Full-Length Article

Music Therapy and Stroke: *An Integrative Review*

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Abstract

Stroke is an acute event and one of the leading causes of death worldwide. The person who experiences stroke can be left with functional deficits in cognition, communication, and motor control. Music has been used to address the sequelae of stroke since the beginning of the 20th century. Researchers have studied music therapy's impact on stroke impairment from the inception of the field, with an increasing amount of research taking place coinciding with advances in neurological imaging. This integrative review explores how clinicians and researchers have addressed the various consequences of stroke through the use of music therapy. Multiple databases were searched, including CINAHL, Cochrane Database of Systematic Reviews, EBSCO, INGENTA, MEDLINE, OVID, as well as online sources such as Grey Literature Report. This process resulted in the identification of 39 articles that researched the use of music therapy in the rehabilitation of persons with stroke. Results from this study may contribute to the ongoing potential role that music therapy plays in stroke rehabilitation. Findings contained within can be used to develop and refine clinical practice.

Keywords: *music therapy, stroke, stroke rehabilitation, integrative review.* multilingual abstract | **mmd.iammonline.com**

Introduction

Music and medicine have been linked throughout history, serving one another in healing mind, body, and spirit. One of the first music therapy courses offered at a university trained musicians to work in hospitals to address the mental and physical disabilities of soldiers returning from World War I [1].

Since the beginning of the 20th century, research confirmed music's effectiveness in rehabilitating individuals with neurological impairments caused by acquired brain injury [2]. Recent research has found that the brain is capable of adapting when damaged, and that music can play a role in neurological re-mapping [3].

Music therapy in the treatment of acquired brain injury was the subject of a Cochrane review in which it was suggested that a systematic review of this topic was needed "to more accurately gauge the efficacy of music therapy as a rehabilitation intervention for people with acquired brain injury as well as to identify variables that may moderate its effects" [4,*p3*].

With the above in mind, the authors narrowed their exploration to those studies where music therapy clinicians and researchers had addressed the consequences of stroke specifically and found that diverse methodologies had been utilized. As a means of reviewing and incorporating the majority of this research, the authors conducted an integrative review, as this format allows for the inclusion of quantitative and qualitative research [5]. The process of conducting an integrative review is the same as that of a systematic review and, consequently, maintains the rigor of the systematic review process [6].

Whittemore and Knafl state that the integrative review's inclusion of experimental and non-experimental research "has the potential to play a greater role in evidence-based practice" for the field of nursing [5,*p547*]. In the field of music therapy, Abrams [7] points out that evidence-based practice (EBP) is increasingly used as a means to solidify the profession's usefulness and reputation, especially within the context of health care services. He states "a close examination of the core elements in some of the more prominent definitions of EBP reveals the possibility for an inclusive understanding, potentially embracing the full range of perspectives" [7,*p351*]. This echoes the conclusion of Noyes, Popay, Pearson, Hannes, and Booth who stated, "evidence from qualitative studies can play an important role in adding value to systematic reviews for policy, practice and consumer decision-making" [8,*p571*].

Stroke is an acute event and one of the leading causes of death worldwide. The impact of stroke is startling in its breadth, stretching well beyond stroke survivors and their caregivers, and deep into the fabric of society. In the United

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States, a stroke occurs every 40 seconds and is the prevailing cause of disability in adults [9]. In the U.K., a stroke occurs every 3 minutes and 27 seconds [10].

The person who experiences stroke can be left with functional deficits in cognition, communication, and motor control. These impairments can lead to mood disorders and isolation, contributing to a significantly higher incidence of depression in the post-stroke population [11]. Such depression often leads to the avoidance of social and physical activities that could improve post-stroke health. The financial impact of stroke is staggering. "Stroke costs the nation $34 billion annually, including the cost of health care services, medications, and lost productivity" [12]. The American Stroke Association estimated that Americans paid "$73.7 million…for stroke-related medical costs and disability" in 2010 (2013) [13].

Music and the Brain

The rapidly growing field of music neuroscience is mounting evidence that music impacts the brain in dynamic ways. An early study, facilitated by Schlaug, Jäncke, Huang, Staiger, and Steinmetz [14] correlated musical training and experience with changes in neurological function and organization. Their research revealed that the anterior corpus callosum, an area of the brain essential to interhemispheric communication, is larger in musicians than non-musicians. Lappe, Trainor, Herholz and Pantev [15] found short-term musical rhythm training produced plastic changes in the auditory cortex. This research suggests that despite the serious consequences of stroke, there is promise for rehabilitation in the brain's ability to recover from this profound event. The research of Wan and Schlaug [16] has shown that the brain can reorganize itself in response to an injury such as stroke. Further, plasticity, a fundamental characteristic of the brain, is not necessarily age-dependent.

The brain's neuroplasticity, however, is not automatic. Neurological re-mapping and rehabilitation are enhanced when the individual encounters stimulating environments and performs activities that require the use of the impaired functional domains, instead of developing compensatory skills [17,18]. Music may be a potent tool for promoting plasticity because it calls upon the brain's faculties of coupling "perception and action mediated by sensory, motor and multimodal integrative regions" [16,*p566*].

Music's impact on the brain is not limited to musical experience or training. A study by Menon and Levitin [19,*p175*] found "that listening to music strongly modulates activity in a network of mesolimbic structures involved in reward processing including the nucleus accumbens (NAc) and the ventral tegmental area (VTA), as well as the hypothalamus and insula." Several modalities, such as melodic intonation therapy, music-supported therapy, music medicine as well as music therapy, use music interventions to treat persons with stroke.

