ADVANCES IN SPECIAL NEEDS EDUCATION AND PRACTICES

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CHAPTER SIX

Emerging Trends in Audiologic Tinnitus Management

Ayo Osisanya

INTRODUCTION

CONTEMPORARY research outcomes have shown that Audiologic Tinnitus Management (ATM, in subsequent reference) has become a global rehabilitative option for managing or treating individuals with tinnitus. This audiologic tinnitus management is a structurally designed rehabilitative protocol, with a philosophy to remediate and improve the quality of life of individuals with tinnitus by suppressing the tinnitus symptoms, compensate for hearing loss, providing sound generating mechanism and directive, and forms of counselling. ATM as a rehabilitative option for the management of tinnitus was popularised in the year 2005, as a detailed and comprehensive management protocol. ATM is a treatment protocol which provides detailed education and informational counselling, step-by-step treatment approach with use of sound generating devices towards alleviating the tinnitus severity and improving the quality of life of persons with tinnitus. Since the year 2005 when the ATM was popularised, it has gone through phases of clinical trials and modifications. Currently, it is a household name (as a veritable rehabilitative option of audiologic rehabilitation) in audiologic practice. To this end, this chapter mirrors out the development, principles, relevance and developmental trends of audiologic tinnitus management in the practice of rehabilitative audiology.

WHAT IS AUDIOLOGIC TINNITUS MANAGEMENT?

Audiologic Tinnitus Management is a structured treatment protocol for the rehabilitation of persons with tinnitus. ATM is designed to alleviate the tinnitus severity, rehabilitating the tinnitus and other associated conditions, and improving the quality of life of persons with tinnitus. The ATM is uniquely

and specifically structured towards providing treatment, management of tinnitus and associated physiological as well as psychosocial related conditions. This treatment protocol was developed and popularised as rehabilitative protocol towards providing treatment for persons with tinnitus. ATM integrates structured informational counselling provisions with individualised programme of sound enhancement through the use of different noise generators (ear-level noise generators), hearing aid, and/or combined noise generator instruments, personal listening devices (i.e. MP3 players), and argumentative sound devices (Henry, Schechter, Zaugg and Myers, 2008).

Audiologic Tinnitus Management provides treatment and adjustment for individuals with tinnitus, hearing loss and other conditions occasioned due to the attendant effects of such conditions or associated health challenges (Osisanya, 2019). ATM combines audiologic therapies, several psychological measures, regular physical activity, behavioural modifications and changes in lifestyles, and complementary and alternative treatments. Essentially, according to Henry, Zaugg and Schecter (2005), ATM is a procedural treatment option based on structural-informational counselling protocol, evaluation, adjustment of sound devices, and assessment of treatment outcomes.

Audiologic Tinnitus Management was developed to incorporate all the available management /treatment options that could be a uniform procedure for the clinical management of persons with tinnitus. And, that the management strategy should be implemented most efficiently by audiologists. Thus, the development of ATM has structurally provided a defined procedure in audiology practice. This procedure has helped modify the procedural stages required to conduct the required (basic) tinnitus assessment, audiologic evaluation, psychoacoustic assessment of tinnitus perceptual characteristics, and procedural step-by-step of providing treatment towards rehabilitating and improving the quality of life of persons with tinnitus.

Going by the emerging reports, ATM has become a common and universal management protocol in audiology practice for rehabilitating, improving the quality of life of persons with tinnitus, and reducing the severity of tinnitus.

TINNITUS: NATURE AND ETIOLOGY

Tinnitus, as a condition is regarded as the sensation of hearing kind(s) such as ringing, buzzing, hissing, chirping, whistling or other sounds without external sound signal. Tinnitus is an observed condition in which people experience different kinds of auditory sensation without any external stimulation. According to Osisanya (2019) tinnitus is a kind of health-related condition which can be described as an evidence of perception of noise or ringing in the ear/head without external influence or generation (propagation) of sound signal(s). It is a symptom of underlying condition(s) such as age-related hearing loss, drug-related conditions, high blood pressure, ear injury, and evidence of accumulated ear wax, cardiovascular disorders or metabolic disorder and/or a circulatory system disorder. To this end, tinnitus is more like a civilised disease in most countries of the world, due to people's lifestyles, which has become more stressful, as stress is one of the risk factors and a psychological symptom of tinnitus. Also, tinnitus may be connected to ageing, poor auditory pathway, hearing loss, psychological issues, and loud sounds, because such exposure to noise could be a high-risk factor of tinnitus experience. Thus, tinnitus could negatively affect the communication skills, quality of life, and social life of any individual with such a condition (Wang and Ho, 2019).

