently there is evidence that neuroplastic changes in both neural pathways are involved in the generation and maintaining of tinnitus. Neuromodulation has been suggested to interfere with these neuroplastic alterations. In this study we aimed to compare the effect of two upcoming forms of transcranial electrical neuromodulation: alternating current stimulation (tACS) and random noise stimulation (tRNS), both applied on the auditory cortex. A database with 228 patients with chronic tinnitus who underwent noninvasive neuromodulation was retrospectively analyzed. The results of this study show that a single session of tRNS induces a significant suppressive effect on tinnitus loudness and distress, in contrast to tACS. Multiple sessions of tRNS augment the suppressive effect on tinnitus loudness but have no effect on tinnitus distress. In conclusion this preliminary study shows a possibly beneficial effect of tRNS on tinnitus and can be a motivation for future randomized placebo-controlled clinical studies with auditory tRNS for tinnitus. Auditory alpha-modulated tACS does not seem to be contributing to the treatment of tinnitus.

186. Cima RFF, Andersson G, Schmidt CJ, et al. Cognitive-behavioral treatments for tinnitus: a review of the literature. *Journal of the American Academy of Audiology* 2014;25(1):29-61. BACKGROUND Tinnitus can be defined as the perception of an auditory sensation, perceivable without the presence of an external sound. PURPOSE The aim of this article is to systematically review the peer-reviewed literature on treatment approaches for tinnitus based on cognitive-behavioral therapy (CBT) and to provide a historical overview of developments within these approaches. RESEARCH DESIGN Experimental studies, (randomized) trials, follow-up assessments, and reviews assessing educational, counseling, psychological, and CBT treatment approaches were identified as a result of an electronic database metasearch. RESULTS Total of 31 (of the initial 75 studies) were included in the review. Results confirm that CBT treatment for tinnitus management is the most evidence-based treatment option so far. Though studied protocols are diverse and are usually a combination of different treatment elements, and tinnitus diagnostics and outcome assessments vary over investigations, a common ground of therapeutic elements was established, and evidence was found to be robust enough to guide clinical practice. CONCLUSION Treatment strategy might best be CBT-based, moving toward a more multidisciplinary approach. There is room for the involvement of different disciplines, using a stepped-care approach. This may provide brief and effective treatment for a larger group of tinnitus patients, and additional treatment steps can be provided for those suffering on a more severe level.

187. Theodoroff SM, Folmer RL. Repetitive transcranial magnetic stimulation as a treatment for chronic tinnitus: a critical review. *Otology & Neurotology* 2013;34(2):199-208. Objective: Because chronic tinnitus is a condition that negatively impacts the quality of life for millions of people worldwide, a safe and effective treatment for tinnitus has been sought for decades. However, a true
"cure" for the most common causes of tinnitus remains elusive. Repetitive transcranial magnetic stimulation (rTMS), a noninvasive procedure, has shown potential for reducing patients’ perception or severity of tinnitus. This article provides background information about rTMS and reviews studies that investigated rTMS as a treatment for chronic tinnitus.

**Data Sources:** PubMed and Medline databases (National Center for Biotechnology Information, U.S. National Library of Medicine) were searched for the terms repetitive transcranial magnetic stimulation, tinnitus, TMS, and rTMS in articles published from 1980 to 2012.

**Study Selection:** Articles included in this review were selected to represent a sampling of rTMS methodologies that have been used with tinnitus patients.

**Data Extraction:** Data extraction included sample size, TMS stimulation frequency, TMS stimulation intensity, number of pulses administered per session, number of TMS sessions, and method of tinnitus assessment.

**Data Synthesis:** Because of the heterogeneity of the studies reviewed, most of which had small populations of subjects, it was not appropriate to perform a meta-analysis. A systematic review of the literature was conducted to summarize and critique published research results.

**Conclusion:** Although optimism for the clinical use of rTMS as an effective treatment for tinnitus remains high among many researchers, clinicians, and patients, several key questions and procedural issues remain unresolved. Suggestions for improving rTMS research protocols are described and discussed.

