Music therapy for acquired brain injury (Review)


This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in The Cochrane Library 2010, Issue 7

http://www.thecochranelibrary.com
Music therapy for acquired brain injury

Joke Bradt1, Wendy L. Magee2, Cheryl Dileo3, Barbara L. Wheeler4, Emer McGilloway5

1The Arts and Quality of Life Research Center, Boyer College of Music and Dance, Temple University, Philadelphia, USA. 2Institute of Neuropalliative Rehabilitation, Royal Hospital for Neuro-disability, London, UK. 3Department of Music Therapy and The Arts and Quality of Life Research Center, Boyer College of Music and Dance, Temple University, Philadelphia, USA. 4School of Music, University of Louisville, Louisville, KY, USA. 5Wolfson Neurorehabilitation Centre, London, UK

Contact address: Joke Bradt, The Arts and Quality of Life Research Center, Boyer College of Music and Dance, Temple University, Presser Hall, 2001 North 13 Street, Philadelphia, USA, jbradt@temple.edu.

Editorial group: Cochrane Stroke Group.
Review content assessed as up-to-date: 28 March 2010.


Copyright © 2010 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

ABSTRACT

Background
Acquired brain injury (ABI) can result in impairments in motor function, language, cognition, sensory processing and emotional disturbances. This may severely reduce a survivor's quality of life. Music therapy has been used in rehabilitation to stimulate brain functions involved in movement, cognition, speech, emotions and sensory perceptions. A systematic review is needed to gauge the efficacy of music therapy as a rehabilitation intervention for people with ABI.

Objectives
To examine the effects of music therapy with standard care versus standard care alone or standard care combined with other therapies on gait, upper extremity function, communication, mood and emotions, social skills, pain, behavioral outcomes, activities of daily living and adverse events.

Search strategy
We searched the Cochrane Stroke Group Trials Register (February 2010), the Cochrane Central Register of Controlled Trials (The Cochrane Library Issue 2, 2009), MEDLINE (July 2009), EMBASE (August 2009), CINAHL (March 2010), PsycINFO (July 2009), LILACS (August 2009), AMED (August 2009) and Science Citation Index (August 2009). We handsearched music therapy journals and conference proceedings, searched dissertation and specialist music databases, trials and research registers, reference lists, and contacted experts and music therapy associations. There was no language restriction.

Selection criteria
Randomized and quasi-randomized controlled trials that compared music therapy interventions and standard care with standard care alone or combined with other therapies for people older than 16 years of age who had acquired brain damage of a non-degenerative nature and were participating in treatment programs offered in hospital, outpatient or community settings.

Data collection and analysis
Two review authors independently assessed methodological quality and extracted data. We present results using mean differences (using post-test scores) as all outcomes were measured with the same scale.
Main results

We included seven studies (184 participants). The results suggest that rhythmic auditory stimulation (RAS) may be beneficial for improving gait parameters in stroke patients, including gait velocity, cadence, stride length and gait symmetry. These results were based on two studies that received a low risk of bias score. There were insufficient data to examine the effect of music therapy on other outcomes.

Authors’ conclusions

RAS may be beneficial for gait improvement in people with stroke. These results are encouraging, but more RCTs are needed before recommendations can be made for clinical practice. More research is needed to examine the effects of music therapy on other outcomes in people with ABI.

Plain Language Summary

Music therapy for acquired brain injury

Acquired brain injury can result in problems with movement, language, sensation, thinking or emotion. Any of these may severely reduce a survivor’s quality of life. Many innovative therapy techniques have been developed to help recover lost functions and to prevent depression. Music therapy involves using music to aid rehabilitation. Specific treatments may include the use of rhythmic stimulation to aid movement and walking, singing to address speaking and voice quality, listening to music to reduce pain and the use of music improvisations to address emotional needs and enhance a sense of wellbeing. We identified and included seven studies (involving 184 participants) in this review, all of which were carried out by a trained music therapist. The results suggest that rhythmic auditory stimulation may be beneficial for improving measures of walking, but there was insufficient information to examine the effect of music therapy on other outcomes. Further clinical trials are needed.

Background

Acquired brain damage embraces a range of conditions involving rapid onset of brain injury, including trauma due to head injury or postsurgical damage, vascular accident such as stroke or subarachnoid hemorrhage, cerebral anoxia, toxic or metabolic insult such as hypoglycemia, and infection or inflammation (RCP 2004). Acquired brain injury (ABI) can result in impairments in motor function, language, cognition, sensory processing as well as emotional disturbances. Hemiplegia and hemiparesis are common and may severely reduce a survivor’s quality of life. Consequently, a primary concern in rehabilitation for acquired brain injury is the restoration of motor function. The improvement of ambulation and upper extremity function directly affects the level of independence of the patient related to activities of daily living. The affected individual is likely to be left with communication impairments, such as a severely reduced ability to understand, speak, and use spoken and written language, which can result in isolation. Furthermore, brain damage often leads to disturbances in memory, learning, and awareness. Sensory disturbances and neuropathic pain may result from damage to the nervous system. Finally, there may be behavioral implications resulting in disinhibition, apathy and motivation. Recovery of lost functions and skills after acquired brain damage is typically incomplete, putting survivors at increased risk for depression. Effective treatment of depression may bring substantial benefits by improving medical status, enhancing quality of life, and reducing pain and disability (van de Port 2007; Whyte 2006).

Acquired brain injury causes significant levels of disabilities which tend to result in long-term problems. It is estimated that in 2003 there were 135,000 people living with long-term problems following brain injury in the UK and a further 300,000 people living with disabilities stemming from stroke (NA 2003). Figures from the US exceed those in the UK with an estimated 1.5 million people who sustain a traumatic brain injury each year, of whom 80,000 to 90,000 will be left with long-term disability (NCIPC 2001). Approximately 5.3 million Americans or 2% of the population of all ages have long-term or lifelong needs for help to perform personal activities of daily living following traumatic brain injury (Thurman 1999). Finally, the World Health Organization estimated that, in 2001, there were over 20.5 million strokes worldwide. With the population ageing, even if the stroke incidence
stagnates, the number of stroke patients requiring medical and rehabilitation care will rise dramatically over the next two decades (WHO 2002). Further work needs to be done to identify the direct and indirect financial costs of acquired brain injury to society within the UK (Turner-Stokes 2003). However, within the US, the costs associated with traumatic brain injury alone were estimated to be around USD 60 billion for 2000 (Finkelstein 2006). Acquired brain injury therefore has significant effects on society in terms of human and economic costs.

Many innovative therapy techniques have been developed to help the restoration of lost functions and to aid in prevention and treatment of depression in acquired brain injury survivors. Music therapy has been used in rehabilitation settings to stimulate brain functions involved in movement, cognition, speech, emotions, and sensory perceptions. Interventions range from the use of rhythmic auditory stimulation to aid in the execution of movement and normalization of gait parameters (Thaut 1993), to music listening and singing to reduce pain (Kim 2005), to the use of music listening, music improvisations, composition and song discussions to address emotional needs and enhance the sense of wellbeing (Nayak 2000). Music listening has also been used by non-music therapists in rehabilitation settings to enhance relaxation, provide distraction, and reduce pain. It is important to distinguish music therapy interventions from the administration of music to patients by medical personnel. Music therapists have specific clinical training in assessing individual patients’ needs. Clinical practice is underpinned by music therapy theory. Treatment involves selecting from a range of music-based interventions, using both music and the therapist-patient relationship as agents of change. In many countries, music therapists are board-certified, registered and/or licensed as professionals. Therefore, interventions are classified as music therapy if the following components are present: (1) implementation of goal-directed music interventions by a trained music therapist, and (2) the use of music experiences individualized to patient need. In rehabilitation settings, these interventions may include (1) listening and moving to live, improvised or pre-recorded music as well as rhythmic auditory stimulation, (2) performing music on an instrument, (3) improvising music spontaneously using voice or instruments or both, (4) singing or vocal activities to music, (5) music-based speech and language activities, (6) composing music, and (7) music combined with other modalities (e.g. imagery, art) (Dileo 2007; Magee 2006; Magee 2009).

Many research studies on the use of music in rehabilitation of acquired brain injury have suffered from small sample size, making it difficult to achieve statistically significant results. In addition, differences in factors such as study designs, methods of interventions, and intensity of treatment have led to varying results. A systematic review is 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.

OBJECTIVES

1. To identify randomized controlled trials (RCTs) examining the efficacy of music therapy in addressing recovery in patients with acquired brain injuries.
2. To compare the efficacy of music therapy and standard care with (a) standard care alone, (b) standard care and placebo treatments, or (c) standard care and other therapies.
3. To compare the efficacy of different types of music therapy interventions.

METHODS

Criteria for considering studies for this review

Types of studies
All prospective RCTs, parallel group designs as well as cross-over trials, of any language, published and unpublished, were eligible for entry. We included controlled clinical trials (CCTs) with quasi-randomized or systematic methods of treatment allocation (e.g. alternate allocation of treatments) because only a limited number of RCTs were identified.

Types of participants
We included patients of any gender and older than 16 years of age who had acquired brain damage of a non-degenerative nature and were participating in treatment programs offered in hospital, outpatient or community settings at the time that they received music therapy. This includes traumatic brain injury, stroke, anoxia, infection and any mixed cause. We excluded any condition of a progressive nature. We did not use the site of lesion and stage of rehabilitation as inclusion or exclusion criteria.

Types of interventions
We included all studies in which standard treatment combined with music therapy was compared with: (1) standard care alone, (2) standard care with placebo, or (3) standard care combined with other therapies. In addition, we considered studies only if (1) music therapy was delivered by a formally trained music therapist or by trainees in a formal music therapy program, and (2) one of the following music therapy interventions was used (Magee 2006):

- clinical improvisation in which participants are involved in active music making in dialogue with the therapist using musical instruments or voice;
- voice and singing techniques including song-singing programs, melodic intonation therapy or modified melodic

Music therapy for acquired brain injury (Review)
intonation therapy, vocal intonation therapy, rhythmic speech cueing, and therapeutic singing:
  * rhythmic auditory stimulation or rhythmic auditory cueing;
  * receptive techniques in which participants listen to music;
  * song-writing;
  * any combination of the above.