Melodic Intonation Therapy

Melodic Intonation Therapy (MIT) was developed in 1973 by researchers Sparks, Helm, and Albert for the treatment of aphasia, a common aftermath of stroke [20]. As early as 1914, it was noted that patients who could not speak were able to sing words in a well-articulated manner [2]. The MIT protocol teaches the person who has experienced stroke to intone everyday words and phrases on two pitches. These short 'melodies' are based on the prosody of the spoken phrase [21].

Beyond the beneficial response that music can promote in the brain, the inherently musical qualities of speech make coupling it with music an effective rehabilitative device. Each of us, regardless of our musical facility, chooses elements such as dynamics, rhythm, and timbre to help express thoughts, ideas, and feelings. In this way, we are implementing prosodic qualities of expression in our communication at every moment of verbalization [18]. An article by Schlaug, Marchina, and Norton [22] addressed previous research claims that the effectiveness of MIT had not been proven with a formal RCT. Their findings, based on a study comparing the effects of MIT and a control intervention, "revealed significant improvement in propositional speech that generalized to unpracticed words and phrases" [22,*p315*].

Music-Supported Therapy

Music-Supported Therapy (MST) is a recently developed protocol intended to address and possibly improve motor functioning in persons who have experienced stroke. This method "uses musical instruments, an electronic piano and an electronic drum set emitting piano sounds, to retrain fine and gross movements of the paretic upper extremity" [23(p282)]. Participants play exercises demonstrated by the experimenter and are given physical support when needed. The effectiveness of this protocol is based upon animal studies, which "have shown that cortical plasticity is increased by the behavioral relevance of the stimulation" [24,*p1340*].

Amengual et al [25,*p1*] used the MST protocol to study 20 chronic stroke patients and found "changes in cortical plasticity leading [to] the improvement of the subjects' motor performance." The participants had slight right-hand paresis after the occurrence of stroke and were given 20 30-minute sessions of MST.

Music Medicine

In the medical setting, music is sometimes employed by medical staff (non-music therapists) as an ancillary treatment. Dileo [26] refers to this type of intervention as "music medicine." Such is the study by Chen, Tsai, Huang, and Lin

[27] which used a between-subject design to test the responses of 19 participants while listening to pleasant music, unpleasant music and white noise. All subjects included in this study experienced unilateral neglect, a frequent aftermath of stroke impairing perception as a result of right hemisphere stroke. The results of this research indicated that listening to pleasant music, more than the other conditions, boosted mood and enhanced visual attention.

Doğan, Tur, Dilek, and Küçükdevedi [28] found that just one session of listening to classical music for 35 minutes reduced the anxiety of 31 persons with stroke. Their intervention also included 5 minutes of breathing exercises and 15 minutes of verbal processing.

Music Therapy

Despite the success of these other modalities in using music to treat the person with stroke, music therapy can play a unique role in addressing the sequelae of stroke. As the website of the American Music Therapy Association testifies "clinical music therapy is the only professional, research-based discipline that actively applies supportive science to the creative, emotional, and energizing experiences of music for health treatment…" [29].

The fact that music therapy addresses the emotional, physical and cognitive domains within a dynamic interpersonal relationship makes it a potent resource in stroke rehabilitation. A recent case study outlined by Hartley, Turry and Raghavan [30] illustrates the effectiveness of music therapy in the treatment of a person with aphasia by treating these multiple domains. As the authors point out, the music improvisation utilized in the sessions addressed both the physical and emotional ramifications of stroke. Furthermore, music therapy "is different from that of a speech therapist working with MIT, who will not, according to the method, create improvised music in the moment according to what the client is doing, singing, or saying to support emotional expression" [30,*p236*].

A key component of any person's wellbeing is his or her level of engagement with the community, often referred to as social capital. Fewer mental health problems occur when individuals have high social capital [31]. Enabling a patient who has experienced stroke to remain connected socially is a key aspect of recovery and rehabilitation; patients who isolate themselves are more liable to have another stroke within 5 years than patients who have significant relationships [32].

Tamplin, Baker, Jones, Way, and Lee [33] found that communal singing benefitted cognitive function in stroke patients and made the recovery of verbal memory and attention more efficient. They studied 17 choristers in Australia with aphasia, who participated in a 2-hour chorus rehearsal once a week. The sessions included songs chosen by the members of the chorus and vocal exercises. Participants experienced enhanced confidence and were able to increase their social capital by forming peer support networks.

Integrative Reviews in Music Therapy

As stated by Hanson-Abromeit and Moore [34], a systematic or integrative review can assist music therapists in various ways, including formulating guidelines for clinical practice or addressing a specific clinical question. Additionally, these types of reviews can function as an aspect of a larger research project.

In pursuit of illuminating past practice which can, in turn, assist in formulating guidelines for the future, the authors considered the following questions, based in part on the criteria set forth by Robb, Burns, and Carpenter [35] when reviewing the selected articles.

- What post-stroke impairments are addressed by music therapy interventions?
- What was the content of the music therapy interventions?
- Where were the interventions delivered? (Was there information regarding location, privacy level and ambient sound?)
- What strategies were outlined to ensure treatment fidelity, i.e., that the treatment was delivered as intended and consistently among the participants?

