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Effects of Music Therapy on Mood in Stroke Survivors: A Narrative Review

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Abstract: *Stroke is the second leading cause of death and the third leading cause of disability worldwide. Positive effects on mood in stroke survivors can inspire motivation for rehabilitation and contribute to improvement in daily living functions and functional level. Guidelines in stroke rehabilitation recommend the use of a multidisciplinary approach. Different approaches and techniques with music are used in the stroke rehabilitation to improve motor and cognitive functions but also psychological outcomes. The aim of this article is to provide a narrative review of the current literature on music therapy and its effects on mood disorders among stroke survivors. In order to carry out a narrative literature review, two independent investigators searched in PubMed, Google Scholar, and Cochrane databases to select randomized controlled trials in English regarding music and music therapy interventions for stroke; the trials were published in peer-reviewed journals from January 2000 to March 2020. Trials that include outcomes concerning mood or depression; where experimental conditions were clearly stated and consisted only or primarily of musical activities were considered for the review. Four articles met the inclusion criteria and were included in this review. Among these, all four were randomized controlled trials. The current review showed music therapy can be used to alleviate mood disorders and how music therapy can improve mood and psychological well-being in stroke survivors. Music therapy is an effective and economical tool to alleviate mood disorders in people with Stroke. Future studies should adopt rigorous methodological criteria to carry out larger samples and various music therapy interventions.*

Keywords: *Stroke, music therapy, depression, anxiety, mood*

I. INTRODUCTION

According to the latest global statistics, the prevalence rate of stroke was approximately 25.7 million and was the second leading cause of death in 2013.[1] Although older people have a higher risk of stroke, the onset of stroke among people aged 20–64 years has increased by 25% from 1990 to 2010 worldwide.[2] These statistics indicate that the world is now facing a grave challenge with an increasing number of stroke survivors, thus more resources are needed for rehabilitation and post-stroke support. During the first weeks and months of recovery after a stroke, the brain can undergo dramatic plastic changes that can be further enhanced by stimulation provided by the environment. [3] Post-stroke motor and somatosensory environmental enrichment [4], virtual environments [5], and electrical cortical and peripheral stimulation [6] have all been shown to improve motor recovery. Interestingly, multimodal stimulation, including auditory, visual and olfactory stimuli, combined to the enriched motor environment enhanced motor and cognitive recovery more than the enriched motor environment alone. [7]

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Most of the stroke survivors have mood disorders as a result of their stroke. The high prevalence and diverse manifestations of mood disorders in patients recovering from stroke and growing evidence that family members and caregivers may also experience depressive symptoms emphasize the need for a system of care that ensures consistent clinical practices across settings. Histories of prior depression, type of functional impairment, the presence of cognitive deficit, and stroke severity have been commonly reported in several studies as risk factors for post-stroke depression.[8] Despite extensive research, systematic reviews have shown that neither the anterior-posterior nor the right-left hemispherical localization of the lesions is a risk factor.[9] Several adjunctive and emerging therapies like physical exercise, music, mindfulness, acupuncture, deep breathing, meditation, visualization, hyperbaric oxygen, and repetitive transcranial magnetic stimulation are used as non-pharmacologic management of mood disorders after stroke.

Music is an enjoyable leisure activity that also engages many emotional, cognitive, and motor processes in the brain. The World Federation of Music Therapy defines music therapy (MT) as "the use of music and/or its musical elements (sound, rhythm, melody and harmony) by a music therapist, and client or group, in a process designed to facilitate and promote communication, relationship learning, mobilization, expression, and organization (physical, emotional, mental, social and cognitive) in order to develop potentials and develop or restore functions of the individual so that he or she can achieve better intra- and/or inter-personal integration and, consequently, a better quality of life".[10] Music listening induces activation in the pleasure and reward systems in the brain which is essentially at the core of the efficacy in all music-based rehabilitation tools. In humans, music listening activates a wide-spread bilateral network of brain regions related to attention, semantic processing, memory, motor functions, and emotional processing. Music exposure also enhances emotional functioning in healthy samples and in various clinical subject groups. here is decidedly less discussion about the impact of MT on quality of life for clients suffering from neurological conditions, despite the fact that MT is increasingly being used in neurorehabilitation. The potential role of music in stroke rehabilitation, however, has not been systematically investigated.