Types of outcome measures

Primary outcomes
Rehabilitation of mobility is crucial in acquired brain injury rehabilitation to enhance personal independence. Therefore, we selected the following primary outcomes for this review.
1. Improvement in gait, measured by changes in gait velocity, cadence, stride length, stride symmetry, stride timing.
2. Improvement in upper extremity function, measured by hand grasp strength, frequency and duration of identified hand function, spatiotemporal arm control.

Secondary outcomes
1. Communication (e.g. language production, parameters of voice production, speaking fundamental frequency)
2. Mood and emotions (e.g. depression, anger, anxiety)
3. Social skills and interactions (e.g. eye contact, non-verbal interactions)
4. Pain
5. Behavioral outcomes (e.g. participation in treatment, motivation, self-esteem)
6. Activities of daily living
7. Adverse events (e.g. death, fatigue,falls)

Search methods for identification of studies
See the 'Specialized register' section in the Cochrane Stroke Group module.
We searched the Cochrane Stroke Group Trials Register, which was last searched by the Managing Editor on 25 February 2010. In addition, we searched the following electronic bibliographic databases and trials registers:
- Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library Issue 2, 2009) (Appendix 1);
- MEDLINE (1950 to July 2009) (Appendix 2);
- EMBASE (1980 to August 2009) (Appendix 3);
- CINAHL (1982 to March 2010) (Appendix 4);
- PsycINFO (1967 to July 2009) (Appendix 5);
- LILACS (Latin American and Caribbean Health Sciences Literature) (1982 to August 2009) (Appendix 6);
- AMED (Allied and Complementary Medicine) (1985 to August 2009) (Appendix 7);
- Science Citation Index (1974 to August 2009) (Appendix 8);
- CAIRSS for Music (Computer-Assisted Information Retrieval Service System) (August 2009) (Appendix 9);
- Proquest Digital Dissertations (1861 to August 2009) (Appendix 10);
- ClinicalTrials.gov (http://www.clinicaltrials.gov/) (August 2009) (Appendix 11);
- Current Controlled Trials (http://www.controlled-trials.com/) (August 2009) (Appendix 12);
- The National Research Register (NRR) Archive (https://portal.nihr.ac.uk/Pages/NRRArchiveSearch.aspx) (August 2009) (Appendix 13);
- Rehab Trials.org (http://www.kesslerfoundation.org/) (August 11 2009) (Appendix 14);
- Indexes to Theses in Great Britain and Ireland (http://www.theses.com/) (August 2009) (Appendix 15);
- Music Therapy World (www.musictherapyworld.net) (November 2007): this specialist music therapy research database is no longer functional, however we handsearched archives of dissertations and conference proceedings (Appendix 16).

We handsearched the following music therapy journals and conference proceedings:
- *Australian Journal of Music Therapy* (1990 to 2009;20);
- *Australian Music Therapy Association Bulletin* (1977 to 2005: final issue);
- *British Journal of Music Therapy* (1987 to 2009;23(1));
- *International Journal of the Arts in Medicine* (1993 to 1999;6(2), final issue);
- *Journal of Music Therapy* (1964 to 2009;46(2));
- *Japanese Journal of Music Therapy* (2005 to 2006;2: latest issue available online);
- *Musiktherapeutische Umsschau* (1980 to 2009;30(3));
- *Music Therapy* (1981 to 1996;14(1), final issue);
- *Music Therapy Yearbook* (1951 to 1962, final issue);
- *Music Therapy Perspectives* (1982 to 2009;27(1));
- *Music Therapy Today* (online journal of music therapy) (2000 to 2007;3, final issue);
- *New Zealand Journal of Music Therapy* (1987 to 2006;20, latest issue with available online abstracts);
- *Voices* (online international journal of music therapy) (2001 to 2009;9(2));
- *Canadian Conference Proceedings* (2004 to 2006);
- *The World Music Therapy Congress Proceedings* (1993 to 1999);
In an effort to identify further published, unpublished and ongoing trials, we searched the bibliographies of relevant studies and reviews and contacted experts in the field. We consulted music therapy association web sites to help identify music therapy practitioners and conference information (e.g. American Music Therapy Association (http://www.musictherapy.org), the British Society for Music Therapy (http://www.bsmt.org/), the Association of Professional Music Therapists (APMT) (http://www.apmt.org/), Music Therapy World (http://musictherapyworld.net)). We also consulted a global network of professional music therapists working in neurology (Music Therapy Neurology Network http://www.rhn.org.uk/institute/mtnn).

We did not apply any language restrictions for either searching or trial inclusion.

Data collection and analysis

Selection of studies

Four review authors (JB, BW, WM, and EM) conducted the searches as outlined in the Search methods for identification of studies. One review author (JB) and a graduate research assistant scanned titles and abstracts of each record retrieved from the search and deleted obviously irrelevant references. When a title or abstract could not be rejected with certainty, a graduate assistant obtained the full article, which was then inspected by two review authors (BW and WM) independently. Both review authors used an inclusion criteria form to assess the trial’s eligibility for inclusion. One review author (JB) checked the inter-rater reliability for trial selection, and in case of disagreement or uncertainty, consulted a third review author (CD). We kept a record of both the article and the reason for exclusion for all excluded studies.

Data extraction and management

One author (JB) and a trained research assistant independently extracted data from the selected trials using a standardized coding form. They discussed any differences in data extraction and sought the input of a third review author (CD) when needed. We extracted the following data:

Trial information
- Study design (parallel group, cross-over)
- Randomization
- Randomization method
- Allocation concealment
- Allocation concealment method
- Level of blinding

Intervention information
- Type of intervention (e.g. clinical improvisation, voice or singing technique, rhythmic auditory stimulation or rhythmic auditory cueing, music listening, song writing, combination)
- Music selection (detailed information on music selection in cases of music listening, beat selection in cases of rhythmic auditory stimulation)
- Music preference (patient preferred versus researcher selected in cases of music listening)
- Professional level of music therapist (professional or student in training)
- Length of intervention
- Intensity of intervention
- Comparison intervention

Participant information
- Total sample size
- Number of experimental group
- Number of control group
- Gender
- Age
- Ethnicity
- Diagnosis
- Site of lesion
- Degree of neurological damage
- Rehabilitation stage
- Setting
- Inclusion criteria

Outcomes
We planned to extract statistical information for the following outcomes (if applicable):
1. parameters of gait (e.g. velocity, cadence, stride length, stride symmetry, stride timing);
2. parameters of upper extremity function (e.g. hand grasp strength, frequency and duration of identified hand function, spatiotemporal arm control);
3. communication outcomes (e.g. language production; parameters of voice production, speaking fundamental frequency);
4. mood and emotion outcomes (e.g. depression, anger, anxiety);
5. social interactions outcomes (e.g. eye contact, non-verbal interactions);
6. pain;
7. behavioral outcomes (e.g. participation in treatment, motivation);
8. activities of daily living;
9. adverse events (e.g. death, fatigue, falls).

Assessment of risk of bias in included studies
Two review authors (JB and CD) independently assessed all included trials for trial quality. We used the following four criteria for quality assessment.

1. **Method of randomization**
   - Was the trial reported as randomized? Yes/No
   - Was the method of randomization appropriate? Yes/No/Unclear
   We rated randomization as appropriate if every participant had an equal chance to be selected for either condition and if the investigator was unable to predict to which treatment the participant would be assigned. We rated date of birth, date of admission, or alternation as inappropriate.

2. **Allocation concealment**
   We used the ratings of A - adequate, B - unclear and C - inadequate in accordance with section 6.3 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2008).
   - A - adequate: methods to conceal allocation include (1) central randomization, (2) serially numbered, opaque, sealed envelopes, or (3) other descriptions with convincing concealment.
   - B - unclear: authors did not adequately report on method of concealment.
   - C - inadequate: allocation was not adequately concealed (e.g. alternation methods were used).

3. **Blinding**
   With music therapy studies, it is not possible to blind participants and those providing the music therapy interventions. However, outcome assessors can be blinded. In this review, we marked blinding as ‘yes’, ‘no’, or ‘unclear’ as it pertains to blinding of outcome assessors.

4. **Incomplete data addressed**
   We gave a rating of adequate when numbers of dropouts and reasons for drop out were reported or if we were able to obtain this information from the study author. If there were no withdrawals and this was indicated in the study, we gave the study a rating of adequate.

Assessment of heterogeneity
We investigated heterogeneity using the $I^2$ test with $I^2 > 50\%$ indicating significant heterogeneity.

Assessment of reporting biases
We could not examine publication bias because the outcomes included had a maximum of two trials.

Data synthesis
One review author (JB) entered all trials included in the systematic review into Review Manager 5 (*RevMan* 2008). JB conducted the data analysis and this was reviewed by CD for accuracy. We presented the main outcomes in this review as continuous variables. We calculated standardized mean differences for outcome measures using the results from different scales; we used mean differences for results using the same scales. We calculated pooled estimates using the fixed-effect model unless there was substantial heterogeneity, in which case we used the random-effects model to obtain a more conservative estimate. We determined levels of heterogeneity using the $I^2$ statistic (Higgins 2002). We calculated 95% confidence intervals (CI) for each effect size estimate. This review did not include any categorical variables.

We made the following treatment comparison:
- music therapy versus standard care alone.

Subgroup analysis and investigation of heterogeneity
We planned the following sub-analyses a priori as described by Deeks 2001 and as recommended in section 8.8 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2008).
but could not perform them because of an insufficient number of studies:

- type of music therapy intervention;
- dosage of music therapy; and
- diagnosis.

Sensitivity analysis

We planned to examine the influence of study quality using a sensitivity analysis where the results of including and excluding lower-quality studies are compared. However, this was not possible because there were only two trials per outcome.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification; Characteristics of ongoing studies.

Results of the search

The database searches and handsearching of conference proceedings and journals identified 3855 citations; we retrieved 94 references for possible inclusion. If necessary we contacted chief investigators to obtain additional information on study details and data. We found many trials on the effects of rhythmic auditory stimulation (RAS) on gait in people with acquired brain injury; however, most of those were one group pre-test/post-test designs. In addition, several trials examined melodic intonation therapy for speech improvement, but we excluded these because the intervention was not implemented by a trained music therapist or the trial was not a RCT or CCT. Fourteen references to seven studies met all the inclusion criteria.