Materials and Methods

Search Strategy

Using a combination of terms drawn from the controlled vocabulary appropriate for each database, a comprehensive search of those listed below was performed between December 1, 2015, and February 1, 2016. Citations of possible articles were exported to RefWorks to identify duplicates. The databases searched were: CINAHL, Cochrane Database of Systematic Reviews, Cochrane Stroke Group, ClinicalTrials.gov, EBSCO, EBSCO: SocINDEX, Gale: Health and Reference Center, INGENTA, JSTOR, MEDLINE, National Guideline Clearinghouse, OVID, PREMEDLINE, Proquest Digital Dissertation, Proquest: Health and Medical, PsychARTICLES, PsychINFO, PUBMED, SAGE Premiere, TRIP (Turning Research into Practice). In addition, a handsearch of a list of references compiled from articles and books on the topic of music therapy and neurological rehabilitation was performed. The following music therapy journals and online sources were searched by hand: *Music & Medicine* (2009 to present, http://mmd.iammonline.com/), *Journal of British Music Therapy* (1987 to present), Grey Literature Report (http://www.greylit.org/), *Journal of Music Therapy* (1964 to 1983), *Music Therapy* (1981 to 1996), *Music Therapy Perspectives* (1982 to 2003), *Music Therapy Today* (2000 to 2007),

(www.wfmt.info/Musictherapyworld/modules/mmmagazine/magazine_start.html) National Institute for Health Research (www.nihr.ac.uk/research/Pages/default.aspx), Open Grey (www.opengrey.eu/about), *Voices: A Worldwide Forum for Music Therapy* (www.voices.no).

Inclusion Criteria

The criteria for articles included in this review were as follows:

- Studies could be of any design (quantitative, qualitative, mixed methods);
- Studies researched the impact music therapy interventions had on persons with stroke;
- Participants must have experienced a stroke within 24 months prior to the study;
- The treatment interventions used were defined as music therapy;
- One of the authors of the study is a music therapist or student enrolled in a professional music therapy program;
- The research articles were published in peer-reviewed or non-peer reviewed journals, theses, dissertations, books, and/or were conference presentations or other relevant gray literature.
- Articles were in English.

Data Extraction

The data on the music therapy interventions were organized following the guidelines set forth by Robb et al [35] which were adapted from the Consolidated Standards for Reporting Trials (CONSORT) and Transparent Reporting of Evaluations with Non-Randomized Designs (TREND). These guidelines have been established to "improve the transparency and specificity of reporting music-based interventions" [35,*p271*]. Their checklist includes information on:

- Intervention theory
- Intervention content (person selecting the music, description of the music, music delivery method, intervention materials, intervention strategies)
- Intervention delivery schedule (number of sessions, duration, and frequency)
- Interventionist
- Treatment fidelity
- Setting
- Unit of delivery (individual or group sessions)

Identification of Studies

After an initial search of databases, the first author and two research associates independently reviewed the studies to determine which met the inclusion criteria. Many articles, lacked specificity regarding the amount of elapsed time between stroke onset and the initiation of music therapy interventions. Consequently, the reviewers agreed that if a specific amount of time was not noted but a study described a participant as an inpatient, it could be assumed that the patient was still in acute care and had probably only recently experienced stroke. With this approach, 39 articles were found meeting the criteria.

Results

Overview of the Articles

The articles that met the criteria were written between the years of 1981 and 2015, with the majority (26) written during or after 2000. Table 1 outlines the study designs implemented, the majority of which (11) are case studies. Table 2 describes the sample sizes of the various studies. The sample size in nearly half of the articles numbered nine or fewer participants, while 12 studies had 20 or more participants.

What post-stroke impairments are addressed by music therapy interventions?

The studies addressed stroke's impact on cognition, speech, physical abilities, behavior, mood and the phenomenon of unilateral neglect. Table 3 summarizes the references by the outcome focus addressed. The largest number of articles focused on physical sequelae (15). Several articles researched more than one realm influenced by the occurrence of stroke. These include Cross, McLellan, Vomberg, Monga, and Monga [36] (mood, behavior, and mobility), Forsblum, Laitinen, Särkämö, and Tervaniemi [37] (physical, mental activation and mood), Forsblum, Särkämö, Laitinen and Tervaniemi [38] (motor activity, relaxation, mood), Guerrero, Turry, Geller, and Raghavan [39] (behavior and mood), Montgomery, Booth, and Hutchinson [40] (self-identity, mood), Nayak, Wheeler, Shiflett, and Agostinelli [41] (mood and behavior), Purdie [42] (dysphagia and mood), Särkämö et al [43] (loss of cognition and mood) and Wheeler, Shiflett, and Nayak [44] (mood and behavior).

Tables 4, 5 and 6 each focus on a functional domain that is impaired post-stroke and list the content of the interventions utilized. Table 4 describes the studies which addressed speech impairment, a very common aftermath of stroke. All of the studies which focused on the disruption of speech addressed production and intelligibility. Only Cohen and Ford [45] and Tomaino [46] included the issue of language content in their research. Table 5 outlines the research included in this review that addressed the impact of music therapy on the physical sequelae of stroke and the intervention content. The majority of these articles (7) study problems in gait arising from the occurrence of stroke. Several

studies used music therapy to address impairment in cognition as a result of stroke, as summarized in Table 6.

What is the content of the music therapy interventions?