The aim of this narrative review is to introduce literature on the effects of music therapy on mood in stroke survivors and to deepen the understanding of music therapy in neurological rehabilitation.

II. METHODS

A literature search was performed using Google Scholar, PubMed and Cochrane databases. A total of 26 items showed up on PubMed and 18 on Cochrane with the term "music therapy on mood in stroke". The search terms used were stroke, music therapy, depression and mood. Research articles published in English, between January 2000 and March 2020, were included. Importantly, we considered only trials including outcomes concerning mood or depression where experimental conditions were clearly stated and consisted only or primarily of musical activities. The studies were double checked and only full text articles were used for the review. Totally, 4 studies were selected to emphasize the effect of music therapy on mood among stroke survivors. These studies were reviewed in a narrative way, and the main findings are summarized.

III. ELIGIBILITY CRITERIA

Studies included in this review were based on the inclusion criteria listed in Table 1

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Table 1: Inclusion criteria of reviewed articles

Study types: Randomized Controlled Trials (RCTs) were included. Studies without the full text, abstracts presented in the conferences, brief reports, case reports and unpublished theses were excluded in this review. **Participants:** Subjects diagnosed with two major types of strokes: hemorrhagic stroke or ischemic stroke. No restrictions on age and nationality were imposed. **Music therapies:** Any intervention that applied music as a medium to achieve any therapeutic goal. The interventions could be delivered in a group or individual formats. **Interventionists:** Interventions both guided by qualified music therapists and by other professionals were included. **Duration:** There were no limitations on the length or duration of the interventions. **Setting:** There were no restrictions on the setting of the interventions. They could be conducted in any venue such as a hospital, or anywhere within the community setting. **Language:** Only articles written in English were included in this review.

IV. MUSIC THERAPY

There may be three neural mechanisms by which music could help stroke survivors to recover:

1. Enhanced arousal (alertness), attention and mood, mediated by the dopaminergic mesocorticolimbic system-the part of the nervous system that is implicated in feelings of pleasure, reward, arousal, motivation and memory;
2. Directly stimulating the recovery of the damaged areas of the brain;
3. Stimulating other more general mechanisms related to brain plasticity -- the ability of the brain to repair and renew its neural networks after damage.

Music can facilitate rehabilitation in congenital or acquired neurological dysfunctions through the induction of emotions and the reward system in the brain. Exposure to music is one of the richest human emotional, sensorimotor and cognitive experiences and is commonly associated with strong emotions such as happiness or sadness (known as Apollo's gift). Neurohormonal status modulations induced by music provide a pleasurable experience but also play a role in MT. Dopamine has a dominant role in the neurobiology of reward based learning and curiosity, and facilitates plastic adaptations in the brain. Dopamine is secreted when a new pleasure is experienced. Serotonin is associated with feelings of Satisfaction. [11] It has also been shown that more aggressive environmental sensory stimuli the more the chance to have Peripheral and central nervous system disorders. [12] Finally, the emotive network of the cingulate gyrus, amygdala, hippocampus, and midbrain plays an important role in any musical activity and underlies the motivation to listen to music. Skilled musicians have a larger corpus callosum in response to high demands for bimanual coordination and the rapid exchange of information between hemispheres. [13] Children learning to play a musical instrument show a similar change with greater brain plasticity than adult amateur musicians. [14] Rueber et al. have found structural differences in the corticospinal tract between musicians and non-musicians. [15]