Tinnitus is derived from a Latin word known as *tinnire* which means to ring, and as a condition it is being described as a conscious perception of an auditory sensation in the absence of a corresponding external stimulus. Tinnitus can be subjective, when the experience is of the individual alone, or less commonly, and it can be objective, when an observer can hear the tinnitus. The sensation is generally of an elementary nature as descriptions of hissing, sizzling and ringing are common, although, in some cases, more complex sounds such as voices or music are perceived (Baguley, McFerran and Hall, 2013). Thus tinnitus is regarded as a kind of sensation of sound in the absence of overt acoustic stimulation. It is also a deafferatation-induced phantom phenomenon characterised by abnormal cerebral synchrony and connectivity, as the reduced or absent afferent cochlear input causes a reorganisation of tonotopic cortical maps, where representations of those frequency regions neighbouring the deafferented part become expanded (Tass and Popovych, 2012). Put differently, tinnitus can be described as a

constant ringing, buzzing noise or a high-frequency whistling sound affecting all the age groups. Tinnitus may be present all the time, or it may be an occasional phenomenon. This deafferatation-induced phantom phenomenon may vary in pitch from low sound to a very high sequel, with attendant capacity towards interfering in one's ability to concentrate or perceive the actual (intended) sounds or messages.

Tinnitus has been identified as a common symptom associated with ageing health-related conditions. Tinnitus is a continuous ringing in the ear or head without any external corresponding sound signal, which features noise in one ear or both ears or in the middle of the head. At times, it is difficult to pinpoint the site of lesion, but it is a manifestation of malfunction in the processing of auditory signals involving perceptual and psychological components. It is the sensation of any sound perceived in the head or in the ears without an evident of external stimulus. At the moment, there is no universal agreeable definition of tinnitus; but some definitions state that it is a phantom auditory sensation (Anderson, 1999; Jastreboff, 2000; Lee, Kim, Hong and Lee, 2004).

Tinnitus ranges from high pitch to low pitch with multiple tones or sounds without tonal quality, but it may be perceived as pulsed, intermittent or continuous noise. This debilitating condition may begin suddenly or gradually, as well as being sensed in one ear (or both ears) or in the head. This health-related condition has been observed to affect 10–33 percent of the aged population, and it is mostly associated with some psychosocial and health conditions such as anxiety, irritation, annoyance, concentration and insomnia, stroke, rhinosinusitis, diabetes, head injury, hypertension (Lasasi, 2010) and reduced quality of life (Mckerra, 2000). Also, it has been observed that a number of health conditions are capable of causing or worsening tinnitus. According to Hinchcliffe and Jackson (1989) the causes of tinnitus include inner ear cell damage, which always affects the random electrical impulses to the brain loading to tinnitus, chronic health conditions/injuries affecting the auditory nerves, exposure to loud noise, age-related hearing loss, head/neck injuries, auditory canal blockage, Meniere's disease, atherosclerosis, malfunction of capillaries (a kind of abnormal connections between arteries and veins) and hypertension as well as other related conditions that can increase blood pressure. It is rather a symptom of underlying condition(s)

such as age-related hearing loss, drug-related conditions, high blood pressure, ear injury, evidence of accumulated ear wax, cardiovascular disorders or metabolic disorder and/or a circulatory system disorder (Osisanya, Ojetoyinbo and Olatunde, 2022).

In some cases, tinnitus might be as a result of infections or blockages in the ear. Once the underlying cause has been treated in some cases, symptoms of tinnitus may completely be eradicated. Another prominent cause of tinnitus is long-term exposure to noise. People who work in construction sites, markets and other places with at least an average of 70dB are at higher risk of tinnitus. Vangerwua (2019) noted that the noise heard in the affected person's ear creates a vicious cycle of anxiety and increase in discomfort. The condition can also be unilateral or bilateral depending on the site of lesion as well as the causative factor. Moller (2006) viewed tinnitus as the perception of meaningless sounds without any sound reaching the ear from outside or inside the body. The sound heard by tinnitus patients is different from the regular physical noise and there are indications that the noise perceived has to do with perception of "self" (Jastreboff, 1990; Møller, 2011). The sound often varies and fluctuates from time to time. In this regard, Møller (2011) remarked that severe tinnitus can be accompanied by lowered tolerance of sounds (hyperacusis), while it is also associated with other conditions such as emotional distress, perception of pain among other psychosocial issues. Tinnitus is associated with a number of medical conditions such as presbycusis, meniere disease, otosclerosis, head trauma, acoustic neuroma, middle ear effusion, temporomandibular joint problems, hyperlidemia, meningitis, syphilis (Nodar, 1996).