A list of the criteria regarding intervention content set forth by Robb et al [35] and the tables summarizing this information in the review follows:

- Person(s) selecting the music (Table 7)
- Intervention strategies (Table 8)
- Intervention materials utilized in sessions incorporating live music (Table 9)
- Intervention materials utilized in sessions incorporating recorded music (Table 10)

Table 1: *Description of Study Designs*

Design Format	Reference
Case Study	Cohen[52] Cohen[79] Cross et al[36] Erdonmez & Morley[63] Guerrero et al[39] Hurkmans et al[47] Montgomery et al[40] Poćwierz-Marciniak[51] Purdie[42] Tamplin[69] Tomaino[46]
Comparison Study	Chong et al[58]
Counter-balanced	Thaut et al[71]
Experimental Design	Carruth[50] Cofrancesco[80] Cohen & Ford[45]
Mixed Design	Forsblum et al[37] Forsblum et al[38] Street et al[55]
Multiple Trials	Thaut et al[62]
Multi-variant analysis	Haydn et al[64] Shin et al[67]
Pilot Study	Malcolm et al[60] Pfeiffer & Sabe[59]
Protocol Review	Kim & Tomaino[57] Kim[81] Kim & Jo[65]
RCT	Conklyn et al[82] Paul & Ramsey[48] Särkämö et al[43] Särkämö et al[83] Thaut et al[61]
Repeated Measures	Kim et al[48] Nayak et al[41] Prassas et al[42] Suh et al[68] Thaut et al[70] Tsai et al[53] Wheeler et al[44]

Table 2: *Sample Sizes for Study*

Total number of participants	
1 to 9	Carruth[50] Cofrancesco[80] Cohen[52] Cohen[79] Erdonmez & Morley[63] Hurkmans et al[47] Kim[81] Kim & Jo[65] Kim & Tomaino[57] Malcolm et al[60] Montgomery et al[40] Poćwierz-Marciniak[51] Prassas et al[42] Purdie[42] Tamplin[69] Tomaino[46]
10 to 19	Cohen & Ford[45] Guerrero et al[39] Haydn et al[64] Kim et al[48] Nayak et al[41] Shin et al[67] Street et al[55] Suh et al[68] Thaut et al[62] Tsai et al[53] Wheeler et al[44]
20 to 29	Chong et al[58] Cross et al[36] Forsblum et al[37] Paul & Ramsey[48]* Pfeiffer & Sabe[59] Thaut et al[71] Thaut et al[70]
30 and above	Conklyn et al[82]* Forsblum et al[38]* Särkämö et al[83]* Särkämö et al[43]* Thaut et al[61]

**=RCT*

Table 3: *Outcome Focus Summary*

Outcome Focus	Reference
Cognition	Carruth[50] Erdonmez & Morley[63] Forsblum et al[37] Forsblum et al[38] Pfeiffer & Sabe[59] Särkämö et al[43]
Speech	Cohen[52] Cohen[79] Cohen & Ford[45] Conklyn et al[82] Hurkmans et al[47] Kim & Tomaino[57] Kim & Jo[65] Purdie[42] Tamplin[69] Tomaino[46]
Physical	Chong et al[58] Cofrancesco[80] Cross et al[36] Guerrero et al[39] Haydn et al[64] Kim[81] Malcolm et al[60] Paul & Ramsey[48] Prassas et al[42] Shin et al[67] Street et al[55] Suh et al[68] Thaut et al[62] Thaut et al[70] Thaut et al[71] Thaut et al[61]
Behavior	Cross et al[82] Guerrero et al[39] Nayak et al[41] Wheeler et al[44]
Mood	Cross et al[36] Forsblum et al[37] Forsblum et al[38] Guerrero et al[39] Kim et al[48] Montgomery et al[40] Poćwierz-Marciniak[51] Nayak et al[41] Purdie[42] Särkämö et al[43] Wheeler et al[44]
Unilateral Neglect	Tsai et al [53]

Table 4: *Summary of Interventions Addressing Post-Stroke Speech Impairment*

Reference	Intervention Content
Cohen[52]	Breathing and vocal exercises
	Rhythmic speech drills
	Singing familiar songs
Cohen[79]	Breathing and vocal exercises
	Paired with Visi-Pitch™ feedback
Cohen & Ford[45]	Singing familiar songs
Conklyn et al[82]	Modified Melodic Intonation Therapy
Hurkmans et al[47]	Singing and rhythmic chanting
	Vocal warm-ups
Kim & Tomaino[57]	Singing familiar songs
	Breathing into single-syllable sounds
	Musically assisted speech
	Dynamically cued singing
	Rhythmic speech cueing
	Oral motor exercises
	Vocal intonation
Kim & Jo[65]	Accent-based Music Speech Protocol (physical warm-up, breathing and vocal exercises, singing familiar songs)
Tamplin[69]	Physical, breathing, vocal, exercises
	Rhythmic and melodic articulation exercises
	Rhythmic speech cuing
	Vocal intonation therapy
	Singing familiar songs
Tomaino[46]	Singing familiar songs
	Memorization of lyrics
	Using expressivity

Table 5*: Summary of Interventions Addressing Post-Stroke Physical Impairment*

	Reference	Intervention Content
Fine motor skills		
Dysphagia	Kim[81]	Vocal exercises Singing of familiar songs Breathing exercises Vocal exercises Repeat familiar song
Hand grip	Cofrancesco[80]	Playing percussion instruments Playing autoharp
	Chong et al[58]	Playing MIDI-keyboard
	Guerrero et al[39]	Hold harp and/or mallets, pick guitar, play piano and shakers, pluck strings
Gross motor skills		
Arm (spatiotemporal patterns)	Thaut et al[71]	RAS (metronome)