Listening to familiar music has recently been reported to be beneficial during recovery from stroke. Stroke survivors might benefit from a variety of different music therapy approaches- the familiar emotional pieces to activate certain areas of the brain, and novel pieces to activate others. The researchers found distinct brain activation patterns for the different music pieces. The self-selected pieces were quite diverse, brought about significant activity in the emotion and memory centers of the brain, while unfamiliar music activated attention and memory areas. Karmonik et al reported that despite such different self-selected musical pieces, the patterns of brain activity were remarkably similar. [16] A study by scientists at Houston Methodist Hospital suggests that familiar, positive music may have the power to increase activation and functional connectivity in the brain-and, as such, may provide targeted therapeutic benefits to those recovering from a stroke. Regular music listening enhanced structural neuroplasticity in the limbic regions, is linked to better emotional recovery.

V. DESCRIPTION OF SELECTED STUDIES

Four studies assessed the effects of music therapy on post-stroke patients. All studies show a positive effect of music therapy on mood in patients with stroke. Kim et al. conducted a study among stroke survivors in in which participants attended 40-minute group sessions twice a week for a period of 4 weeks. The music therapy program in this study followed the 40-minute music therapy format and was carried out in accordance with the physical strength and individual characteristics of patients. The session consisted of a hello song and sharing of events in their lives (5 minutes); planned musical activities (30 minutes) including respiration and phonation, improvised play, hand bell play, singing, songwriting, and expression in tune with music; and sharing of feelings and a goodbye song (5 minutes). Keyboards, hand bells, percussion instruments, flutes, and other tools such as picture cards, flowers, and fruit scents were used in accordance with the planned activities. Patients were encouraged to improvise depending on their feelings and sing children's and folk songs. The authors reported that music therapy has a positive effect on mood in post-stroke patients and may be beneficial for mood improvement with stroke. Stroke survivors participated in the music therapy program for four weeks. Psychological status was evaluated with the Beck Anxiety Inventory (BAI) and Beck Depression Inventory (BDI) before and after music therapy. Satisfaction with music therapy was evaluated by a questionnaire. Music therapy satisfaction in patients was found affirmative. [17]

Another study evaluated the effects of combined music-movement therapy on physical and psychological functioning of hospitalized stroke patients. Patients hospitalized for stroke and within two weeks of the onset of stroke were randomized to either an experimental group (received music-movement therapy in their wheelchairs for 60 minutes three times per week for 8 weeks) or control group (received only routine treatment). The effect of music-movement therapy was assessed in terms of physical outcomes (range of motion, muscle strength and activities of daily living) and psychological outcomes (mood states, depression). The findings of this study shows that significantly increased shoulder flexion and elbow joint flexion in physical function and improved mood state in psychological function. The authors suggest that rehabilitation for stroke patients should begin as early as possible, even during their hospitalization. [18] Chen et al. reported a similar mood improvement effect, and an increase in arousal. [19]

Improvement with regards to higher levels of attention focusing, lower levels of depression, and lower levels of decreased mood in a group listening to music, in comparison to a group listening to audiobooks, as well as a control group was reported in a study among stroke survivors. The study was aimed to gain more insight about the emotional and psychological factors underlying the therapeutic effects of listening to music after a stroke, by combining both qualitative and quantitative methods. Thirty-nine patients who had suffered a stroke were interviewed about their subjective experiences when listening, on a daily basis, to either self-selected music or audiobooks during the first 2 months after the stroke. Music listening was specifically associated with better relaxation, increased motor activity, and improved mood, whereas both music and audiobook listening provided refreshing stimulation and evoked thoughts and memories about the past. The findings of this study highlight the clinical importance of providing stimulating and pleasant leisure activities after a stroke and further encourage the use of music in stroke rehabilitation.[20]