Tinnitus sounds can be high-pitched, low-pitched, soft, loud, intermittent or constant. Therefore, it ranges from high pitch to low pitch with multiple tones or sounds without tonal quality, but it may be perceived as pulsed, intermittent or continuous noise. Often, this debilitating condition begins suddenly or gradually, as well as being sensed in one ear (or both ears) or in the head (Osisanya, 2019). According to Han, Lee, Kim, Lim and Shin (2009), the manifestations of tinnitus are usually unrelated to any type or severity of any associated hearing impairment and most tinnitus patients match their tinnitus to a pitch above 3 kHz (Baguley, Williamson and Moffat, 2006), while those tinnitus patients with comorbid meniere's disease describe

their sounds as matching a low-frequency tone that is usually 125 to 250 Hz (Douek and Reid, 1968; Han, Lee, Kim, Lim and Shin, 2009). About 90 percent of people with tinnitus also have hearing loss, which usually goes unnoticed until when it is diagnosed. Although, most people who have hearing loss do have tinnitus, but only 30 percent of people with hearing loss have tinnitus (Ehrenfeld, 2019). Therefore, diagnosis and treatment are majorly based on self-report. It is important to note that tinnitus is neither a disease nor an illness but a symptom to many treatable health conditions. At one time or the other, people may experience ringing in the ears as a result of the usage of certain drugs (antibiotics or aspirin) and/or being exposed to loud noise of 85 dB and above for 8 hours daily and without adequate ear protection and traumatic brain injury, as part of normal ageing process (presbycusis). It can also coexist with some ear problems such as impacted wax, inner ear abnormality, etc.

Tinnitus is a prevalent problem and common in all groups, although in the past, it had been considered as a problem of youths, but now it has been discovered that it is more common among the aged (Hinchcliffe and Jackson, 1989). Henry and Wilson (2010) estimated that tinnitus affects approximately 50 million people in the United States of America, as well as a similar ratio has been reported in the United Kingdom. In Nigeria, it is mostly associated with treatable health conditions such as otitis media, stroke, rhinosinusitis, diabetes, head injury and hypertension, which affect 10–33% of the population. The association between tinnitus with functional impairment and reduced quality of life highlights the need for its inclusion in any comprehensive medical programme for the elderly, but it cannot be overemphasised (Lasasi, 2010). It is also important to say that tinnitus is a kind of heterogeneous condition. Therefore, people have to be educated on how to take care of their health to prevent any health hazard which can lead to tinnitus and to avoid suffering from ringing in the ear in their old age. Osisanya, Ojetoyinbo and Olatunde (2022) noted that people suffering from tinnitus go through tough time as a result of associated psychosocial (emotional and behavioural) problems which include severe headache, negative thoughts, dizziness, hearing problem, anxiety, irritation, annoyance, concentration problem, sleep difficulties, depression and poor attention focus. Studies have shown that the quality of life is reduced in patients

suffering from the aforementioned problems (Mckerra, 2000; Bald, Doree and Lazzarini, 2006). Meanwhile, it is noteworthy to say that psycho-acoustical characterisation of tinnitus cannot fully determine the level of discomfort evoked by this condition. Thus, it has been observed that a person suffering from tinnitus may not be aware of it and may not feel any discomfort occasioned by the affliction, while another person suffering from tinnitus is constantly aware of the difficulty in attention focus, falling asleep, and enjoying life; this is because tinnitus is perceived differently and allows the individual to react to it differently.

TYPES OF TINNITUS

There are four basic types of tinnitus based on its characteristics, nature and manifestation symptoms. Although there are other subtypes of tinnitus, both the main and subtypes were discussed as follows:

(1) **Objective tinnitus**: This type of tinnitus can be explained as the one that can be heard by another person, apart from the sufferers. Objective tinnitus is an uncommon type of tinnitus caused by inner ear structural defects such as hair cell damage, vascular anomalies or repetitive middle ear muscle contractions and presence of chronic recurrent rhino-sinusitis leading to Eustachian tube dysfunction. This kind of tinnitus can be easily treated, by treating the cause(s) or by avoiding the risk factors.