Arm (shoulder and elbow flexion)	Guerrero et al[39]	OT-lead upper limb exercises accompanied by improvisation on piano by music therapist
	Paul & Ramsey[48]	Music-making on electronic instruments
		RAS (metronome)
Arm movement (kinematics)	Malcolm et al[60]	
Gait	Haydn et al[64]	RAS (using music in country western or big band style)
	Prassas et al[42]	RAS (original composition in Big Band style/accented beats)
	Shin et al[67]	RAS (chordal progression played on electronic keyboard with metronome)
		RAS (metronome)
	Suh et al[68]	
Gait (cont'd.)	Thaut et al[62]	RAS (original composition in Renaissance style/ accented beats)
	Thaut et al[70]	RAS (original composition in Renaissance style/ accented beats) or metronome

Table 6: *Summary of References Addressing Post-Stroke Cognitive Impairment*

Reference	Cognitive Impairment	Intervention
Carruth[50]	Face/name recall	Singing a song chosen by therapist used in conjunction with spaced retrieval technique
Erdonmez & Morley[63]	Musical alexia	Playing pre-morbidly-learned repertoire for keyboard chosen by patient
Forsblum et al[37]	Verbal memory, focused attention	Listening to self-selected music, daily for an hour
Pfeiffer & Sabe[59]	Attention, auditory processing, working memory, musical memory, initiation and response inhibition, new learning	Listening & identifying musical cues and melodies; playing percussion independently; repeating musical cues
Särkämö et al[43]	Verbal memory, focused attention	Listening to self-selected music, daily for an hour

Table 7: *Summary of Person(s) Responsible for Selecting the Music*

Person Responsible for Selecting Music	Reference
Pre-selected by researcher	Chong et al[58] Cohen[52] Cohen[79] Conklyn et al[82] Hurkmans et al[47] Kim & Jo[65] Malcolm et al[60] Montgomery et al[40] Nayak et al[41] Paul & Ramsey[48] Pfeiffer & Sabe[59] Shin et al[67] Street et al[55] Suh et al[68] Thaut et al[71]* Thaut et al[61]* Thaut et al[62]* Thaut et al[70]* Tsai et al[53] Wheeler et al[44]
Participant selected	Cohen[92] Cohen[79] Cohen & Ford[45] Guerrero et al[39] Haydn et al[64]* Nayak et al[41] Prassas et al[42]* Tamplin[69] Thaut et al[70]* Wheeler et al[44]
Participant selected from own collection	Cofrancesco[80] Cohen[52] Erdonmez & Morley[63] Forsblum et al[37] Forsblum et al[38] Kim & Tomaino[58] Kim[81] Paul & Ramsey[48] Särkämö et al[83] Särkämö et al[43] Tomaino[46]
Music was improvised in the moment	Guerrero et al[39] Hurkmans et al[47] Kim et al[48] Nayak et al[41] Paul & Ramsey[48] Purdie[42] Wheeler et al[44]
Not specified	Carruth[50] Cross et al[36]

* These researchers altered a predetermined piece of music or, in some cases, an auditory stimulus in the form of a metronome based upon the capabilities of the participants displayed at the time of the intervention. This protocol is called Rhythmic Auditory Stimulation (RAS) and utilizes specially modified music tapes, the rhythm frequency of which was altered based upon the participant's "self-paced movement" (Thaut et al [71,*p1075*]). In two of these studies [61, 70] the tempo was purposely increased in subsequent trials by "5 to 10%, depending on the patient's ability" [70(p209)]. The researchers stated that increasing the speed with which the participants walked enhanced stride symmetry and was "an important functional goal in gait rehabilitation" [70,*p211*].

Table 8: *Summary of Intervention Strategies*

Intervention	Reference
Re-creation (or performing)	Carruth[50] Chong et al[58] Cofrancesco[80]* Cohen[52]* Cohen[79] Cohen & Ford[45] Conklyn et al[82] Cross et al[36] Erdonmez & Morley[63]* Guerrero et al[39] Hurkmans et al[47]* Kim & Tomaino[57] Kim[81] Kim & Jo[65] Kim et al[48]* Montgomery et al[40] Nayak et al[41]* Paul & Ramsey[48]* Pfeiffer & Sabe[59]* Poćwierz-Marciniak[51]* Purdie[42] Street et al[55] Tamplin[69] Tomaino[46] Wheeler et al[44]*
Improvising	Guerrero et al[39] Kim et al[48]* Nayak et al[41]* Paul & Ramsey[48]* Purdie[42] Wheeler et al[44]*

Listening	Cofrancesco[80]* Cohen[52]* Erdonmez & Morley[63]* Forsblum et al[37] Forsblum et al[38] Haydn et al[64] Hurkmans et al[47]* Malcolm et al[60] Nayak et al[41]* Pfeiffer & Sabe[59]* Poćwierz-Marciniak[51]* Prassas et al[42] Särkämö et al[83] Särkämö et al[43] Shin et al[67] Suh et al[68] Thaut et al[62] Thaut et al[70] Thaut et al[71] Thaut et al[61] Tsai et al[53] Wheeler et al[44]*
Composing	Kim et al[48]* Nayak et al[41]* Wheeler et al[44]*