Included studies

We included seven studies with a total of 184 participants. These studies examined the effects of music therapy on gait parameters (Thaut 1997; Thaut 2007), speech outcomes (Jungblut 2004), hemiparetic arm movement (Paul 1998; Thaut 2002), agitation and orientation (Baker 2001) and pain during exercise (Kim 2005) in patients with an acquired brain injury. Fifty-four per cent of the participants were male. The average age of the participants was 59.4 years. The studies were conducted in four different countries: USA (Paul 1998; Thaut 1997; Thaut 2002), South Korea (Kim 2005), Germany (Jungblut 2004), Australia (Baker 2001), and USA and Germany (Thaut 2007) by professional music therapists. Five of the seven studies did not report on the ethnicity of the participants (Jungblut 2004; Paul 1998; Thaut 1997; Thaut 2002; Thaut 2007). Trial sample size ranged from 10 to 78 participants. Three studies used rhythmic auditory stimulation (RAS) as the music therapy intervention (Thaut 1997; Thaut 2002; Thaut 2007). RAS involves the use of rhythmic sensory cuing of the motor system. It engages entrainment principles in which “rhythmic auditory cues synchronize motor responses into stable time relationships. The fast-acting physiological entrainment mechanisms between auditory rhythm and motor response serve as coupling mechanisms to stabilize and regulate gait patterns” (Thaut 2007) or reaching arm movements. Two studies (Thaut 1997; Thaut 2007) examined the effects of RAS versus standard neurodevelopmental therapy (NDT/Bobath) on improvement in gait as measured by changes in gait velocity, cadence, stride length, and stride symmetry. Both studies included stroke patients two to three weeks post-stroke. Patients were eligible if they were able to complete five stride cycles with hand-held assistance. The training duration of Thaut 1997 was six weeks with training held twice daily, 30 minutes each session, five days a week. Thaut 2007 followed the same protocol but the training duration was only three weeks. One study (Thaut 2002) examined the effects of RAS on spatiotemporal control of reaching movements of the paretic arm. In this study, patients were asked to move their affected arm back and forth for 30 seconds as evenly timed as possible between two touch-sensitive sensors (for details about sensor placement please see Thaut 2002). Patients completed one trial with and one trial without RAS in a randomized cross-over trial. During rhythmic trials, patients were asked to move their affected arm in time with the metronome beat. Other music therapy interventions included electronic music making (Paul 1998), rhythm-melodic voice training (SIPARI®) (Jungblut 2004) and listening to pre-recorded songs (Kim 2005) or live music (Baker 2001).

Paul 1998 evaluated the effects of music-making activity on elbow extension in patients with hemiplegia. Electronic music devices were used that required active shoulder flexion and elbow extension and that enabled easy sound manipulation by the participants. Electronic paddle drums were individually set to the maximum range of motion of each participant. Participants in the music therapy group participated in music-making activity for 30 minutes twice a week for 10 weeks. The control group participated in a physical exercise group in which they were encouraged to reach their affected extremity as far as they could in different directions.

Only one trial (Jungblut 2004) that examined the effects of music therapy on speech parameters met our inclusion criteria. This study used SIPARI® with participants who suffered from chronic aphasia (Broca’s aphasia or global aphasia) due to stroke with a mean aphasia duration of 11.5 years and who were no longer receiving speech therapy. SIPARI® is a music therapy technique that is based on specific use of the voice. It actively works with the remaining speech capabilities in the right hemisphere of aphasics.
patients, namely singing, intonation, prosody embedded in physiologically appropriate breathing (Atmung). The SIPARI method also employs instrumental and vocal rhythmic exercises and music improvisations to practice communication scenarios. Participants in the experimental group (eight participants) received 20 group music therapy sessions and 10 individual sessions over a period of seven months. Participants in the control group (five participants) did not receive any music therapy.

Listening to pre-recorded music involves methods where the patient is directed to listen to audio recordings of music played on any media device such as compact discs, vinyl recordings, cassettes, or other digital technology, and is not required to be involved actively in making the music him/herself. Listening to live music involves methods where the patient is directed to listen to vocal or instrumental music created by the therapist (or another) within the patient’s environment, and is not required to be involved actively in making the music him/herself. One trial (Baker 2001) examined the effects of music therapy on agitation and orientation levels in 22 people with a severe head injury with a diagnosis of post-traumatic amnesia. Participants were exposed to three conditions (listening to live music, listening to taped music, no music), in random order, twice over six consecutive days. The songs in the live and taped music condition were identical and were suggested by family members as the participant’s preferred music. We found one RAS trial that investigated the effects of listening to pre-recorded music on pain in people with acquired brain injury. Kim 2005 exposed 10 stroke patients to music (listening to songs and listening to karaoke instrumental music) and no music conditions during upper extremity joint exercises over an eight-week period. Frequency and duration of treatment sessions greatly varied among the studies. The total number of sessions ranged from three sessions to 60 sessions. Most sessions lasted 30 minutes, with the exception of one RAS trial that used 30 seconds trial intervals for different treatment conditions (Thaut 2002). Details on frequency and duration of sessions for each trial are included in the Characteristics of included studies table.

Four studies used parallel group designs (Jungblut 2004; Paul 1998; Thaut 1997; Thaut 2002), whereas the other studies used cross-over designs. Not all studies measured all outcomes identified for this review. Details of the studies included in the review are shown in the Characteristics of included studies table.

Excluded studies
We identified 21 additional experimental research studies that appeared eligible for inclusion. However, we excluded these after closer examination or after receiving additional information from the chief investigators. Reasons for exclusions were: (1) not an RCT or CCT (16 studies), (2) insufficient data reporting (one study), (3) could not be categorized as music therapy (as defined by the authors in the background section) (two studies), (4) comparative study of two music therapy interventions (one study), and (5) control participants did not have ABI (one study). Details of the excluded trials are listed in the Characteristics of excluded studies table.

Risk of bias in included studies
We included studies that used appropriate methods of randomization (e.g., computer-generated table of random numbers, draw of lots, flip of coins) (Baker 2001; Kim 2005; Thaut 1997; Thaut 2002; Thaut 2007) as well as studies that used alternate group assignment as allocation method (Jungblut 2004; Paul 1998). Four studies used allocation concealment (Kim 2005; Thaut 1997; Thaut 2002; Thaut 2007). In three trials, blinding of the outcome assessors was not used (Baker 2001; Kim 2005; Thaut 2002), and this inevitably introduced potential for biased assessment. Blinding of intervention allocation is not possible in music therapy interventions, adding another layer of possible bias. The dropout rate was less than 20% for four of the trials (Baker 2001; Paul 1998; Thaut 1997; Thaut 2007). Two studies had a drop out rate between 24% and 29% (Jungblut 2004; Kim 2005), and one study did not report on drop-out rate (Thaut 2002). Most studies reported reasons for dropout. Detailed information on dropout rate is included in the Characteristics of included studies table.

As a result, only two studies (Thaut 1997; Thaut 2007) received a low risk of bias rating. For all other studies there was a high risk of bias. Risk of bias is detailed for each study in the risk of bias tables included with the Characteristics of included studies table. As all but two trials were rated at the same level (high risk) and because of the limited number of studies per outcome, we did not carry out sensitivity analysis on the basis of overall quality rating.

Effects of interventions

Primary outcomes

Gait
Two studies (Thaut 1997; Thaut 2007) with a total of 98 participants examined the effects of RAS versus standard neurodevelopmental therapy (NDT/Bobath) on improvement in gait as measured by changes in gait velocity, cadence, stride length, and stride symmetry. The pooled estimate of these two studies indicated that RAS improved gait velocity by an average of 14.32 meters per minute compared to the control group (95% CI 10.98 to 17.67, P < 0.00001), and results were consistent between the two studies (I² = 0%) (Analysis 1.1). The RAS group also showed significantly greater improvements in stride length (MD = 0.23 meters, 95%
Analysis 1.2 examined the effects of a music therapy method, and gait; Included studies (8.00 steps/minute, 95% CI -6.47 to 22.47, N = 20). Finally, the RAS intervention led to greater improvements in gait symmetry (defined as the ratio between the swing time of two consecutive steps using the longer step as the denominator) than standard treatment (MD = 0.12, 95% CI 0.09 to 0.15, P < 0.00001) and these results were consistent between the two studies (I^2 = 0%) (Analysis 1.3).

**Upper extremity function**

Two trials (Paul 1998; Thaut 2002) measured the effects of music therapy on upper extremity function in hemispheric stroke patients. Elbow extension angle was the only common outcome measure in these two studies. However, because of the significant clinical heterogeneity of the studies, their effect sizes were not pooled. Thaut 2002 examined the effects of RAS on spatiotemporal control of reaching movements of the paretic arm in 21 patients. Results indicated that RAS increased the elbow extension angle by 13.8% compared to the non-rhythmic trial, and this difference was statistically significant (P = 0.007). Results further indicated that variability of timing and reaching trajectories were reduced significantly (35% and 40.5%, respectively, P < 0.05).

Paul 1998 evaluated the effects of music-making activity on elbow extension in 20 participants with hemiplegia. The elbow extension (measured from 135 to 0 with negative numbers expressing limitations) post-intervention was -29.4 (SD 29.49) for the experimental group and -39.2 (SD 38.19) for the control group. This difference was not statistically significant. Post-test shoulder flexion data indicated no statistically significant difference (P = 0.44) between the music therapy group (85.6°, SD 26.71) and the control group (71.8°, SD 39).

**Secondary outcomes**

**Communication**

Jungblut 2004 examined the effects of a music therapy method, SIPARI®, as described in the Included studies section, on speech parameters in 13 participants with chronic aphasia. Post-treatment speech evaluation found that the use of SIPARI® was effective in improving articulation and prosody (effect size (ES) = 2.12, P = 0.024), speech repetitions (ES = 1.29, P = 0.045), and speech comprehension (ES = 1.36; P = 0.037). The effect on labeling was not statistically significant (ES = 0.74; P = 0.22). The total speech profile of the music therapy participants on the Aachen Aphasia Test was improved significantly compared to the control group (ES = 2.08, P = 0.003).