Nayak et al conducted a study to investigate the efficacy of music therapy techniques as an aid in improving mood and social interaction after traumatic brain injury or stroke. Eighteen individuals with traumatic brain injury or stroke were assigned either standard rehabilitation alone or standard rehabilitation along with music therapy. Participant self-rating of mood, family ratings of mood and social interaction, and therapist rating of mood and participation in therapy were assessed. There was a significant improvement in family members' assessment of participants' social interaction in the music therapy group relative to the control group. The staff rated participants in the music therapy group as more actively involved and cooperative in therapy than those in the control group. The authors reported that there was a trend suggesting that self-ratings and family ratings of mood showed greater improvement in the music group than in the control group. The findings of this study lend preliminary support to the efficacy of music therapy as a complementary therapy for social functioning and participation in rehabilitation with a trend toward improvement in mood during acute rehabilitation.[21] Studies examining the effectiveness of music therapy in the treatment of mood disorders are summarized in Table 2.

Table 2: Characteristics of the included studies concerning effects of music therapy for mood disorders in stroke

Author, Year, Study Design	Interventions	Frequency	Outcomes	Results
Jun et al. (2013) RCT	E: Music-movement therapy C: Usual care	Three times per week for 8 weeks for 60 min	CES Depression Scale Profile of Mood State	Improvements in mood states (P = 0.04)

Kim et al. (2011) RCT	E: Music therapy (8 sessions) C: Usual care	Twice a week for 4 weeks for 40 min	Beck Depression Inventory Beck Anxiety Inventory Questionnaire of satisfaction	Improvement in depression (P= 0.048) and positive trends for anxiety
Forsblom et al. (2010) RCT	E: Music listening C: Audiobook listening	Every day for 2 months for 1 h (at minimum)	Analysis of patient's interviews	Improved mood ($P < 0.0001$), better relaxation, increased motor activity in music listening group
Nayak et Al. (2000) RCT	E: Singing, playing instruments, composing, improvising, listening C: Usual care	2 or 3 sessions a week during the hospitalization up to a maximum of 10 sessions	Faces Scale, Visual Analogue Scale, Sickness Impact Profile, Questionnaire (Staff rating of participation in therapy)	Positive trends in mood and significant improvements in social interaction ($P < 0.02$) and involvement in therapy ($P< 0.01$)

VI. DISCUSSION

Mood disorders in stroke are common and disabling. Their etiology is complex and may be multifactorial. Good history taking and detailed examination of physical and mental state will usually reveal the diagnosis and the formulation. Providing a correct diagnosis of an emotional disorder and starting an appropriate treatment may help physicians to increases in function and quality of life of their clients. [22]

Music is a powerful stimulus that induces and communicates emotions and meaning through the perception of its intrinsic symbolic structure of musical elements, as well as through emotional responses that have become connected to it through an associative learning process. [23] The music is characterized by a unique ability to access affective-motivational systems in the brain, which have an important regulatory function in organization of behavior, change of behavior and in learning. Attention, perception, memory, learning, executive functions and physical responses can be effectively influenced by appropriate affective states. It is considered a major mechanism of therapeutic effectiveness of music therapy. The limbic areas of the brain, known to be associated with emotions, are involved in the rhythm and tonality processing. The brain areas related to emotion and reward have been found to be activated during intensely pleasurable moments of music listening.

Music (favorite songs) evoked autobiographical memories in stroke survivors, and the evoked memories were positive. [24] The use of MT in clients with middle cerebral artery stroke in the early recovery phase (measured 1week, 3 months, and 6 months after the stroke) indicated that: 1) listening to pleasant music can have a short-

term facilitating effect on visual awareness in clients with visual neglect, which is associated with functional coupling between emotional and attentional brain regions; 2) daily, long-term music listening can improve auditory and verbal memory, focus of attention, and mood, as well as induce structural gray matter changes in the early post-stroke stage. [25] Listening interventions seem to be quite common in clinical literature, usually based on self-selected or other-selected music proposed individually[26] or in group, as in the case of background music.[27] Songs are tools that help to express what patients feel and soothe their loneliness. Patients can express their emotions (e.g., happiness, sadness) and their hopes and despairs through songs. [28] Therapists assist patients to alter their negative emotions to positive ones through the process of psychological therapy. [29] Music imaging refers to the experience of musical listening and imagery. [30] Patients experience imagery through the music program provided by the therapist and subsequently discuss their imagery with the therapist. Music therapy is an effective form of psychological therapy; it can soothe the suppressed emotions of patients and add vitality to the body, while giving them the energy to share their feelings with others.