(2) **Subjective tinnitus**: The subjective type of tinnitus is differentiated from other types as it is the only one that can be perceived or heard by the affected person. Subjective tinnitus can be defined as an acoustic phantom phenomenon of a perception of sound in the absence of external-physical generated sound signals (Osisanya, Ojetoyinbo and Olatunde, 2022), which is typically initiated by damage to the peripheral hearing system leading to a sequence of structural and functional changes in the central hearing system (Tyler, 2005; Saunders, 2007). Subjective tinnitus is the most common type of tinnitus, and it occurs always as a result of exposure to excessive noise. Most of the times, this type of tinnitus appears and disappears suddenly, and may last for a period of

time before it disappears. There are two types of subjective tinnitus, which are:

(a) **Non-pulsatile subjective tinnitus,** which is the most common type of tinnitus and is typically caused by damage to the peripheral hearing system due to undetectable sounds within the central nervous system;

(b) **Pulsatile subjective tinnitus,** that could be referred to as vascular or pulse-synchronous tinnitus due to its relationship with disturbances in the blood flow.

Pulsatile subjective tinnitus can be explained as a kind of ringing in the ear/head which is perceived as a rhythmic pulsing experience of thumping or whooshing sound due to increased blood flow or narrowing of the opening of the blood vessel.

(3) **Somatic tinnitus:** This is a kind of tinnitus which can be classified in line with the manifestation of ringing in the ear/head due to dysfunction along the sensory system. It is purely the ringing in the ear/head as a result of underlying dysfunction of the sensory system.

(4) **Neurological tinnitus**: The neurological tinnitus is a kind of tinnitus that always manifests as a result of neurological disorder(s) which affect the brain auditory functions. This type of tinnitus is rare and can be caused by some neurological diseases such as Meniere's disease.

Other types of tinnitus are:

(5) **Otologic tinnitus:** This is a kind of tinnitus due to hearing loss Meniere's disease and other related challenges.

(6) **Musical tinnitus:** This type of tinnitus is caused by increased sensitivity to high level of sounds (noise), leading to musical hallucination or auditory imagery.

(7) **Infectious tinnitus:** This is caused by infection or inflammatory health conditions.

(8) **Drug-induced tinnitus**: This is a kind of tinnitus as a result of the

usage of ototoxic medications, non-steroidal anti-inflammatory drugs (NSAIDS). Although the tinnitus severity and its nature depends on the type(s) of drug, the dosage, and duration of usage. Drug-induced tinnitus is like other types of tinnitus which could be temporary or permanent in nature.

(9) **Rhythmic tinnitus:** This type of tinnitus can be caused by several health conditions such as anemia or an overactive thyroid gland making the blood to flow rapidly and loudly, hardening of the arteries (atherosclerosis), high blood pressure or irregular blood flow in the brain and around the ear leading to pressure or internal noise generation within the central nervous system. Apart from the common signs and symptoms of tinnitus, inflicted individuals with this type of tinnitus will manifest a health condition referred to as idiopathic intracranial hypertension.

CAUSES AND RISK FACTORS OF TINNITUS

Tinnitus can be caused or involved by a lot of factors, which include: Traumatic brain injury; hearing loss; exposure to hazardous noise of industrial; recreational and military purposes; age-related hearing loss; impacted ear wax; acoustic neuroma or tumours; inner ear damages; middle ear infection and/or abnormal bone growth in the middle ear (otosclerosis); and regular exposure to musical (recreational) noise. Other factors are individual's lifestyle (e.g smoking, alcohol consumption and clubbing); disruptions along the auditory pathways, leading to alterations in synaptic transmission and neurotransmitter releases into more central areas of the auditory system (Shore, Roberts and Langgwth, 2016), neural activity abnormalities in different parts of the brain, high blood pressure, thyroid gland related problem, and atherosclerosis (narrowing of the arteries).

DETERMINATION AND ASSESSMENT

There are several assessment procedures available to evaluate and determine the presence as well as severity of tinnitus in man. These measures ranging from subjective, psychological to objective diagnostic procedures. The assessment procedures include the following:

(1) The tinnitus functional index, which is a self-reporting questionnaire on the severity and impact of tinnitus.

(2) Tinnitus Handicap Inventory (THI) – This a 25-item self-report measure to determine perceived tinnitus handicap severity.

(3) Tinnitus Reaction Questionnaire – This is a scale designed to assess the psychological distress associated with tinnitus.

(4) Standardised Tinnitus Case-history Questionnaire.