188. Sönmez O, Külahlı I, Vural A, et al. The evaluation of ozone and beta-histidine in the treatment of tinnitus. European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery 2013;270(7):1999-2006. The aim of the study is to evaluate the effectiveness of ozone and beta-histidine treatments in the treatment of tinnitus. Sixty-eight patients were enrolled in this randomized, prospective controlled study. The ozone group consisted of 27, beta-histidine group consisted of 26 and control group consisted of 15 patients. The patients in ozone group received 10 sessions of ozone treatment via major autohemotherapy. Beta-histidine group received 48 mg/day beta-histidine tablets per oral for 3 months duration. The control group was followed up without any treatment given. The evaluation of tinnitus was made by tinnitus loudness and tinnitus handicap inventory (THI). The changes in findings from baseline to 3rd and 6th months were assessed, and the group results were compared. Comparison of the initial mean tinnitus loudness and 3 and 6 months after treatment in each of the three groups did not reveal a significant difference. The comparison between the groups in terms of the improvement of tinnitus loudness was not significant (p = 0.821). Comparison of the initial mean THI and 3 and 6 months after treatment revealed a significant difference in ozone and beta-histidine groups but not in the control group. When the delta (Δ) THI (the change of mean THI between the initial and 6th month) was compared between the groups, there was no significant difference. This randomized controlled study investigating the effects of ozone in tinnitus tries to shed light to a new method of treatment in tinnitus. The findings of the study does not provide enough evidence to support ozone and beta-histidine as a treatment for tinnitus and further research on the subject is necessary.

189. Schecklmann M, Landgrebe M, Poepppl TB, et al. Neural correlates of tinnitus duration and distress: a positron emission tomography study. Human brain mapping 2013;34(1):233-40. Cerebral (18)F-deoxyglucose positron emission tomography (FDG-PET) has shown altered auditory pathway activity in tinnitus. However, the corresponding studies involved only small samples and analyses were restricted to the auditory cortex in most studies. Evidence is growing that also limbic, frontal, and parietal areas are involved in the pathophysiology of chronic tinnitus. These regions are
considered to mediate perceptual, attentional, and emotional processes. Thus, the aim of the present study was the systematic evaluation of metabolic brain activity in a large sample of tinnitus patients. Ninety one patients with chronic tinnitus underwent FDG-PET. The effects of tinnitus severity (assessed by a tinnitus questionnaire score), duration and laterality were evaluated with statistical parametric mapping (SPM) in whole brain analyses. In addition, region of interest analyses were performed for primary auditory areas. Tinnitus duration correlated positively with brain metabolism in right inferior frontal, right ventro-medial prefrontal, and right posterior cingulate cortex. Tinnitus distress correlated positively with activation of left and right posterior inferior temporal gyrus as well as left and right posterior parahippocampal-hippocampal interface. Region of interest analysis demonstrated an overactivation of left in contrast to right Heschl's gyrus independently from tinnitus laterality and anatomical hemispheric differences. Tinnitus duration and distress were associated with areas involved in attentional and emotional processing. This is in line with recent findings indicating the relevance of higher order areas in the pathophysiology of tinnitus. Earlier results of asymmetric activation of the auditory cortices in tinnitus were confirmed, i.e., left-sided overactivation was found independently from tinnitus laterality.

190. Piccirillo JF, Kallogjeri D, Nicklaus J, et al. Low-frequency repetitive transcranial magnetic stimulation to the temporoparietal junction for tinnitus: four-week stimulation trial. *JAMA Otolaryngology-Head & Neck Surgery* 2013;139(4):388-95. Importance: This research examines the impact of 4 weeks of repetitive transcranial magnetic stimulation (rTMS) stimulation to the temporoparietal junction and compares the results of this longer duration of treatment with a similar stimulus protocol of only 2 weeks' duration. Objective: To examine the effectiveness and safety of 4 weeks of low-frequency rTMS to the left temporoparietal junction in a cohort of patients with bothersome tinnitus. Design: Crossover, double-blind, randomized controlled trial. Setting: Outpatient academic medical center. Participants: The study population comprised 14 adults aged between 22 and 59 years with subjective, unilateral or bilateral, nonpulsatile tinnitus of 6 months' duration or greater and a score of 34 or greater on the Tinnitus Handicap Inventory (THI). Interventions: Low-frequency (1 Hz) 110% motor threshold rTMS or sham to the left temporoparietal junction for 4 weeks. Main Outcome and Measure: The difference of the change in the THI score between active rTMS and sham rTMS. Results: Active treatment was associated with a median reduction in THI score of 10 (range, -20 to +4) points, and sham treatment was associated with a median reduction of 6 (range, -24 to +12) points. The median difference in THI score between the change associated with active and sham rTMS was 4 (95% CI, -9 to 10; and range, -32 to +14) points. Conclusions and Relevance: Daily low-frequency active rTMS to the left temporoparietal junction area for 4 weeks was no more effective than sham for patients with chronic bothersome tinnitus. Possible explanations for this negative study include the failure of rTMS to stimulate deeper parts of auditory cortex within the sylvian fissure and more widespread cortical network changes not amenable to localized rTMS effects. Trial Registration: clinicaltrials.gov Identifier: NCT00567892.