**Behavioral outcomes**

One trial (Baker 2001) examined the effects of listening to live music and listening to taped music on agitation and orientation levels in 22 people with a severe head injury with a diagnosis of post-traumatic amnesia. Listening to live music had a significant effect on participant orientation levels (as measured by the Westmead PTA scale) compared to the no music control condition (ES = 0.82, P < 0.001), and this effect was slightly larger than the effect of listening to taped music compared to the control condition (ES = 0.72, P < 0.001). Listening to live music was also effective in reducing agitation scores (as measured by the Agitation Behavior Scale) (ES = 5.01 ABS units, P < 0.0001). Agitation also decreased after listening to taped music (6.25 ABS units, P < 0.0001). The difference in effect between live and taped music was not statistically significant (1.2 ABS units, P = 0.8).

**Pain**

Kim 2005 examined the effects of listening to pre-recorded music on pain in people with acquired brain injury. Pain ratings on a zero-to-10 numeric scale indicated that there was no statistically significant difference in pain ratings between the music and the no-music condition (P > 0.05).

We did not identify any studies that addressed the other secondary outcomes listed in the Secondary outcomes section, namely mood and emotions, social skills and interactions, activities of daily living and adverse events.

**DISCUSSION**

**Summary of main results**

The results of this review suggest that rhythmic auditory stimulation (RAS) may be beneficial for improving gait velocity, cadence, stride length and stride symmetry in stroke patients. These results were based on two studies that received a low risk of bias score. However, given the limited number of studies and the small total sample size (98 participants), more RCTs are needed to strengthen this evidence.

Two trials investigated the effects of music therapy on upper extremity function in hemispheric stroke patients. Because of clinical heterogeneity, these results could not be pooled. One study (Thaut 2002) found significant improvement in elbow extension, variability of timing and reaching trajectories during rhythmic auditory stimulation. In contrast, one study (Paul 1998) that examined the effects of active music making on elbow extension and
shoulder flexion did not find statistically significant results. More research is needed to investigate which music therapy techniques are most effective for improvement of upper extremity function. Few trials that examined the effects of music therapy on the secondary outcomes in this review met our inclusion criteria. The results of one trial (Jungblut 2004) indicated that SIPARI®, a music therapy rhythmic-melodic voice training technique, significantly improved the speech profile of people with chronic aphasia. One RCT (Baker 2001) found that music therapy is effective in reducing agitation and improving orientation levels in people with post-traumatic amnesia following a severe head injury. In a trial evaluating the effects of music therapy on pain levels during upper extremity exercise in stroke patients, no support was found for the effectiveness of listening to music for pain management (Kim 2005). More RCTs are needed to investigate the effects of music therapy on these outcomes before any reliable conclusions can be drawn.

Other secondary outcomes listed in the Secondary outcomes section of this review, namely mood and emotions, social skills and interactions, activities of daily living and adverse events were not addressed in any of the trials that met our inclusion criteria.

Overall completeness and applicability of evidence

This review included seven trials. The strength of our review is that we searched all available databases and a large number of music therapy journals, checked reference lists of all relevant trials, contacted relevant experts for identification of unpublished trials and reviewed publications for eligibility without restricting language. In spite of such a comprehensive search, it is still possible we missed some published and unpublished trials. We requested additional data where necessary for all trials we considered for inclusion. This allowed us to get accurate information on the trial quality and data for most trials and helped us make well-informed trial selection decisions.

The results of two studies suggest that RAS may be effective for improving gait velocity, cadence, stride length, and stride symmetry in stroke patients. These findings coincide with data from non-controlled trials about the beneficial effects of RAS on gait in patients with acquired brain injury (Thaut 1993; Thaut 1997b). As pointed out in Thaut 1997, hemispheric stroke patients may benefit from RAS because auditory rhythm is processed bilaterally, and no difference was observed in performance between left and right hemispheric patients. However, more RCTs are needed to further support this evidence.

One trial examined the effects of RAS on hemiparetic arm movements in stroke patients. The positive results of this study are supported by evidence of non-controlled trials (Malcolm 2009; Thaut 1999). Given the fact that rhythmic stimulation appears to induce temporal stability and enhance motor control in walking, it could very well be that rhythmic cueing has a similar effect on upper extremity functioning. Even though functional arm movements, unlike gait, are “discrete, biologically non-rhythmic, and volitional” (Thaut 2002), rhythmic stimuli are successfully used to enhance the execution of motor skills in non-rehabilitation areas such as music performance and sports (Thaut 2002). It is important that additional RCTs are conducted to further examine the potential benefits of RAS on upper extremities functioning.

The RAS trials solely included hemiparetic stroke patients. The majority of the patients had middle cerebral artery strokes (78%). Patients in the gait trials (Thaut 1997; Thaut 2007) entered the studies within four weeks of the stroke incident and were categorized as a stage four or early stage three on the Brunnstrom recovery scale. Patients in the upper extremity trial (Thaut 2002) were, on average, 11.4 (SD 5.2) months post-stroke before admission to the study and were categorized as a stage four to five on the Brunnstrom recovery scale. Site of lesion and length of post-injury recovery period are important factors to consider when selecting music interventions for adults with acquired brain injury. However, because of the limited number of studies in this review and the heterogeneity of neurological injury, recommendations linking specific interventions to specific neurological damage cannot be made at this time.

Single controlled clinical trials have shown promising results for the effects of music therapy on speech, agitation and orientation levels in people with acquired brain injury but no conclusions can be drawn at this time regarding the clinical applicability of this evidence. In addition, several RCTs and CCTs which could not be categorized as music therapy (as defined by the authors in the background section) have reported positive effects of listening to music and music making on cognitive and motor outcomes for ABI populations (Särkämö 2008; Schneider 2007).

Quality of the evidence

The quality of reporting in general was poor with only one study detailing the method of randomization, allocation concealment and level of blinding (Thaut 2007). We needed to contact the chief investigators of all other studies to provide additional methodological and statistical information. As a result, only two studies (Thaut 1997; Thaut 2007) received a low risk of bias rating. Both of these studies contributed evidence on the effects of RAS on gait parameters. However, because of the limited number of trials, the results on gait parameters need to be interpreted with caution. It is important to consider the potential bias introduced by incomplete outcome data. For the gait studies (Thaut 1997; Thaut 2007) there were no drop-outs in Thaut 1997 (personal communication with author). In Thaut 2007, participant drop-outs were much higher in the control group. Reasons for withdrawal were hospital transfer, early discharge, medical complications, or unspecified personal reasons. Since both studies implemented the same intervention and their results were highly homogenous ($I^2 = 0\%$ for three out of four gait parameters), one could assume that
the incomplete data of Thaut 2007 did not bias the results. However, since the raw data could not be accessed and no intention-to-treat analyses were used, we cannot be certain of this. The quality of evidence of the other trials was poor because of high risk of bias and limited number of studies.

**AUTHORS’ CONCLUSIONS**

**Implications for practice**

Rehabilitation of mobility is crucial in stroke rehabilitation. The results of two studies included in this review suggest that rhythmic auditory stimulation may help improve gait velocity, cadence, stride length and stride symmetry in stroke patients. These results are encouraging, but more RCTs are needed before recommendations can be made for clinical practice. As most of the included studies successfully improved motor outcomes with rhythm-based methods, we suggest that rhythm may be a primary factor in music therapy methods facilitating functional gains with this population.

At this time, there is not sufficient evidence from RCTs or CCTs to support the use of music therapy for improvement of upper extremity function, speech, agitation and cognitive orientation. Other secondary outcomes listed in this review, namely mood and emotions, social skills and interactions, activities of daily living and adverse events, were not addressed in any of the trials that met our inclusion criteria. In the absence of sufficient evidence, recommendations for clinical practice cannot be made for these outcomes.

**Implications for research**

This review shows encouraging results for the effects of rhythmic auditory stimulation (RAS) on gait parameters; however, more RCTs are needed to strengthen the current data. Several small non-controlled trials have shown impressive results of RAS for gait improvement. This, combined with the results of the two RCTs included in this review, warrants the progression to much needed large scale studies on the effects of RAS on gait. Likewise, the results of one RCT included in this review on the effects of RAS on upper extremity function in stroke patients combined with the positive results of non-controlled trials, calls for continued research commitment on the efficacy of this specific music therapy intervention for hemiparetic stroke patients. Since four of the studies producing significant results involved rhythm-based methods to address upper limb and gait functioning, we recommend more RCT investigations of rhythmic auditory stimulation across functional domains.

Future studies need to examine the relationship between the frequency and duration of RAS interventions and treatment effects. Thaut 2007 also recommended that future studies (1) compare RAS against other current gait-training methods besides neurodevelopmental treatment/Bobath, (2) investigate the effect of RAS combined with other current gait therapy techniques, and (3) study the effect of RAS in long-term outpatient or community-based settings.

More RCTs are needed to examine the effect of music therapy interventions on speech in people with acquired brain injury. We identified several trials but could not include them in this review because of lack of a control group, lack of randomization, or lack of pseudo-randomization. Given the many clinical reports in the music therapy literature of beneficial effects of music on speech in this population, research efforts need to focus on conducting music therapy trials with high quality designs.

Future studies should consider including the following outcomes: agitation, cognitive orientation, mood and emotions, social skills and interactions, activities of daily living and adverse events.

Finally, several studies in this review used a small sample size (10 to 20 participants). Future studies need to include power analyses so that sufficiently large samples are used.

**ACKNOWLEDGEMENTS**

The Cochrane Stroke Group Editorial Team for advice and support and Brenda Thomas for her assistance in the design of the search strategy. We would also like to acknowledge Patricia Gonzalez and Mike Viega, graduate assistants, for their help in screening the titles and abstracts and the retrieval of articles.
References to studies included in this review

Baker 2001 [published and unpublished data]


Jungblut 2004 [published data only]

Kim 2005 [published data only]

Paul 1998 [published data only]

Thaut 1997 [published data only]


Thaut 2002 [published data only]


Thaut 2007 [published data only]


References to studies excluded from this review

Baker 2004 [published data only]

Baker 2005 [published data only]

Cofrancesco 1985 [published data only]

Cohen 1992 [published and unpublished data]

Cohen 1995 [published data only]

Ford 2007 [published data only]

Goh 2001 [unpublished data only]
Goh M. The role of music therapy in the rehabilitation of people who have had strokes, specifically focusing on depression. National Research Register, Issue 1 2001.