(5) Self –reported questionnaire for noise exposure.

(6) Investigation of auditory and vestibular functions.

(7) Investigation of Brain Anatomy and Function.

(8) Tinnitus Psychoacoustic Assessment, including the following tests; pitch matching; loudness matching; minimum masking level (MML); and residual inhibition (RI). These investigative procedure is known as specialised audiometric tests used to determine subjective tinnitus (Fioretti, Eibenstein and Fusetti, 2011).

(9) Visual Analogy Scales (VAS) – This is also employed to assess loudness, pitch and disturbance of the tinnitus, (Figueiredo, Azevedo and Olivetra, 2009).

(10) Neurophysiological Assessment – This is another investigation conducted with the use of electroencephalography (EEG), Magnetoencephalography (MEG). The procedure is meant to identify tinnitus - associated pathological spontaneous brain activity patterns, and to assess the brain's neuro-chemical characteristics in tinnitus.

(11) Hearing Assessment: This hearing assessment (Audiologic assessment) is a kind of comprehensive hearing investigation involving higher frequency resolution and extended high frequencies. The hearing assessment includes speech-in-Noise, immittance tympanometry, acoustic reflex assessment, auditory brainstem responses (ABR), otoacoustic emissions and loudness discomfort levels (Simoens *et al*, 2021)

Determination of tinnitus as well as assessing persons with tinnitus require holistic investigation due to the tinnitus mechanism, its heterogeneity pathological and psycho-social related complexities.

DIFFERENT AUDIOLOGIC TINNITUS MANAGEMENT (ATM) OPTIONS

In line with the emerging trends and development in audiologic rehabilitation towards managing persons with tinnitus. Nowadays, there are several ATM options, and some of the available ones could be combined, in order to effectively rehabilitate and enhance the quality of life of persons with tinnitus. The available options are presented as follows:

(1) Surgical Rehabilitative Option

Surgical intervention(s) might be required by some patients with tinnitus. The surgical intervention might be done to resolve the underlying medical condition that creates internal acoustic mechanical sounds, as well as to resolve issue relating tinnitus – condition or severity as a result of neurophysiologic-induced tinnitus, vascular, muscular, respiratory or temporomandibular Joint (TMJ) origin (Henry Zaugg, Meyers, *et al*, 2010). Surgery can also be done for the purpose of implanting cochlear implants, as this would help in reducing tinnitus by making sounds.

(2) Pharmacology-based Option

This is purely pharmalogical treatment of tinnitus with the use of drugs to resolve tinnitus and tinnitus-associated symptoms (such as fatigue, stress, depression and sleep problem). The drugs used might include anti-depressants, vasodilators, vasoactive substances and other categories (Noble, 2008).

(3) Non-invasive Neuro-stimulation

This is a kind of treatment through the process of non-neuromodulator techniques, which includes transracial magnetic stimulation, transracial electrical stimulation and neuro-feedback (Simeos et al, 2019). Any of the neuro-stimulation can be engaged to treat patient (s) with tinnitus if need arises.

(4) Neuromonics Tinnitus Treatment Option

This treatment option is used as a combined therapy, and as a combination of acoustic stimulation with a structured programme of counselling. The treatment mechanism is structured to provide stimulation to auditory pathways that are deprived by hearing loss, engage positively with limbic system, and allow intermittent, momentary tinnitus perception within a pleasant and relaxing stimulus, thereby facilitating desensitisation to the signal (Davis, Paki and Hanely, 2007). Neuromonics tinnitus treatment has been recognised as one of the essential rehabilitative options in managing persons with tinnitus, because it helps to interact and desensitise tinnitus disturbance using a customised sound therapy in a framework of structured counselling (Hanley and Davis, 2008).

(5) Temporomandibular Joint Treatment (TMJ)

Temporomandibular joint treatment option is used to resolve issues relating to TMJ disorders, while at the same time reducing the effects of tinnitus and other conditions. TMJ treatment option is also used to solve problems affecting the temporomandibular Joint, masticulatory muscles, and /or the adjoining structures causing pain and tiredness for the patients (Ash and Pinto, 1991).