* = used more than one intervention strategy

Table 9: *Summary of Intervention Materials (Live)*

Reference	Materials
Carruth[50]	Voice, guitar
Chong et al[58]	MIDI keyboard
Cofrancesco[80]	Piano, tambourine, cymbal, drum, autoharp, tom-tom or claves
Cohen[52]	Voice, electric keyboard, Suzuki hand drum
Cohen[79]	Voice, electric keyboard
Cohen & Ford[45]	Voice, hand drum, electric keyboard
Conklyn et al[82]	Voice
Cross et al[36]	Autoharp, hand drum, Orff mallet, maracas, tambourine, kazoo, piano, recorder
Erdonmez & Morley[63]	Piano
Guerrero et al[39]	Piano, percussion
Hurkmans et al[47]	Voice
Kim[81]	Voice, keyboard
Kim & Jo[65]	Voice, drum
Kim & Tomaino[57]	Voice, guitar, drum
Kim et al[48]	Voice, handbells, keyboard, percussion, flutes
Malcolm et al[60]	Metronome
Montgomery et al[40]	Guitar, drums
Nayak et al[41]	Simple percussion, simple pitched and melodic instruments, voice
Paul & Ramsey[48]	Electronic paddle drums
Pfeiffer & Sabe[59]	Piano, frame drum
Poćwierz-Marciniak[51]	Voice, instruments (unspecified)

Purdie[42]	Piano
Shin et al[67]	Electronic keyboard, metronome
Street et al[55]	Smartpiano, bongo, cymbal
Suh et al[68]	Metronome
Tamplin[69]	Voice, guitar
Tomaino[46]	Voice, piano
Wheeler et al[44]	Simple percussion, simple pitched and melodic instruments, voice

Table 10: *Summary of Intervention Materials (Recorded)*

Reference	Materials
Forsblum et al[37]	Portable CD players with headphones
Forsblum et al[38]	Portable CD players with headphones
Haydn et al[64]	Portable CD player placed on floor in hallway
Prassas et al[42]	Synthesizer, sequencer with variable tempo driver
Särkämö et al[43]	CD players
Särkämö et al[83]	CD players
Thaut et al[62]	MIDI synthesizer, sequencer with variable tempo driver
Thaut et al[70]	MIDI synthesizer, sequencer with variable tempo driver
Thaut et al[71]	MIDI synthesizer, sequencer with variable tempo driver
Thaut et al[61]	MIDI synthesizer, sequencer with variable tempo driver
Tsai et al[53]	Computer & speakers

The music of an intervention could be chosen by the participant, researcher or both; or could be improvised. In seven cases [39, 41, 42, 44, 47, 48, 49] the music was improvised in the moment, based upon an assessment of the participants' abilities. Three studies [36, 50, 51] did not specify who selected the music. The intervention strategies mentioned in Table 8 include those outlined by Bruscia [52,*p113*], "improvising, re-creating (or performing), composing and listening." The majority of the studies utilized re-creating (25), listening (22), or a combination of the two and used individual music therapy interventions. The only study that considered how different treatment conditions could be addressed via group versus individual sessions was Wheeler et al [44], although Carruth [50] mentions this aspect when making recommendations.

Most studies (29) utilized live music as the delivery method. For these live interventions, the materials employed are those commonly found, such as voice, keyboard, guitar, simple percussion and melodic instruments. In the instances when music was delivered via recording, portable CD players and synthesizers were used. However, specific information on the volume and who controlled the volume were generally missing. Tsai et al noted that the music was played for their study "at a listening volume comfortable for each patient" [53,*p330*].

The degree of specificity within the studies regarding the music itself varied with most articles failing to provide details necessary for replication. For example, no information was given regarding the publishers or arrangers, in the case of pre-composed songs, or record label and artists, in the case of

recorded music. The exceptions are Cohen [54], in the case of recorded music and Street, Magee, Odell-Miller, Bateman and Fachner [55] for live music. If improvised music was used, authors failed to provide details about the structure of the music (form, elements, key, etc.). Additional content of the music interventions such as the number of sessions, their length, frequency and the materials used in the interventions are outlined in Tables 9, 10, 11, 12, and 13.

Where were the interventions delivered?

Researchers provided incomplete information regarding the settings for the interventions. According to Robb et al [35], providing an appropriate location for the interventions is essential. Researchers are advised to record where the intervention occurred, the level of privacy, and the amount of ambient sound. These considerations are especially salient in the area of stroke research and rehabilitation, as pointed out in the research of Hochstenbach, Prigatano, and Mulder who found that "intolerance of bustle…and intolerance of noise" [569,*p1588*] are among the six most common complaints of persons with stroke.

A few of the included studies did address the issue of the intervention setting. Carruth [50] suggested that one mitigating factor in her results was the inability to have consistency in the setting for the music therapy interventions.

***Table 11**: Summary of Number of Sessions*

Number of Sessions	
1 to 9	Chong et al[58] Cofrancesco[80] Cohen[52] Conklyn et al[82] Kim[81] Kim et al[48] Montgomery et al[40] Prassas et al[42] Tsai et al[53] Thaut et al[62] Thaut et al[71]
10 to 19	Carruth[50] Cohen[79] Cohen & Ford[45] Guerrero et al[39] Kim & Jo[65] Kim & Tomaino[57] Malcolm et al[60] Nayak et al[41] Poćwierz-Marciniak[51] Shin et al[67] Street et al[55] Wheeler et al[44]
20 or more	Cross et al[36] Forsblum et al[37] Forsblum et al[38] Haydn et al[64] Hurkmans et al[47] Paul & Ramsey[48] Särkämö et al[43] Särkämö et al[83] Tamplin[69] Thaut et al[70] Thaut et al[61] Tomaino[46]
Not Specified	Erdonmez & Morley[63] Pfeiffer & Sabe[59] Purdie[42]