191. Oz I, Arslan F, Hizal E, et al. Effectiveness of the combined hearing and masking devices on the severity and perception of tinnitus: a randomized, controlled, double-blind study. *ORL; journal for oto-rhino-laryngology and its related specialties* 2013;75(4):211-20. OBJECTIVE: The aim of this study was to evaluate the effect of combined hearing and tinnitus masking devices that are appropriately programmed for acoustic stimulations using wide-band noise over the specific frequency range of tinnitus. MATERIAL AND METHODS: A total of 21 patients were randomly divided into 2 groups. Group I (12 patients) was managed with betahistine dihydrochloride (2HCl) and fitted either with a
combined hearing aid or a sound generator, and group II (9 patients) was treated with betahistine 2HCl for 3 months. Audiological tests, pitch matching to determine the frequency of tinnitus, an assessment of tinnitus severity, and subjective scores (visual analog scale, VAS; Mini-Tinnitus Questionnaire) were used to assess the patients in both groups, and a loudness scale was also analyzed in group I. The results were evaluated in a double-blinded manner.

**RESULTS**

Significant decreases in the severity of tinnitus, Mini-Tinnitus Questionnaire score and VAS were observed in both groups. No significant differences were obtained in pitch-matched frequency of tinnitus in the two groups.

**CONCLUSION**

The findings obtained using either the combined devices or the masking devices with wide-band masking demonstrate that these devices are an effective tinnitus treatment alternative.

192. Nyenhuis N, Zastrutzki S, Weise C, et al. The efficacy of minimal contact interventions for acute tinnitus: a randomised controlled study. *Cognitive behaviour therapy* 2013;42(2):127-38. Acute tinnitus can lead to substantial distress and eventually result in long-lasting impairment. The aim of this study was to compare the efficacy of a cognitive-behavioural intervention (delivered as Internet self-management, bibliotherapy or group training) to the information-only control condition. Applicants suffered from subjective tinnitus for up to six months, were between 18 and 75 years old and received no other tinnitus-related psychological treatment. A total of 304 participants were randomly assigned to one of the four study arms. Tinnitus distress, depressive symptoms, psychosomatic discomfort and treatment satisfaction were assessed. At the post-assessment tinnitus distress was significantly lower in the Internet and the group training conditions compared to the control condition. Inter-group effect sizes were moderate to large. At follow-up, all active training conditions showed significantly reduced tinnitus distress compared to the control condition (intention-to-treat analysis). An additional completer analysis showed a significant reduction in tinnitus distress only for the group condition. All effect sizes were moderate. There were no differences regarding psychosomatic discomfort, but depressive symptoms were reduced in the group condition at the post-assessment (intention-to-treat analysis). Treatment satisfaction was significantly higher in the training conditions. The dropout rate was 39%. The present study shows that distress can be reduced as early as the acute stadium and that minimal-contact interventions are a promising way to do this. In particular, the Internet and group conditions led to a large, immediate decrease in distress, and the participants were highly satisfied with the training.