(6) Herbal Therapeutic Option

Nowadays, a variety of medicinal herbs and their derivates are being engaged in some parlance and culture towards rehabilitating persons with tinnitus. This herbal treatment option considers the use of different medicinal plants as well as a variety of herbal medications for treating tinnitus and associated health conditions. The most popular among the various herbal medications are:

(i) Ginkgobiloba

Ginkgobiloba which is also known as Jinko, is a Chinese traditional herb from the family of Ginkgoaleae. Ginkgo biloba has been tested and proven to be effective, safe and in expensive treatment option for the management of various central nervous system pathologies, including tinnitus (Khosravi, Saeedi, Yousefi, Bagherihagh and Ahmadzadeh, 2019).

(ii) Garlic

Garlic is another herbal medication found to be beneficial for the management of tinnitus (Smith, Romanellin-Gobbi, Karagrigoriou and Artz, 2013). This herbal medication has been found having capacity for lowering blood pressure, stabilising blood pressure and augmentation in antioxidant capacity of the blood (Khosravi, *et al*, 2019).

(iii) Yoku-Kan-San

This is another herbal medication, a traditional Japanese herbal remedy for the treatment of psychological conditions such as irritability, insomnia, night terrors and hypnic myoclonia (Aizawa *et al*, 2002) and found to be effective in the management of patients with tinnitus resulting treatment undifferentiated somatoform disorder (Okamoto, Okami, Ikeda, and Takevchi, 2005).

(iv) Panax ginseng (Jinseng)

Jinseng is another veritable herbal remedy, which is also a Chinese medication from the Araliaceae family. According to Salehi (2009), this herbal medication had been in use for the treatment of tinnitus since the dawn of traditional medicine. Jinseng is capable of inhibiting production of reactive oxygen species and attenuates hydrogen peroxide-induced oxidative stress in human neuroblastoms cells, and increases the quality of life of patients with tinnitus (Khosravi, *et al*, 2019).

(7) Complementary and Alternative Treatment Option

The complementary and alternative treatment option is known as complementary alternative medicine (CAM), and it seems popular in most countries of the world, and its efficacy as a treatment option has been encouraging. Although there are several CAM products across the globe, the following are some of the CAM products used for the management of patients with tinnitus.

(i) Acupuncture

Acupuncture is one of the CAM mechanism that is universally known as a

method of treatment in which needles are inserted into the body of a patient and manipulated in such a way that will make the patient become relief of the pain or health condition.

Acupuncture is engaged as therapeutic and preventive measure of management of tinnitus, and it has been found to enhance hearing perception, decreases the intensity of tinnitus-condition, and improves the quality of life of tinnitus suffers (Aytac, 2019).

Acupuncture is a kind of psychosocial behaviour therapeutic option, and has been efficient in the reduction of the interference of tinnitus in the quality of life, easy masking of the environmental sound and making the tinnitus sufferers to forget tinnitus in the presence of normal sounds during daily life more easily (Tano, Schultz, Borges, and Marchiori, 2016). This treatment option is known for its significant improvement in the area of decreasing the intensity level of the tinnitus as well as improving the quality of life of patient with tinnitus.

(ii) Yoga

Yoga is a known holistic therapeutic mechanism that involves the engagement of appropriate physical postures, breathing exercises and medication. According to Aytac (2019) adopting certain postures allows the body to completely relax, and this helps towards achieving a higher state of body consciousness. Thus, yoga mechanism makes the patients with tinnitus have stress reduction through certain body postures, relaxing the muscles of the body and thereby allowing the control of autonomous nervous activity through a system of deep breathing. Yoga, as a therapeutic option has significantly enhanced the quality of life of patients with tinnitus, by reducing the associated anxiety, stress, depression, sleep disorders and stress-related insomnia (Aytac, 2019).

(iii) Hypnotherapy

This treatment option involving the alteration of state of consciousness of a patient with tinnitus, and at the same time allows the subconscious mind to be more open to selective and deep state of relaxation. Hypnotherapy is used to help patients with tinnitus feel more relaxed and comfortable with perceived noise. It also makes patients with tinnitus to cope with the

psychological aspects of tinnitus such as anger, stress, and anxiety (Aytac, 2019).

Complementary and alternative treatment is globally practised towards providing therapies for patients with tinnitus. Therefore, it has become one of the veritable measures for rehabilitating persons with tinnitus.

(8) Sound-based Treatment Option

The sound-based tinnitus treatment option emphasises the use of electronic devices ranging from hearing aids, cochlear implants, acoustic neuromodulation, and environmental sound enrichment techniques. The techniques are as follow:

(i) Hearing Aids

Fitting and using this kind of assistive listening device either unilaterally or bilaterally is to stimulate the auditory systems and brain of individual with tinnitus towards preventing a spike in the central auditory nerve as well as to ensure that the tinnitus condition does not impair the person's quality of life (Vangerrwua, 2019). Hearing aids are used in this context to increase the overall level of ambient sound coming to the hearing system of a patient with tinnitus.