Hitchen 2007 [published and unpublished data]

Hurt 1998 [published data only]

Lin 2007 [published and unpublished data]
Lin SI. Effect of rhythmic auditory cues on gait of stroke patients. Cerebrovascular Diseases 2007;23 Suppl 2:128. [: Stroke Trial Registry Ref 12104]
References to studies awaiting assessment

References to ongoing studies

Additional references

Deeks 2001

Dileo 2007

Finkelstein 2006

Higgins 2002

Higgins 2008
Kim 2005

Magee 2006

Magee 2009

Malcolm 2009

NA 2003

NCIPC 2001

RCP 2004

RevMan 2008

Schneider 2007

Thurman 1999

Turner-Stokes 2003

van de Port 2007

WHO 2002

Whyte 2006

* Indicates the major publication for the study
Characteristics of included studies  

Baker 2001

<table>
<thead>
<tr>
<th>Characteristics of included studies (ordered by study ID)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methods</strong></td>
</tr>
<tr>
<td>RCT</td>
</tr>
<tr>
<td>Cross-over trial</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
</tr>
<tr>
<td>22 adults with a severe head injury with a diagnosis of post-traumatic amnesia, scoring less than or equal to 8 on the Westmead PTA Scale on the day prior to commencement of the experiment.</td>
</tr>
<tr>
<td>Live music therapy condition: 22 patients</td>
</tr>
<tr>
<td>Taped music condition: 22 patients</td>
</tr>
<tr>
<td>Control condition: 22 patients</td>
</tr>
<tr>
<td>Mean age: 34 years (SD 15.34)</td>
</tr>
<tr>
<td>Sex: 5 female, 17 male</td>
</tr>
<tr>
<td>Ethnicity: 72.7% Australian, 9% Croatian, 4.5% Taiwanese, 4.5% Bangladeshi, 9% Italian</td>
</tr>
<tr>
<td>Setting: rehabilitation hospital</td>
</tr>
<tr>
<td>Country: Australia</td>
</tr>
<tr>
<td><strong>Interventions</strong></td>
</tr>
<tr>
<td>Music conditions: listened to 10 to 12 minutes of live or taped music conditions. The music conditions were individualized for each participant and comprised 3 music pieces that were chosen from selections suggested by family members. All styles of music were permitted. The same 3 pieces were played during the live music condition and the taped music condition, and played in the same order. During both the live and taped music conditions, the researcher was present in the room sitting opposite and facing the participant. In the taped music condition, the music selections were played free-field on an audio cassette player. No headphones were used because this could agitate the patient. Control condition; the music therapist was present in the room but no music was played. Participants were free to do whatever they wanted. Like in the music conditions, the verbal interactions were kept to a minimum.</td>
</tr>
<tr>
<td>Number of sessions: 6 (2 of each condition)</td>
</tr>
<tr>
<td>Length of session: 10 to 12 minutes each</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
</tr>
<tr>
<td>Agitation (Agitation Behavior Scale): effect size reported</td>
</tr>
<tr>
<td>Level of orientation (Westmead PTA Scale): effect size reported</td>
</tr>
<tr>
<td><strong>Notes</strong></td>
</tr>
<tr>
<td><strong>Risk of bias</strong></td>
</tr>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Adequate sequence generation?</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Computer-generated list of random numbers</td>
</tr>
<tr>
<td>Allocation concealment?</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>No allocation concealment used</td>
</tr>
</tbody>
</table>
### Blinding?

| Objective outcomes | No | Blinding of outcome assessors (unit nurses) was attempted but the authors reported that the nurses could still hear the music coming from the rooms at times (personal communication) |

| Incomplete outcome data addressed? | Yes | 1 drop-out because of early resolution of PTA |

### Jungblut 2004

**Methods**
- Pseudo-randomized controlled trial (alternate group allocation)
- 2-arm parallel group design

**Participants**
- 13 stroke patients suffering from chronic aphasia (Broca's aphasia and global aphasia) who were no longer receiving speech therapy.
- Mean duration of aphasia: 11.5 years
- Music therapy group: 8 participants
- Control group: 5 participants
- Mean age: 63.8 years experimental group; 67.8 years control group
- Sex: 6 female, 7 male
- Ethnicity: not reported
- Setting: outpatient services
- Country: Germany

**Interventions**
- Music therapy group: rhythmic-melodic voice training (SIPARI®) sessions. SIPARI® is a music therapy technique that is based on specific use of the voice. It actively works with the remaining speech capabilities in the right hemisphere of aphasic patients, namely singing, intonation, prosody embedded in physiologically appropriate breathing (Atmung). The SIPARI method also employs instrumental and vocal rhythmic exercises and music improvisations to practice communication scenarios.
- Control group: no treatment
- Number of sessions: 20 group music therapy sessions and 10 individual sessions over a period of 7 months

**Outcomes**
- Articulation and prosody, repetitions, labeling, speech comprehension, total speech profile (Aachener Aphasia Test); effect size reported

### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>No</td>
<td>Alternate group allocation</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>No</td>
<td>No allocation concealment used</td>
</tr>
</tbody>
</table>
### Jungblut 2004 (Continued)

<table>
<thead>
<tr>
<th>Blinding? Objective outcomes</th>
<th>Yes</th>
<th>Independent outcome assessors were used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete outcome data addressed? All outcomes</td>
<td>Yes</td>
<td>1 experimental and 1 control participant were excluded because they could not be clearly classified as having global aphasia or Broca's aphasia. In addition, 2 more control participants had to be excluded because they became gravely ill during the research study time frame.</td>
</tr>
</tbody>
</table>

### Kim 2005

| Methods | RCT  
| Cross-over trial |
| Participants | 10 adult stroke patients; 8 with severe hemiplegia, 2 with mild hemiplegia  
| Approximately 3 years post-stroke  
| Music therapy conditions: 10 participants  
| Control condition: 10 participants  
| Mean age: not reported, age range: 61 to 73 years  
| Sex: 9 female, 1 male  
| Ethnicity: 100% South Korean  
| Setting: daycare center for seniors  
| Country: South Korea |
| Interventions | Music therapy conditions: (1) listening to taped songs with lyrics, and (2) listening to karaoke accompaniment (without lyrics) during upper extremities exercises  
| Control condition: no music during upper extremities exercises |
| Outcomes | Pain: no post-test means or change scores were reported; only F-statistic and significance level |
| Notes | The author informed us that she no longer had access to the raw data; therefore, no means or SD could be obtained |

### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors' judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>Yes</td>
<td>Computer-generated list of random numbers</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>Yes</td>
<td>All participants underwent the 3 conditions in random order</td>
</tr>
<tr>
<td>Blinding? Objective outcomes</td>
<td>No</td>
<td>Blinding not possible as only subjective pain report was used</td>
</tr>
</tbody>
</table>
### Kim 2005 (Continued)

| Incomplete outcome data addressed? | Yes | 4 patients withdrew due to health condition or frequent absences (personal communication with author) |

### Paul 1998

| Methods | Pseudo-RCT  
2-arm parallel group design |
| Participants | 20 adults with unilateral cerebral hemiplegia determined to have reached their maximum capacity of physical function and subsequently discharged from occupational and physical therapies. All participants had at least 10 degrees of limitation in active shoulder flexion and elbow extension. Mean duration post-stroke: 93.4 days (SD 49.5).  
Music therapy group: 10 participants  
Control group: 10 participants  
Mean age: 61.75 years (SD 5.1)  
Sex: 9 female, 11 male  
Ethnicity: not reported  
Setting: nursing/rehabilitation facility  
Country: USA |
| Interventions | Music therapy group: participants engaged in active music improvisation sessions with the music therapist using electronic music devices that allowed for easy sound manipulation. Improvisations emphasized steady rhythmic pulses.  
Control group: physical exercise group conducted by recreational therapist for the same duration as the music therapy group  
Number of sessions: 2 times per week for 10 weeks  
Duration of each session: 30 minutes |
| Outcomes | Active shoulder flexion (JAMAR goniometer): pre-test and post-test values are reported  
Elbow extension (JAMAR goniometer): pre-test and post-test values are reported |

### Notes

#### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors’ judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>No</td>
<td>Alternate group allocation</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>No</td>
<td>No allocation concealment used</td>
</tr>
<tr>
<td>Blinding? Objective outcomes</td>
<td>Yes</td>
<td>Occupational therapist who completed the goniometric measurements was unaware of group assignment</td>
</tr>
<tr>
<td>Incomplete outcome data addressed? All outcomes</td>
<td>Yes</td>
<td>There were no withdrawals</td>
</tr>
</tbody>
</table>
### Thaut 1997

| Methods | RCT  
| 2-arm parallel group design |
| --- | --- |
| Participants | 20 adults with hemiparetic stroke  
Average post-stroke: 16.1 (SD 4) days for experimental group, 15.7 (SD 4) days for control group  
Mean age: 73 years (SD 7) experimental group, 72 years (SD 8) control group  
Sex: 10 female, 10 male  
Ethnicity: not reported  
Setting: hospital  
Country: USA |
| Interventions | Music therapy group: RAS  
Control group: standard neurodevelopmental treatment/Bobath  
Number of sessions: twice daily for 6 weeks  
Duration of session: 30 minutes |
| Outcomes | Gait parameters: velocity, stride length, cadence, symmetry: pre-test and post-test values  
EMG variability: change score |
| Notes |  |

#### Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors’ judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>Yes</td>
<td>Computer-generated list of random numbers (personal communication)</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>Yes</td>
<td>Recruiters did not know group conditions (personal communication)</td>
</tr>
</tbody>
</table>
| Blinding?  
Objective outcomes | Yes | Outcome assessors (physical therapists) were blinded to the experiment |
| Incomplete outcome data addressed?  
All outcomes | Yes | No participant loss (personal communication) |

### Thaut 2002

| Methods | RCT  
| Cross-over trial |
| --- | --- |
| Participants | 21 adults with left hemispheric stroke  
Mean post-stroke: 11.4 (SD 5.2) months  
Music therapy condition: 21 participants  
Control condition: 21 participants  
Mean age: 52.7 years (SD 13.7)  
Sex: 8 female, 13 male |
### Thaut 2002