193. Nyenhuis N, Golm D, Kröner-Herwig B. A systematic review and meta-analysis on the efficacy of self-help interventions in tinnitus. *Cognitive behaviour therapy* 2013;42(2):159-69. This study is a review and meta-analysis on the efficacy of cognitive-behavioural therapy (CBT) self-help interventions for tinnitus. Randomized controlled trials were identified by searching in databases (e.g. ISI Web of Knowledge, PubMed, Cochrane Library, and PSYNDEX) and by manual search. Ten studies with 1188 participants in total were included in the meta-analysis. Participants were 49.2 years old and had tinnitus for 5.2 years. Self-help interventions significantly reduced tinnitus distress ($d = 0.48$) and depressiveness ($d = 0.25$) when compared with a passive control (e.g. information only and discussion forums) at post-assessment. There was no difference to the face-to-face controls (group treatment). The presence of therapists and the methodological quality of the studies did not influence the results. Sensitivity analysis revealed that there might be a publication bias regarding the comparison to the face-to-face control. However, the results suggest that CBT self-help interventions are an effective treatment for tinnitus distress. Since few studies were identified, this conclusion must be supported by future meta-analyses.
194. Mollasadeghi A, Mirmohammadi SJ, Mehrparvar AH, et al. Efficacy of low-level laser therapy in the management of tinnitus due to noise-induced hearing loss: a double-blind randomized clinical trial. TheScientificWorldJournal 2013;2013:596076. Background. Several remedial modalities for the treatment of tinnitus have been proposed, but an effective standard treatment is still to be confirmed. In the present study, we aimed to evaluate the effect of low-level laser therapy on tinnitus accompanied by noise-induced hearing loss. Methods. This was a double-blind randomized clinical trial on subjects suffering from tinnitus accompanied by noise-induced hearing loss. The study intervention was 20 sessions of low-level laser therapy every other day, 20 minutes each session. Tinnitus was assessed by three methods (visual analog scale, tinnitus handicap inventory, and tinnitus loudness) at baseline, immediately and 3 months after the intervention. Results. All subjects were male workers with age range of 30-51 years. The mean tinnitus duration was 1.85 ± 0.78 years. All three measurement methods have shown improved values after laser therapy compared with the placebo both immediately and 3 months after treatment. Laser therapy revealed a U-shaped efficacy throughout the course of follow-up. Nonresponse rate of the intervention was 57% and 70% in the two assessment time points, respectively. Conclusion. This study found low-level laser therapy to be effective in alleviating tinnitus in patients with noise-induced hearing loss, although this effect has faded after 3 months of follow-up. This trial is registered with the Australian New Zealand clinical trials registry with identifier ACTRN12612000455864).

195. Martin WH, Griest SE, Sobel JL, et al. Randomized trial of four noise-induced hearing loss and tinnitus prevention interventions for children. International Journal of Audiology 2013;52 Objective: To evaluate the effectiveness of four NIHL prevention interventions at improving knowledge, attitudes, and intended behaviors regarding sound exposure and appropriate use of hearing protective strategies in children. Design: A randomized trial of the four interventions with a non-intervention comparison group. Questionnaires were completed prior to, immediately after, and three months after each intervention. Study: Interventions included: (1) A classroom presentation by older-peer educators, (2) A classroom presentation by health professionals, (3). Exploration of a museum exhibition, and (4). Exploration of an internet-based virtual museum. A comparison group received no intervention. Study sample: Fifty-three fourth grade classrooms (1120 students) participated in the study. Results: All interventions produced significant improvements but the number of improvements decreased over time. In terms of effectiveness, the classroom programs were more effective than the internet-based virtual exhibit, which was more effective than the visit to the museum exhibition. Self-reported exposures indicated that as many as 94.5% of participants were at risk for NIHL. Conclusions: Interpersonal, interactive educational interventions such as the classroom program are more effective and have longer impact than self-directed learning experiences for NIHL and tinnitus prevention, however each may have an important role in promoting hearing health in elementary school students.

196. Mahmoudian S, Lenarz M, Esser K-H, et al. Alterations in early auditory evoked potentials and brainstem transmission time associated with tinnitus residual inhibition induced by auditory electrical stimulation. The international tinnitus journal 2013;18(1):63-74. INTRODUCTIONResidual inhibition (RI) is the temporary inhibition of tinnitus by use of masking stimuli when the device is turned off.OBJECTIVEThe main aim of this study was to evaluate the effects of RI induced by auditory electrical stimulation (AES) in the primary auditory pathways using early auditory-evoked potentials (AEPs) in subjective idiopathic tinnitus (SIT) subjects.MATERIALS AND METHODSA randomized placebo-controlled study was conducted on forty-four tinnitus subjects. All enrolled
subjects based on the responses to AES, were divided into two groups of RI and Non-RI (NRI). The results of the electrocochleography (ECochG), auditory brain stem response (ABR) and brain stem transmission time (BTT) were determined and compared pre- and post-AES in the studied groups. 