(ii) Cochlear Implant (CI)

This cochlear implant commonly referred to as CI is a surgically implanted electronic device for the standard treatment of patients with severe to profound bilateral hearing loss. The CI helps to mask the tinnitus sound with positive effect on the reorganisation of the central auditory nervous system and restoration of peripheral sensory input (Fioretti, Eibemstein and Fusetti, 2011).

(iii) Acoustic Coordinated Reset (CR) Neuromodulation

Acoustic coordinated reset neuromodulation is also a veritable mechanism to make a patient with tinnitus have a relief over tinnitus condition towards the reduction in neural synchrony which is considered as a cause of the decrease in the connectivity in the brain. Thus, acoustic CR neuromodulation

is an essential rehabilitative mechanism for the elderly patients with comorbidity of hypertensive and tinnitus.

(iv) Environmental Sound Enrichment

Environmental sound enrichment is another psychology-based treatment to habituate any disordered auditory system through the use of low-level sounds (sound enrichment) to regulate the auditory functions of any individual with experience of tinnitus. The most effective way for sound therapy is the usage of a kind of sound enrichment suitable (pleasant and well tolerated) to the patient(s) with tinnitus, although some natural background sounds such as recorded traffic noise or music playing functions (instrumental sounds) and sound generators are well encouraged or advised for effective and prompt result (Osisanya, 2019).

(9) Psychological Rehabilitative Option

There are several psychology-based rehabilitative options for managing persons with tinnitus. These psychological treatments include:

(i) Relaxation therapeutic exercise

Relaxation therapy is a designed psychology-based therapy to reduce the effects of noise in the ears/head and psychosocial reactions occasioned by the tinnitus-related conditions, as well as making the patients with tinnitus cope with everyday stress (Osisanya, 2019). Relaxation therapy is a kind of stress management mechanism to consciously relax the body and mind of any individual with health-related conditions and stress either directly or through guided assistance by initiating calmness into the lives of those who are exposed to it. Relaxation therapy is always achieved through regular deep breathing exercises, relaxing music, mediation and mindfulness exercises.

(ii) Sleep therapy

This is another type of psychology-based treatment option meant to rehabilitate people with sleep disorder. Sleep therapy is employed to help the tinnitus patients, due to their regular experience of sleep disorder as a

result of the attendant effects of the tinnitus condition on their physical, mental and emotional functioning status. Sleep disorder often leads to cognitive changes, mental health conditions and daytime distress. Most of the times, the attendant difficulty often prevents the tinnitus patients from falling asleep. Thus, it is necessary to resolve the sleep difficulty through the development of skills towards the modification of unwanted sleep patterns. Sleep therapy is a planned psychological treatment to help patients with tinnitus condition to reflect on their beliefs about sleep and negative feeling as a result of tinnitus.

(iii) Tinnitus retraining therapy (TRT)

Tinnitus retraining therapy is a kind of therapeutic mechanism which is used as a noise generator towards rehabilitating individuals with tinnitus by exposing them to a kind of background noise level towards reducing the negative effect of unwanted sound perception and to also overshadow the perception of the ringing in the ear/head. Tinnitus retraining therapy is designed to alter the mechanism that transfers the signal from the auditory mechanisms to the limbic and autonomous nervous systems, thereby removing tinnitus-induced reactions. TRT is a therapeutic mechanism, which always helps an individual with tinnitus to gradually ignore the sound and the associative effects of the tinnitus condition (Osisanya, 2019). TRT is used as habitual therapy to give hope to individuals with tinnitus as well as a mechanism of relief to those who are willing to be rehabilitated or adjusted with the condition. Structurally, TRT is designed to help individuals with tinnitus to understand and learn how to stop thinking about the perceived ear/head noise. The therapy makes use of white noise or environmental sounds to block out the tinnitus noise, thereby training the brain to ignore the perception of the negative sound (Jastreboff and Jastreboff, 2000; Osisanya, 2019).