**Setting:** out-patient services  
**Country:** USA

**Interventions**  
Music therapy condition: RAS  
Control condition: non-cued repetitive training  
Number of sessions: 1 session with RAS and 1 session without external time cueing  
Length of session: 30 seconds each

**Outcomes**  
Arm timing, variability of movement timing, wrist trajectories, wrist trajectory variability,  
elbow range of motion: pre-test and post-test values

**Notes**

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors’ judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>Yes</td>
<td>Computer-generated list of random numbers (personal communication)</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>Yes</td>
<td>Serially numbered opaque sealed envelopes (personal communication)</td>
</tr>
<tr>
<td>Blinding? Objective outcomes</td>
<td>No</td>
<td>No blinding used</td>
</tr>
<tr>
<td>Incomplete outcome data addressed?</td>
<td>Unclear</td>
<td>It is not clear whether there were any participant withdrawals</td>
</tr>
</tbody>
</table>

### Thaut 2007

**Methods**  
RCT  
2-arm parallel group design

**Participants**  
78 adults with subacute hemiparetic stroke  
Approximately 21 days post-stroke  
Music therapy group: 43 participants  
Control group: 35 participants  
Mean age: 69.2 years (SD 11.5) experimental group; 69.7 years (SD 11.2) control group  
Sex: 37 female, 41 male  
Ethnicity: not reported  
Setting: 2 research centers  
Country: USA and Germany

**Interventions**  
Music therapy group: RAS  
Control group: standard neurodevelopmental therapy/Bobath  
Number of sessions: daily, 5 days/week for 3 weeks  
Duration of session: 30 minutes
Outcomes

Gait parameters: velocity, stride length, cadence, symmetry; post-test values
Patient satisfaction with treatment: F-statistic and P value

Notes

Risk of bias

<table>
<thead>
<tr>
<th>Item</th>
<th>Authors’ judgement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>Yes</td>
<td>Computer-generated list of random numbers</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>Yes</td>
<td>Serially-numbered opaque sealed envelopes</td>
</tr>
<tr>
<td>Blinding?</td>
<td>Yes</td>
<td>Outcome assessors were unaware of group assignment</td>
</tr>
<tr>
<td>Objective outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete outcome data addressed?</td>
<td>Yes</td>
<td>23% dropouts in German center, 10% in US center (absolute numbers are not reported) Reasons: hospital transfer, early discharge, medical complications, unspecified personal reasons</td>
</tr>
</tbody>
</table>

PTA: post-traumatic amnesia
RAS: rhythmic auditory stimulation
RCT: randomized controlled trial
SD: standard deviation

Characteristics of excluded studies  [ordered by study ID]

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker 2004</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Baker 2005</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Cofrancesco 1985</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Cohen 1992</td>
<td>Unacceptable treatment allocation method</td>
</tr>
<tr>
<td>Cohen 1995</td>
<td>Compared rhythmically cued speech, melodically cued speech, and verbal speech of patients who had been receiving music therapy No standard treatment group Insufficient data reporting</td>
</tr>
<tr>
<td>Ford 2007</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Goh 2001</td>
<td>Planned to be conducted as RCT, however, only 2 participants enrolled</td>
</tr>
<tr>
<td>Study</td>
<td>Issue Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hitchen 2007</td>
<td>Insufficient data collection (personal communication)</td>
</tr>
<tr>
<td>Hurt 1998</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Lin 2007</td>
<td>Not administered by music therapist</td>
</tr>
<tr>
<td>Magee 2002</td>
<td>Comparative study of 2 music therapy interventions</td>
</tr>
<tr>
<td>Malcolm 2009</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Moon 2008</td>
<td>Not RCT or CCT (personal communication with author's project advisor)</td>
</tr>
<tr>
<td>Nayak 2000</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td></td>
<td>People were assigned to music therapy group individually or groups of varying sizes</td>
</tr>
<tr>
<td></td>
<td>as this was the only way they were available to the researchers, compromising</td>
</tr>
<tr>
<td></td>
<td>the randomization procedures (personal communication)</td>
</tr>
<tr>
<td>Prassas 1997</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Purdie 1997</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Studebaker 2007</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Särkämö 2008</td>
<td>Not music therapy as defined by authors of this review</td>
</tr>
<tr>
<td></td>
<td>Participants listened to prerecorded music without music therapist present</td>
</tr>
<tr>
<td>Thaut 1992</td>
<td>Control participants were normal people</td>
</tr>
<tr>
<td>Thaut 1993</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Thaut 1997b</td>
<td>Not RCT or CCT</td>
</tr>
<tr>
<td>Thaut 1999</td>
<td>Not RCT or CCT</td>
</tr>
</tbody>
</table>

CCT: controlled clinical trial  
RCT: randomized controlled trial

**Characteristics of studies awaiting assessment**  
*ordered by study ID*

**Eslinger 1997**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>Randomized controlled trial</td>
</tr>
<tr>
<td>Participants</td>
<td>Brain-injured patients</td>
</tr>
<tr>
<td>Study</td>
<td>Intervention Details</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Eslinger 1997 (Continued) | Music therapy group: 20 active music therapy sessions over 10 weeks  
Control group: social support group sessions | Self-perceived competency, emotional empathy, cognitive empathy, social-emotional perception, depression and emotional expression | Study results have not been published  
We have requested additional study details and data from the authors  
This information could not be provided at this time but will be provided for the update of this review |

**Characteristics of ongoing studies (ordered by study ID)**

**Ala-Ruona 2010**

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>Examining the effects of active music therapy on post-stroke recovery: a randomised controlled cross-over trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>Randomized controlled cross-over trial; computer generated randomization</td>
</tr>
<tr>
<td>Participants</td>
<td>45 stroke patients</td>
</tr>
</tbody>
</table>
| Interventions       | Music therapy condition: 2 (60-minute) weekly sessions of active music therapy in individual setting over a period of 3 months  
The music therapy includes a combination of structured musical exercises with different levels of difficulty, interactive clinical improvisation, rhythmic dynamic playing with changing movement sequences, music assisted relaxation and therapeutic discussion  
Control condition: standard care according to the Finnish Current Care guidelines for stroke |
| Outcomes            | Functional disability and activities of daily living independency (BI), level of impairment (NIHSS), disability grade (mRs), neglect (BIT) and motor function of upper extremity (ARAT) |
| Starting date       |                                                                                                              |
| Contact information | Professor Esa Ala-Ruona  
Email: esa.aluona@jyu.fi                                                                 |

**Breitenfeld 2005**

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>Is there a benefit for aphasic stroke patients treated with music therapy?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>Controlled clinical trial: randomization method unknown at this time</td>
</tr>
<tr>
<td>Participants</td>
<td>Aphasic stroke patients</td>
</tr>
</tbody>
</table>
**Breitenfeld 2005  (Continued)**

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Music therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcomes</td>
<td>Speech</td>
</tr>
<tr>
<td>Starting date</td>
<td></td>
</tr>
<tr>
<td>Contact information</td>
<td>Dr Demarin Vida</td>
</tr>
<tr>
<td></td>
<td>Email: <a href="mailto:vida.demarin@zg.t-com.hr">vida.demarin@zg.t-com.hr</a></td>
</tr>
<tr>
<td>Notes</td>
<td>Preliminary results were presented at the 14th European Stroke Conference (30 patients) Authors will provide data as soon as the study is completed</td>
</tr>
</tbody>
</table>

**Magee 2006**

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>Music therapy for adults with acquired brain injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>Validation study of measurement tools for music therapy with adults with acquired brain injury in rehabilitation</td>
</tr>
<tr>
<td>Participants</td>
<td>Adults with acquired brain injury</td>
</tr>
<tr>
<td>Interventions</td>
<td>Music therapy</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Functional outcomes across behavioral, visual, auditory, communication and physical domains</td>
</tr>
<tr>
<td>Starting date</td>
<td></td>
</tr>
<tr>
<td>Contact information</td>
<td>Email: <a href="mailto:drwmagee@rhn.org.uk">drwmagee@rhn.org.uk</a></td>
</tr>
<tr>
<td>Notes</td>
<td>Multisite project validating 2 music therapy measures</td>
</tr>
</tbody>
</table>

ARAT: Action Research Arm Test  
BI: Barthel index  
BIT: Behavioral Inattention Test  
mRS: modified Rankin Scale  
NIHSS: National Institutes of Health Stroke Scale
## DATA AND ANALYSES

### Comparison 1. Music therapy versus control

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Gait velocity</td>
<td>2</td>
<td>98</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>14.32 [10.98, 17.67]</td>
</tr>
<tr>
<td>2 Gait stride length</td>
<td>2</td>
<td>98</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.23 [0.14, 0.32]</td>
</tr>
<tr>
<td>3 Gait cadence</td>
<td>2</td>
<td>98</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>16.71 [3.40, 30.01]</td>
</tr>
<tr>
<td>4 Gait symmetry</td>
<td>2</td>
<td>98</td>
<td>Mean Difference (IV, Fixed, 95% CI)</td>
<td>0.12 [0.09, 0.15]</td>
</tr>
</tbody>
</table>

#### Analysis 1.1. Comparison 1 Music therapy versus control, Outcome 1 Gait velocity.

Review: Music therapy for acquired brain injury  
Comparison: Music therapy versus control  
Outcome: Gait velocity

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference IV/Fixed</th>
<th>95% CI</th>
<th>Weight</th>
<th>Mean Difference IV/Fixed</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thaut 1997</td>
<td>10</td>
<td>10</td>
<td>6.9 %</td>
<td>16.00 [3.24, 28.76]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thaut 2007</td>
<td>43</td>
<td>35</td>
<td>93.1 %</td>
<td>14.20 [10.73, 17.67]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>53</td>
<td>45</td>
<td>100.0 %</td>
<td><strong>14.32 [10.98, 17.67]</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\chi^2 = 0.07$, df = 1 ($P = 0.79$); $I^2 = 0.0$

Test for overall effect: $Z = 8.39$ ($P < 0.00001$)
### Analysis 1.2. Comparison 1 Music therapy versus control, Outcome 2 Gait stride length.