**RESULTS**

The mean differences in the compound action potential (CAP) amplitudes and III/V and I/V amplitude ratios were significantly different between the RI, NRI and PES controls. BTT was significantly decreased associated with RI.

**CONCLUSION**

The observed changes in AEP associated with RI suggested some peripheral and central auditory alterations. Synchronized discharges of the auditory nerve fibers and inhibition of the abnormal activity of the cochlear nerve by AES may play important roles associated with RI. Further comprehensive studies are required to determine the mechanisms of RI more precisely.


Although some therapies may be beneficial for some patients in reducing tinnitus, there is no curative therapy. Repetitive transcranial magnetic stimulation (rTMS) has been applied as a treatment for chronic tinnitus, but the effect remains controversial. MATERIAL AND METHODS

Fifty patients were treated with rTMS or placebo. Treatment consisted of 2,000 TMS pulses on each auditory cortex, at a rate of 1 Hz and an intensity of 110% of the individual motor threshold, on 5 consecutive days. rTMS and placebo effects were evaluated directly after treatment, after 1 week, and after 1, 3 and 6 months. Primary outcome was the Tinnitus Questionnaire (TQ). Secondary outcomes were the Tinnitus Handicap Inventory (THI) and a visual analogue scale. RESULTS

At none of the follow-up evaluation moments a significant difference between rTMS and placebo was observed with respect to changes in TQ or THI scores relative to pretreatment scores. Multilevel modelling (MLM) analyses did not show a global treatment effect either. Patients with a higher degree of burden showed slightly greater improvement after rTMS (only significant on the THI with MLM analyses). CONCLUSION

Bilateral low-frequency rTMS of the auditory cortex was not effective in treating tinnitus.

198. Hilton MP, Zimmermann EF, Hunt WT. *Ginkgo biloba for tinnitus*. *Cochrane Database of Systematic Reviews* 2013(3)

This is an update of a Cochrane review first published in The Cochrane Library in Issue 2, 2004 and previously updated in 2007 and 2009. Tinnitus can be described as the perception of sound in the absence of external acoustic stimulation. At present no specific therapy for tinnitus is acknowledged to be satisfactory in all patients. There are a number of reports in the literature suggesting that Ginkgo biloba may be effective in the management of tinnitus. However, there also appears to be a strong placebo effect in tinnitus management. To assess the effect of Ginkgo biloba in patients who are troubled by tinnitus. We searched the Cochrane Ear, Nose and Throat Disorders Group Trials Register; the Cochrane Central Register of Controlled Trials (CENTRAL); PubMed; EMBASE; AMED; Web of Science; BIOSIS Previews; Cambridge Scientific Abstracts; ICTRP and additional sources for published and unpublished trials. The date of the most recent search was 12 March 2012. Adults (18 years and over) complaining of tinnitus or adults with a primary complaint of cerebral insufficiency, where tinnitus forms part of the syndrome. Both original authors independently extracted data and assessed trials for quality. For the 2012 update two authors determined trial eligibility, extracted data, analysed data and updated the contents of the review. Four trials with a total of 1543 participants were included in the review; we assessed all the included studies as having a low risk of bias. Three trials (1143 participants) included patients with a primary
complaint of tinnitus and one (400 participants) included patients with mild to moderate dementia, some of whom had tinnitus. There was no evidence that Gingko biloba was effective in patients with a primary complaint of tinnitus. In the study of patients with dementia, mean baseline levels of tinnitus were low (1.7 to 2.5 on a 10-point subjective symptom rating scale). A small but statistically significant reduction of 1.5 and 0.7 points was seen in patients taking Gingko biloba with vascular dementia and Alzheimer’s disease respectively. The practical clinical significance of this is unclear. The incidence of side effects was low. The limited evidence does not demonstrate that Ginkgo biloba is effective for tinnitus when this is the primary complaint.