(iv) Tinnitus masking therapy (TMT)

Tinnitus masking therapy is another psychological treatment option, designed to promote the reduction of audibility of tinnitus by introducing another sound signal through an instrument known as tinnitus masker (Henry, Jastreboff, Jastreboff, Schectte and Fausti, 2002). The tinnitus masker is used to

generate masking noise which can either be applied to the ipsilateral or contralateral ear. Also, the tinnitus masker is used as a sound therapy that could be placed on a bed side for a patient with tinnitus who is experiencing sleeping difficulty (Vernon, 1996). It is also used to minimise the contrast between the tinnitus and the surrounding sound, promoting a shift of the patient's focus away from the tinnitus, while at the same to reduce the fatigue and stress occasioned by the tinnitus (Osisanya, 2019). TMT involves the use of several devices to produce masking sounds that will interfere with the ringing in the ear. It also means to offer an expected relief to the individuals with severe tinnitus and associated psychosocial reactions.

(v) Cognitive behavioural therapy (CBT)

Cognitive behavioural therapy is another psychology-based therapy designed to minimise the negative thoughts flowing in the mind of an individual with tinnitus while at the same time changing the person's behaviour towards the tinnitus. CBT has the capability to rehabilitate and reduce the effect of tinnitus and its attendant psychosocial reactions by reducing the distress caused by tinnitus. CBT has an audiologic tinnitus management mechanism make use of relaxation strategies, cognitive restructuring mechanism of thoughts reasoning and modified situations to re-pattern the thoughts and feelings of an individual with tinnitus to acquire essential skills to respond positively to tinnitus and live well-adjusted life, even with the tinnitus condition(Osisanya, 2019).

(vi) Tinnitus desensitisation therapy (TDT)

Tinnitus desensitisation therapy is another audiologic therapeutic strategy employed to desensitise the abnormal processing of negative sound perceived. TDT is employed towards redirecting the attention (cognitive processing) of the individuals with tinnitus away from the tinnitus-induced signal and enabling the brain to naturally habituate the perceived tinnitus signal. TDT involves the use of directional (specific) counselling signal therapy and relaxation exercises to enable the natural habituation processing of the tinnitus-induced signal.

(vii) Biofeedback therapy

Biofeedback therapy is another psychology-based treatment option employed

to rehabilitate individual with stress and pain health-related conditions. The treatment strategy is designed towards alleviating the negative feelings and psychosocial effects of poor health condition on people. In audiology parlance biofeedback therapy is used to rehabilitate individuals with pulse-synchronous tinnitus through relaxation methods. The therapy is structured to help individuals with tinnitus to control his/her breathing system, heart rate and involuntary functions so as to reduce the effect of hypertension-related conditions, control of all the bodily processes, such as heart rate, breathing system and blood pressure.

(10) Progressive Audiologic Tinnitus Management

Progressive audiologic tinnitus management, is commonly referred to as PATM is an expanded and upgraded form of audiologic tinnitus management. According to Henry *et al* (2008) PATM is a sound-based treatment method that is used as a combined therapy of sound-based approach, tinnitus masking, and tinnitus retraining therapy and neuromonics tinnitus therapies. PATM is an improvement with more detailed provisions of education and informational counselling towards assisting people with tinnitus have adequate self-management knowledge. Progressive audiologic tinnitus management involves 5 stepped-care levels of management, and thus each patient with tinnitus is treated based on his/her health needs. (Schmidt, Kaelin, Henselmen and Henry, 2017).

CONCLUSION

Tinnitus is the perception of sound without an external auditory stimuli or environmental sound signal. This health-related condition is a distressing condition capable of disturbing the day-to-day life of individuals with such a condition, especially with ringing in the ear/head, distress, anxiety, annoyance, fatigue, disruption of sleep and depression. People with tinnitus always experience some physiological, physical and psychosocial difficulties, financial stress and poor self-efficacy due to difficulty towards habituation. Thus, in managing the tinnitus condition and attendant psychosocial problems, several treatment approaches have been developed and in use towards reducing the severity of the problem, eliminating the tinnitus and removing the tinnitus-induced reactions.

Most of the strategies in use lack the required capability to restore the tinnitus-condition due to its complex nature and attendant health and psychosocial related conditions, thus, leading to the development of audiologic tinnitus management protocols. Audiologic tinnitus management has overtime become a universally acceptable treatment option for rehabilitating persons with tinnitus. The ATM treatment protocol allows the integration of structured informational counselling provisions based on the individualised programme of sound enhancement that is beneficial to persons with tinnitus. To this end, the management of persons with tinnitus should be based on individualised provisions, tips for self-adequate management, proper evaluation and determination of therapeutic needs, giving room for combined therapies, interdisciplinary (multidisciplinary) management and holistic management approaches.

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