**Review:** Music therapy for acquired brain injury  
**Comparison:** Music therapy versus control  
**Outcome:** Gait stride length

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)[meters]</td>
<td>N</td>
<td>Mean(SD)[meters]</td>
<td>IV, Fixed, 95% CI</td>
</tr>
<tr>
<td>Thaut 1997</td>
<td>10</td>
<td>1 (0.3)</td>
<td>10</td>
<td>0.69 (0.19)</td>
<td></td>
</tr>
<tr>
<td>Thaut 2007</td>
<td>43</td>
<td>0.88 (0.21)</td>
<td>35</td>
<td>0.67 (0.24)</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>53</strong></td>
<td></td>
<td><strong>45</strong></td>
<td></td>
<td><strong>100.0 % 0.23 [0.14, 0.32]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: $\chi^2 = 0.65, df = 1 (P = 0.42); I^2 = 0.0$

Test for overall effect: $Z = 4.85 (P < 0.00001)$

### Analysis 1.3. Comparison 1 Music therapy versus control, Outcome 3 Gait cadence.

**Review:** Music therapy for acquired brain injury  
**Comparison:** Music therapy versus control  
**Outcome:** Gait cadence

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)[steps/min]</td>
<td>N</td>
<td>Mean(SD)[steps/min]</td>
<td>IV(Random, 95% CI)</td>
</tr>
<tr>
<td>Thaut 1997</td>
<td>10</td>
<td>98 (17)</td>
<td>10</td>
<td>90 (16)</td>
<td></td>
</tr>
<tr>
<td>Thaut 2007</td>
<td>43</td>
<td>82 (12.9)</td>
<td>35</td>
<td>60 (9.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>53</strong></td>
<td></td>
<td><strong>45</strong></td>
<td></td>
<td><strong>100.0 % 16.71 [3.40, 30.01]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: $Tau^2 = 67.41; Ch^2 = 3.20; df = 1 (P = 0.07); I^2 = 69$

Test for overall effect: $Z = 2.46 (P = 0.014)$
Analysis 1.4. Comparison 1 Music therapy versus control, Outcome 4 Gait symmetry.

Review: Music therapy for acquired brain injury

Comparison: 1 Music therapy versus control

Outcome: 4 Gait symmetry

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Fixed,95% CI</td>
<td></td>
<td>IV,Fixed,95% CI</td>
</tr>
<tr>
<td>Thaut 1997</td>
<td>10 0.82 (0.14)</td>
<td>10 0.68 (0.23)</td>
<td>2.7 %</td>
<td>0.14 [ -0.03, 0.31 ]</td>
<td></td>
</tr>
<tr>
<td>Thaut 2007</td>
<td>43 0.58 (0.05)</td>
<td>35 0.46 (0.07)</td>
<td>97.3 %</td>
<td>0.12 [ 0.09, 0.15 ]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>53</td>
<td>45</td>
<td>100.0 %</td>
<td>0.12 [ 0.09, 0.15 ]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 0.05, df = 1 (P = 0.82); I² =0.0%

Test for overall effect: Z = 8.68 (P < 0.00001)

APPENDICES

Appendix 1. CENTRAL search strategy

#1 MeSH descriptor Cerebrovascular Disorders explode all trees

#2 (stroke in All Text or poststroke in All Text or post-stroke in All Text or cerebrovasc* in All Text or (brain in All Text and vasc* in All Text) or (cerebral in All Text and vasc* in All Text) or cva* in All Text or apoplex* in All Text or SAH in All Text)

#3 (brain* in All Text or cerebr* in All Text or cerebell* in All Text or intracran* in All Text or intracerebral in All Text)

#4 (ischemi* in All Text or ischaemi* in All Text or infarct* in All Text or thrombo* in All Text or emboli* in All Text or occlus* in All Text)

#5 (#3 and #4)

#6 (brain* in All Text or cerebr* in All Text or cerebell* in All Text or intracerebral in All Text or intracranial in All Text or subarachnoid in All Text)

#7 (haemorrhage* in All Text or hemorrhage* in All Text or haematoma* in All Text or hematoma* in All Text or bleed* in All Text)
<table>
<thead>
<tr>
<th>#</th>
<th>MeSH descriptor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#8</td>
<td>(#6 and #7)</td>
<td></td>
</tr>
<tr>
<td>#9</td>
<td>MeSH descriptor hemiplegia this term only</td>
<td></td>
</tr>
<tr>
<td>#10</td>
<td>MeSH descriptor paresis explode all trees</td>
<td></td>
</tr>
<tr>
<td>#11</td>
<td>(hemipleg* in All Text or hemipar* in All Text or paresis in All Text or paretic in All Text)</td>
<td></td>
</tr>
<tr>
<td>#12</td>
<td>MeSH descriptor aphasia explode all trees</td>
<td></td>
</tr>
<tr>
<td>#13</td>
<td>(aphasi* in All Text or dysphasi* in All Text)</td>
<td></td>
</tr>
<tr>
<td>#14</td>
<td>MeSH descriptor craniocerebral trauma this term only</td>
<td></td>
</tr>
<tr>
<td>#15</td>
<td>MeSH descriptor brain injuries explode all trees</td>
<td></td>
</tr>
<tr>
<td>#16</td>
<td>MeSH descriptor Head Injuries, Closed explode all trees</td>
<td></td>
</tr>
<tr>
<td>#17</td>
<td>MeSH descriptor Intracranial Hemorrhage, Traumatic explode all trees</td>
<td></td>
</tr>
<tr>
<td>#18</td>
<td>MeSH descriptor skull fractures explode all trees</td>
<td></td>
</tr>
<tr>
<td>#19</td>
<td>MeSH descriptor Brain Damage, Chronic this term only</td>
<td></td>
</tr>
<tr>
<td>#20</td>
<td>MeSH descriptor Brain Injury, Chronic this term only</td>
<td></td>
</tr>
<tr>
<td>#21</td>
<td>MeSH descriptor brain stem explode all trees with qualifiers: IN</td>
<td></td>
</tr>
<tr>
<td>#22</td>
<td>MeSH descriptor cerebellum explode all trees with qualifiers: IN</td>
<td></td>
</tr>
<tr>
<td>#23</td>
<td>(head in All Text or brain* in All Text or cerebral in All Text or cranial in All Text or craniocerebral in All Text or skull in All Text)</td>
<td></td>
</tr>
<tr>
<td>#24</td>
<td>(injur* in All Text or trauma* in All Text or damage* in All Text)</td>
<td></td>
</tr>
<tr>
<td>#25</td>
<td>(#23 and #24)</td>
<td></td>
</tr>
<tr>
<td>#26</td>
<td>(diffuse in All Text and axonal in All Text and injur* in All Text)</td>
<td></td>
</tr>
<tr>
<td>#27</td>
<td>MeSH descriptor anoxia this term only</td>
<td></td>
</tr>
<tr>
<td>#28</td>
<td>MeSH descriptor encephalitis explode all trees</td>
<td></td>
</tr>
<tr>
<td>#29</td>
<td>MeSH descriptor meningitis explode all trees</td>
<td></td>
</tr>
<tr>
<td>#30</td>
<td>MeSH descriptor brain neoplasms explode all trees</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2. MEDLINE search strategy

MEDLINE (Ovid)
1. cerebrovascular disorders/ or exp basal ganglia cerebrovascular disease/ or exp brain ischemia/ or exp carotid artery diseases/ or cerebrovascular accident/ or exp brain infarction/ or exp cerebrovascular trauma/ or exp hypoxia-ischemia, brain/ or exp intracranial arterial diseases/ or intracranial arteriovenous malformations/ or exp “Intracranial Embolism and Thrombosis”/ or exp intracranial hemorrhages/ or vasospasm, intracranial/ or vertebral artery dissection/ 2. (stroke or poststroke or post-stroke or cerebrovasc$ or brain vasc$ or cerebral vasc$ or cva$ or apoplex$ or SAH).tw.
3. ((brain$ or cerebr$ or cerebell$ or intracran$ or intracerebral) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw.
4. ((brain$ or cerebr$ or cerebell$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage$ or hemorrhage$ or haematoma$ or hematoma$ or bleed$)).tw.
5. hemiplegia/ or exp paresis/
6. (hemipleg$ or hemipar$ or paresis or paretic).tw.
7. exp aphasia/
8. (aphasi$ or dysphasi$).tw.

Music therapy for acquired brain injury (Review)
Copyright © 2010 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
9. craniocerebral trauma/ or exp brain injuries/ or exp head injuries, closed/ or exp intracranial hemorrhage, traumatic/ or exp skull fractures/
10. brain damage, chronic/ or brain injury, chronic/
11. exp brain stem/in or exp cerebellum/in
12. ((head or brain$ or cerebral or cranial or craniocerebral or skull) adj5 (injur$ or trauma$ or damage$)).tw.
13. diffuse axonal injur$.tw.
14. anoxia/ or exp encephalitis/ or exp meningitis/ or exp brain neoplasms/
15. (anoxi$ or hypoxi$ or encephalit$ or meningit$).tw.
16. (brain or cereb$) and (neoplasm$ or lesion$ or tumor$ or tumour$).tw.
17. or/1-16
18. music/ or music therapy/ or acoustic stimulation/
19. (music$ or rhythmic$ or melod$).tw.
20. (auditory or acoustic) adj5 (stimulat$ or cue$)).tw.
21. (sing or sings or singing or song$ or compose or composing or improvis$).tw.
22. or/18-21
23. Randomized Controlled Trials/
24. random allocation/
25. Controlled Clinical Trials/
26. control groups/
27. clinical trials/
28. double-blind method/
29. single-blind method/
30. Placebos/
31. placebo effect/
32. cross-over studies/
33. Multicenter Studies/
34. Therapies, Investigational/
35. Research Design/
36. Program Evaluation/
37. evaluation studies/
38. randomized controlled trial.pt.
39. controlled clinical trial.pt.
40. clinical trial.pt.
41. multicenter study.pt.
42. evaluation studies.pt.
43. random$tw.
44. (controlled adj5 (trial$ or stud$)).tw.
45. (clinical$ adj5 trial$).tw.
46. ((control or treatment or experiment$ or intervention) adj5 (group$ or subject$ or patient$)).tw.
47. (quasi-random$ or quasi random$ or pseudo-random$ or pseudo random$).tw.
48. ((multicenter or multicentre or therapeutic) adj5 (trial$ or stud$)).tw.
49. ((control or experimental or conservative) adj5 (treatment or therapy or procedure or manage$)).tw.
50. ((singl$ or doubl$ or tripl$ or trebl$) adj5 (blind$ or mask$)).tw.
51. (coin adj5 (flip or flipped or toss$)).tw.
52. latin square.tw.
53. versus.tw.
54. (cross-over or cross over or crossover).tw.
55. placebo$tw.
56. sham.tw.
57. (assign$ or alternate or allocat$ or counterbalance$ or multiple baseline).tw.
58. controls.tw.
59. (treatment$ adj6 order).tw.
60. journal of music therapy.jn.
Appendix 3. Embase search strategy