199. Formby C, Scherer R. Rationale for the tinnitus retraining therapy trial. Noise & Health 2013;15(63):134-42. The Tinnitus Retraining Therapy Trial (TRTT) is a National Institutes of Health-sponsored, multi-centered, placebo-controlled, randomized trial evaluating the efficacy of tinnitus retraining therapy (TRT) and its component parts, directive counseling and sound therapy, as treatments for subjective debilitating tinnitus in the military. The TRTT will enroll 228 individuals at an allocation ratio of 1:1:1 to: (1) directive counseling and sound therapy using conventional sound generators; (2) directive counseling and placebo sound generators; or (3) standard of care as administered in the military. Study centers include a Study Chair’s Office, a Data Coordinating Center, and six Military Clinical Centers with treatment and data collection standardized across all clinics. The primary outcome is change in Tinnitus Questionnaire (TQ) score assessed longitudinally at 3, 6, 12, and 18-month follow-up visits. Secondary outcomes include: Change in TQ sub-scales, Tinnitus Handicap Inventory, Tinnitus Functional Index, and TRT interview visual analog scale; audiometric and psychoacoustic measures; and change in quality of life. The TRTT will evaluate TRT efficacy by comparing TRT (directive counseling and conventional sound generators) with standard of care; directive counseling by comparing directive counseling plus placebo sound generators versus standard of care; and sound therapy by comparing conventional versus placebo sound generators. We hypothesize that full TRT will be more efficacious than standard of care, directive counseling and placebo sound generators more efficacious than standard of care, and conventional more efficacious than placebo sound generators in habituating the tinnitus awareness, annoyance, and impact on the study participant’s life.

200. Barwood CHS, Wilson WJ, Malicka AN, et al. The effect of rTMS on auditory processing in adults with chronic, bilateral tinnitus: a placebo-controlled pilot study. Brain stimulation 2013;6(5):752-59. BACKGROUND On the basis that tinnitus may result from neural hyperactivity in the auditory cortex, researchers have investigated the use of low frequency (1 Hz) repetitive transcranial magnetic stimulation (rTMS) as a potential modulator of this hyperactivity. While these investigations show promise, investigations to date have neglected to consider the possible effect of 1 Hz rTMS on other functions of the auditory cortex of these individuals, such as auditory processing. OBJECTIVE / HYPOTHESIS This placebo-controlled pilot study aimed to determine whether 1 Hz rTMS applied to the primary auditory cortex (PAC), specifically Brodmann Area 41 (BA41), of adults with chronic, bilateral tinnitus would influence their auditory processing abilities. METHODS Eight participants with bilateral, chronic tinnitus were randomized to receive a 10-day course of neuronavigationally guided active rTMS (n = 4) or placebo rTMS (n = 4) treatment applied to a focal region of the left PAC (BA41). Participants’ auditory processing was measured using Time Compressed Reverberant Speech and three-pair Dichotic Digits (DD). Their tinnitus was measured using the Tinnitus Handicap Inventory (THI) and a psychoacoustic measure of tinnitus perception. All outcome measures were administered at baseline (1 week prior to rTMS), 1 week, 1,
2 and 3 months post-rTMS. RESULTS All four participants in the active rTMS (A) group, and none of the participants in the sham (placebo) rTMS (S) group, showed improved auditory processing scores at multiple assessment points post-stimulation, with the group differences in median normalized gain scores reaching significance at the 5% level from 1 week or 1 month post-stimulation onwards. Three of the four participants in the active rTMS (A) group, and none of the participants in the sham rTMS (S) group, showed improved tinnitus scores at multiple assessment points post-stimulation, with some of the group differences in median normalized gain scores reaching significance at the 5% level. CONCLUSIONS The results of this preliminary study suggest that 1 Hz rTMS applied to the PAC (BA41) has the capacity to improve both auditory processing and tinnitus perception in some adults with chronic, bilateral tinnitus.

**Databases searched:** CINAHL, Cochrane, Embase, Medline, NICE Evidence

**Search terms:**

1. Medline TINNITUS/ 7825
2. Medline TINNITUS/ep,et,th,rh,pa,pp 5669
3. Medline *TINNITUS/et,ep,pc,th,pp 3285
4. Medline (systematic* OR randomi*).ti,ab,af 1067906
5. Medline (3 AND 4) 301
6. CINAHL *TINNITUS/ep,et,pp,rh,th,pc,rf 1547
7. CINAHL (systematic* OR randomi*).ti,ab,af 412538
8. CINAHL (6 AND 7) 199

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