***Table 12:** Summary of Duration of Sessions*

Duration of Each Session	
1 to 20 minutes	Carruth[50] Conklyn et al[82] Cross et al[36] Pfeiffer & Sabe[59] Suh et al[68]
21 – 44 minutes	Cofrancesco[80] Cohen[52] Haydn et al[64] Hurkmans et al[47] Kim & Jo[65] Kim & Tomaino[57] Kim et al[48] Paul & Ramsey[48] Purdie[42] Shin et al[67] Street et al[55] Tamplin[69] Thaut et al[70] Thaut et al[71]
Over 45 minutes	Cohen[79] Forsblum et al[37] Forsblum et al[38] Guerrero et al[39] Kim et al[48] Malcolm et al[60] Särkämö et al[43] Särkämö et al[83] Tsai et al[53]
Not Specified	Chong et al[58] Cohen & Ford[45] Erdonmez & Morley[63] Montgomery et al[40] Nayak et al[41] Poćwierz-Marciniak[51] Prassas et al[42] Thaut et al[62] Thaut et al[71] Tomaino[46] Wheeler et al[44]

***Table 13:** Summary of Frequency of Sessions*

Frequency of Sessions	
1 to 7 days	Chong et al[58] Pfeiffer & Sabe[59]* Thaut et al[71] Tsai et al[53]
8 to 14 days	Kim[81] Kim & Jo[65] Malcolm et al[60]
15 to 30 days	Carruth[50] Cofrancesco[80] Cohen[52] Cohen & Ford[45] Haydn et al[64] Kim & Tomaino[57] Kim et al[48] Nayak et al[41] Poćwierz-Marciniak[51] Suh et al[68] Wheeler et al[44]
31 or more days	Cohen[79] Cross et al[36] Erdonmez & Morley[63] Forsblum et al[37] Forsblum et al[38] Guerrero et al[39] Hurkmans et al[47] Montgomery et al[40] Paul & Ramsey[48] Prassas et al[42] Särkämö et al[83] Särkämö et al[43] Shin et al[67] Street et al[55] Tamplin[69] Thaut et al[62] Thaut et al[70] Thaut et al[61] Tomaino[46]
Not Specified	Conklyn et al[82] Purdie[42]

** This is a one-time assessment that is repeated after one month.*

The interventions she facilitated took place in "one large open area" [50,*p176*]. Kim and Tomaino described the location for their interventions as a "quiet undisturbed office" [57,*p556*]. Further, they noted how the participant sat in relation to the therapist. Three other studies [53, 58, 59], described the settings for the interventions as private or quiet. Two articles [55,60] reported on music therapy sessions taking place in the home. As Street et al point out, however, home sessions cannot be judged ideal as they "introduce variables that cannot be controlled" [55,*p6*] such as space limitations and interruptions by family members.

What strategies were outlined to ensure treatment fidelity?

Information regarding fidelity strategies, which Robb et al [35] defined as protocols that ensure consistency in the treatment and/or control conditions, such as maintaining the time of day and settings for the interventions, was inconsistently reported. Hochstenbach et al [56] note that fatigue is one of the most common aftermaths of stroke and, consequently, the scheduling of an intervention could impact the effectiveness of treatment and/or confound results. Only three articles [50, 61, 62] included information about whether or not interventions were scheduled at consistent times of the day

Another aspect of treatment fidelity includes the use of manualized protocols, which were used in 16 of the studies. Refer to Table 14 for a list of the various protocols and references. One study explored the effectiveness of "music-based tasks in the assessment of cognitive functioning" [59,*p392*] via the Screening of Music and Cognition (SCM) assessment tool developed by the authors.

Are there variables that moderated the effects of the music therapy interventions?

Tomaino [46] suggested recovery from stroke might be greater for musicians or persons who have studied music. Few other of the studies noted whether participants had premorbid musical abilities that might moderate the effects of the music therapy interventions. 4 studies relied on premorbid musical abilities in order to formulate music therapy interventions and assess outcomes. In the case study by Erdonmez and Morley [63], the subject had right hemiparesis and musical apraxia, post-stroke. In the music therapy interventions, he was able to play the treble parts of Bach two- and three-part inventions with his left hand, even though the stroke had left him unable to name the notes. The participant in Purdie's [42] case study also retained the ability to read the left-hand part of music but was not able to read words. Tomaino utilized pre-learned song repertoire with a patient with stroke who had "spent his life in music, recording and archiving folk songs" [46,*p85*]. This background proved a rich context for the rehabilitation of speech function. In the study by Montgomery et al [40], the interventions were initially devised to utilize the participant's premorbid bass guitar skills. However, the occurrence of stroke in this patient made returning to this activity frustrating and he soon grew apathetic. Rather, his musical knowledge, if not facility, was used by encouraging him to play the drum, which proved rehabilitative.