Recent neurological rehabilitation techniques are based on new technologies such as stimulation via the so-called Binaural Beat Stimulation. [31] It is a special type of rhythmic auditory stimulation that requires two sine tones, one presented to each ear, differing in frequency by 1 to 30 Hz, creating an auditory beating effect for the listener. This technique appears to be capable of systematically modifying ongoing brain activity and results in states of increased vigilance and altered mood. Another multi-modal technique effective in the treatment of stroke, brain injury, dementia and other conditions of cognitive deficits is an audio-visual stimulation, i.e. the use of rhythmic music in conjunction with rhythmic light therapy. Therapeutic effects of these new techniques of brain stimulation can be controlled by fMRI, in particular through neurofeedback combined with fMRI. It allows us to observe not only the altered activity in individual brain regions, but also targeting patterns of interactions or functional connectivity between brain areas. [32] As with most rehabilitative techniques, challenging the injured brain can improve abilities. Exactly how and why this happens on a cellular level remains unclear. There are several leading theories regarding the mechanism by which music therapy improves client's abilities in stroke recovery. Music plays a large role in mood for many people. Musical pieces can elicit pleasant or unpleasant emotions that are rooted in life memories. The response of mood to music may be conscious or subconscious. Music that evokes memories of pleasant interpersonal connections or achievements may elevate the mood of some stroke survivors. Positive mood has been shown to play a significant role in stroke recovery. [33] The current review showed how MT and musical interventions can improve mood and psychological wellbeing in stroke survivors. These clinical results are in accordance with the literature that highlights the effects that music listening and music making have on brain structures of emotion regulation,[34] on various neurochemical systems,[35] and on neural plasticity.[36]

Additionally, rehabilitative techniques are believed to augment neuroplasticity. Yet why some methods seem to have this effect is not clear. And, yet another theory is that enhanced connectivity between regions of the brain can allow stroke survivors to regain skills that were lost. There are some overlaps between this idea and that of theories surrounding neuroplasticity, but there are also some aspects of the two concepts that are independent. Thus far, research on music therapy in stroke recovery is favorable. Given the relatively low cost of music therapy and the lack of treatment for brain injury incurred by stroke, it is an interesting option for recovering stroke survivors. Even with all the positive results with this new therapy considerations must be taken before administering the therapy for stroke survivors. There may be a number of intervening factors for the success of the therapy including

environment of treatment, time of exposure to music, psychological status of the client etc. A more methodological rigor and a clearer definition of music approaches are needed to improve the quality of MT research in the field of stroke rehabilitation. This review points out a positive effect of interventions with music on psychosocial outcomes such as mood and depression when compared to standard care or other treatments. More high-quality randomized controlled trials with less methodological issues and noted heterogeneity are required to back up the present findings.

Music therapy can inspire motivation for rehabilitation treatment and contribute to improvement in functional level by its impact on emotional processing. Rather than an alternative, music listening should be considered as an addition to other active forms of therapy, such as speech therapy or neuropsychological rehabilitation. This is a rationale for implementing this form of therapy as a regular treatment in the neurorehabilitation of individuals who have experienced a stroke. However, the strength of this review's findings is limited due to a generally poor methodological quality of the studies and the restricted size of samples. Future studies should include more subjects, and also perform a follow-up measurement to make inferences about long-term effects of MT on mood. Moreover, more research is needed to explore the differential impact of various MT approaches, frequencies, durations, and interventional time points.

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VIII. CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest in this work.

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