***Table 14**: Summary of References Utilizing Manualized Protocols*

Protocol Utilized	Reference
Accent-Based Music Speech Protocol	Kim & Jo[65]
Lucia Vocal Skills (adapted)	Cohen[52]
Modified Melodic Intonation Therapy	Conklyn et al[82]
Nordoff Robbins	Guerrero et al[39]
Rhythmic Auditory Stimulation	Haydn et al[64] Malcolm et al[60] Prassas et al[42] Shin et al[67] Suh et al[68] Thaut et al[71] Thaut et al[61] Thaut et al[62] Thaut et al[70]
Speech-Music Therapy for Aphasia (SMTA)	Hurkmans et al[47]
Therapeutic Instrumental Music Performance (TIMP)	Street et al[55] Kim and Tomaino*[57]

** No specific name was given for this protocol*

Was any element of music used with greater frequency in the interventions?[1]

Rhythm, unlike any other element of music, is used by many of the researchers as the catalyst for change in the participant [33, 52, 55, 57, 60-62, 64-68, 70, 71], Thaut [72(p170)] tells us that "rhythm in music, the element of temporal order, has a unique and profound influence on our perceptual processes related to cognition, affect, and motor function." Conversely, two studies [39,47] emphasized the use of a complete array of the musical elements. The first chose live music that specifically incorporated all of the musical elements, believing that "the effects of music upon movement may be related to its melodic structure and emotional qualities" [39,*p40*]. Hurkmans et al [47,*p941*] state that "using all musical elements might permit a combination of strengths of both of these therapeutic approaches" (that of the speech therapist

[1] This particular question was not one outlined by Robb et al[35] and Bradt et al,[4] but is included here as it identifies a finding of this review.

and music therapist who treat the person with stroke simultaneously).

Discussion

This review illustrates the various trends and lacunae in research that, if addressed, could enhance the contribution made by music therapists in the treatment of stroke. Both music therapy and neurological science are growing in sophistication. Such evolution not only allows for but also requires heightened specificity regarding music therapy interventions that address stroke rehabilitation.

Very few studies reviewed gave precise information regarding the exact amount of time that elapsed between stroke and the initiation of therapy. The evidence regarding a "golden period" for stroke rehabilitation is contradictory. Huang, Chung, Lai, and Sung [73] found that treatment within six months is preferable. The work of Dam et al [74,*p1186*] found that "disabled poststroke subjects may attain significant functional improvements in response to prolonged restorative therapy." The research by Dam et al [74] corresponds with a study cited by the National Institute of Neurological Disorders and Strokes [75] "which goes against the conventional wisdom that most recovery is complete by 6 months." The findings of one of the identified studies [55,*p5*] indicate that "inconclusive evidence was found for time since stroke being a predictor" of, in this case, upper limb recovery.

Using this detail as an independent variable in future research could benefit the discussion regarding such "golden periods." There is some research indicating that music therapy is effective in the rehabilitation of long-term impairment. Jungblut [17] studied persons with chronic aphasia utilizing SIPARI®, a music therapy protocol that she developed. Participants in her study had experienced aphasia from four to 26 years. Jungblut found that "patients, when treated with this music therapy intervention, would improve their expressive linguistic skills as an overall profile score on the Aachen Aphasia Test" [17,*p197*]. Another trend within these studies that hinders generalization is the small sample sizes used. Wheeler[76] discusses the complex issues surrounding sample sizes, noting that practical considerations (access to a setting, permission to administer, discharge from hospital) often prohibit enlisting large groups of people for research projects, yet "the size of the sample must be adequate to support generalization" [76,*p114*].

None of the studies compared the particulars of the interventions (content, delivery schedule, unit of delivery), which could provide more detailed information regarding the impact of music therapy treatment. Wheeler et al [44,*p145*] stated that "group and individual sessions are useful for different purposes." Group music therapy could be more efficacious in enhancing social capital whereas individual sessions might address issues of motivation. Moreover, music therapy researchers could address the implications, if any, of using pre-composed versus improvised music. Magee [77,*p20*] compared the effect of pre-composed songs with improvised music in an effort to identify those "methods which are most suited to meeting the complex physical and emotional needs of individuals living with chronic illness." Her conclusions did not seek to determine if one method was better than another. Rather the conclusions from her study, like those of Wheeler et al [77] found that particular types of interventions addressed different sequelae. The pre-composed songs helped the individual express difficult emotions whereas improvisation acted as a physical activity that assisted the participant in exploring changes in functional abilities. Only one of the identified studies [53] mentions unilateral spatial neglect, despite this being an extremely common and pervasive aftermath of stroke, typically right hemispheric cerebral infarctions [78].

More research is needed regarding music therapy's impact on behavior of persons experiencing stroke. Of the 39 reviewed articles, 4 studies alone [39, 41, 44, 82] looked at this type of stroke sequelae. A more detailed look at behavior, particularly rehabilitative measures that enhance motivation, could add significantly to the guidelines music therapists develop in the future to treat stroke survivors. Ultimately, music therapists might consider widening the therapeutic goals targeted in their treatments. As Loewy et al [84] comment, music's capacity to engage and involve multiple domains allows for treating the whole person rather than just the impairments caused by stroke. Such an approach "may prove necessary in optimally treating all aspects of the individual's needs" [84,*p2870*].

Conclusion

This review coalesces findings from research pertaining to music therapy in the treatment of stroke. A database search identified 39 articles matching criteria determined by the authors. The identified studies included both qualitative and quantitative research. Consequently, the findings have been presented in the format of an integrative review. The overriding objective and intention of this review is to illumine and inform the future practice of music therapists, who might consider these specific research questions:

- Is there a "golden period" for the use of music therapy in stroke rehabilitation?
- Are certain stroke sequelae best addressed by group or individual music therapy?
- Does pre-composed or improvised music offer better treatment for stroke survivors?
- What stroke-induced behaviors can be alleviated by music therapy?
- Should the content of the music therapy intervention be altered depending on the location of the lesion?

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