1. CEREBROVASCULAR-DISEASE#.DE. 127204
2. BASAL-GANGLION#.DE. 7146
3. BRAIN-ISCHEMIA#.DE. 27862
4. CAROTID-ARTERY-DISEASE#.DE. 13288
5. CEREBROVASCULAR-ACCIDENT#.DE. 15445
6. BRAIN-HYPOXIA#.DE. 3930
7. BRAIN-ARTERIOVENOUS-MALFORMATION#.DE. 1883
8. BRAIN-EMBOLISM#.DE. 2186
9. THROMBOSIS#.W..DE. 60661
10. 8 AND 9 262
11. BRAIN-HEMORRHAGE#.DE. 23280
12. BRAIN-VASOSPASM#.DE. 1756
13. ARTERY-DISSECTION#.DE. 2636
14. BRAIN#.W..DE. 265092
15. 13 AND 14 334
16. VERTEBRAL-ARTERY#.DE. 2779
17. ARTERY-DISSECTION#.DE. 2636
18. 16 AND 17 419
19. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 10 OR 11 OR 12 OR 15 OR 18 135371
20. (STROKE OR POSTSTROKE OR POST-STROKE).TLAB. 55444
21. (CEREBROVASC#5 OR BRAIN ADJ VASC#5 OR CEREBRAL ADJ VASC#5 OR CV A#1 OR APOPLEX#2 OR SAH).TLAB. 18086
22. 20 OR 21 69383
23. BRAIN$1 OR CEREB$3 OR CEREBELL$2 OR INTRACRAN$3 OR INTRACEREBRAL$3 OR INTRACEREBRAL$3 OR INTRACRANIAL$3 OR SUBARACHNOID$3).TLAB. 461900
24. 23.TLAB. 311588
25. (ISCH$5 OR CMA OR INFARCT$3 OR THROMBOS$3 OR EMBOLISS1 OR OCCLUS$3).TLAB. 216016
26. 24 NEAR 25 27603
27. (BRAIN$1 OR CEREBR$3 OR CEREBELL$3 OR INTRACEREBRAL OR INTRACRANIAL OR SUBARACHNOID).TLAB. 314775
28. (HAEOMORRHAGES1 OR HEMORRHAGES1 OR HAEMATOMAS1 OR HEMATOMAS1 OR BLEEDS3).TLAB. 90167
29. 27 NEAR 28 15381
30. HEMIPELAGIA#.W..DE. 3127
31. PARESIS#.W..DE. 1597
32. 30 OR 31 4672
33. (HEMIPLEG$2 OR HEMIPAR$4 OR PARESIS OR PARETIC).TLAB. 8703
34. APHASIA#.W..DE. 5128
35. (APHASIS1 OR DYSPHASIS1).TLAB. 4272
36. HEAD-INJURY#.DE. 58268
37. BRAIN-INJURY#.DE. 35070
38. BRAIN-HEMORRHAGE#.DE. 23280
39. SKULL- FRACTURE#.DE. OR TRAUMATIC-BRAIN-INJURY#.DE. 5646
40. 36 OR 37 OR 38 OR 39 78916
41. BRAIN ADJ DAMAGE ADJ CHRONIC 7
42. BRAIN ADJ STEM 16877
43. BRAIN-STEM#.DE. 43572
44. CEREBELLUM 24297

Music therapy for acquired brain injury (Review)

Copyright © 2010 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
Music therapy for acquired brain injury (Review)
Music therapy for acquired brain injury (Review)

Copyright © 2010 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

107 INVESTIGATIONAL ADJ THERAPY 106
108 (INVESTIGATION ADJ THERAPY).TLAB. 134
111 (RESEARCH ADJ DESIGN).TLAB. 6513
114 (PROGRAM ADJ EVALUATION).TLAB. 848
115 (EVALUATION ADJ STUDIES OR EVALUATION ADJ STUDY).TLAB. 1440
116 (MULTICENTRE ADJ STUDY).TLAB. 9887
117 RANDOM$4.TI,AB. 272854
118 (CONTROLLED NEAR TRIALS1 OR STUDY$3).TLAB. 2227101
119 (CLINICAL NEAR TRIALS1 OR STUDY$3).TLAB. 2264572
120 (CLINICAL NEAR TRIALS1).TLAB. 88793
121 (CONTROL OR TREATMENT OR EXPERIMENT$3 OR INTERVENTION).TLAB 1911277
122 (GROUPS1 OR SUBJECTS1 OR PATIENTS1).TLAB. 2143855
123 (121 NEAR 122).TLAB. 452104
124 (QUASI-RANDOM$4 OR QUASI ADJ RANDOM$4 OR PSEUDO-RANDOM$4 OR PSEUDO ADJ RANDOM$4).TLAB. 203
125 (MULTICENTER OR MULTICENTRE OR THERAPEUTIC).TLAB. 252037
126 (TRIALS1 OR STUDY$3).TLAB. 2321790
127 (MULTICENTER OR MULTICENTRE OR THERAPEUTIC).TLAB. 252031
128 (127 NEAR 126).TLAB. 41906
129 (CONTROL OR EXPERIMENT$3 OR CONSERVATIVE).TLAB. 1033345
130 (TREATMENT OR THERAPY OR PROCEDURE OR MANAGES4).TLAB. 1542337
131 (129 NEAR 130).TLAB. 65544
132 (SINGLES1 OR DOUBLES1 OR TRIPLES1 OR TREATMENTS1).TLAB. 465484
133 (BLINDS2 OR MASKS2).TLAB. 94835
134 (132 NEAR 133).TLAB. 57683
135 (FLIP OR FLIPPED OR TOSS$2).TLAB. 2874
136 COIN.TLAB. 807
137 (136 NEAR 135).TLAB. 42
138 (LATIN ADJ SQUARE).TLAB. 536
139 VERSUS.TLAB. 155325
140 (CROSS-OVER OR CROSS ADJ OVER OR CROSSOVER).TLAB. 23436
141 PLACEBO$1.TLAB. 70826
142 SHAM.TLAB. 21506
143 (ASSIGNS2 OR ALTERNATE OR ALLOCAT$3 OR COUNTERBALANCES1 OR MULTIPLE ADJ BASELINE).TLAB. 93768
144 CONTROLS.TLAB. 702865
145 (TREATMENTS1 NEAR ORDER).TLAB. 5973
146 (JOURNAL ADJ OF ADJ MUSIC ADJ THERAPY).SO. 0
147 138 OR 139 OR 140 OR 141 OR 142 250805
148 (138 OR 139 OR 140 OR 141 OR 142).TLAB. 250805
149 (144 OR 146 OR 146).TLAB. 702865
150 99 OR 100 OR 101 OR 103 OR 108 OR 114 OR 115 OR 116 OR 118 OR 123 OR 128 OR 131 OR 143 OR 137 OR 148 OR 149 2844110
151 150.TLAB. 2704175
152 67 AND 76 AND 151 990
153 152 AND HUMAN=YES 635
Appendix 4. CINAHL search strategy

Database: CINAHL - Cumulative Index to Nursing & Allied Health Literature, 1982 to March 2010; EBSCO

S38 .S28 and S37
S37 .S29 or S30 or S31 or S32 or S35 or S36
S36 .TI ( sing or sings or singing or song* or compose or composing or improvis* ) or AB ( sing or sings or singing or song* or compose or composing or improvis*)
S35 .S33 and S34
S34 .TI ( stimulat* or cue* ) or AB ( stimulat* or cue* )
S33 .TI ( auditory or acoustic ) or AB ( auditory or acoustic )
S32 .TI ( music* or rhythmic* or melod* ) or AB ( music* or rhythmic* or melod* )
S31 .(MH "Singing")
S30 .(MH "Acoustic Stimulation")
S29 .(MH "Music") or (MH "Music Therapy") or (MH "Music Therapy (IowaNIC)") or (MH "Performing Artists") or (MH "Performing Arts")
S28 .S1 or S2 or S5 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S27 S27 .S25 and S26
S26 .TI ( neoplasm* or lesion* or tumor* or tumour* ) or AB ( neoplasm* or lesion* or tumor* or tumour* )
S25 .TI ( brain or cereb* ) or AB ( brain or cereb* )
S24 .TI ( anoxi* or hypoxi* or encephalit* or meningit* ) or AB ( anoxi* or hypoxi* or encephalit* or meningit* )
S23 .(MH "Brain Neoplasms+")
S22 .(MH "Meningitis+")
S21 .(MH "Encephalitis+")
S20 .(MH "Anoxia")
S19 .TI diffuse axonal injur* or AB diffuse axonal injur*
S18 .S16 and S17
S17 .TI ( injur* or trauma* or damage* ) or AB ( injur* or trauma* or damage* )
S16 .TI ( head or brain* or cerebral or cranial or craniocerebral or skull ) or AB ( head or brain* or cerebral or cranial or craniocerebral or skull )
S15 .(MH "Brain Stem/IN") or (MH "Cerebellum/IN")
S14 .(MH "Brain Damage, Chronic")
S13 .(MH "Head Injuries+")
S12 .TI ( aphasi* or dysphasi* ) or AB ( aphasi* or dysphasi* )
S11 .(MH "Aphasias")
S10 .TI ( hemipleg* or hemipar* or paresis or paretic ) or AB ( hemipleg* or hemipar* or paresis or paretic )
S9 .(MH "Hemiplegia")
S8 .S6 and S7
S7 .TI ( haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed* ) or AB ( haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed* )
S6 .TI ( brain* or cereb* or cerebell* or intracerebral or intracranial or subarachnoid ) or AB ( brain* or cereb* or cerebell* or intracerebral or intracranial or subarachnoid )
S5 .S3 and S4
S4 .TI ( ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus* ) or AB ( ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus* )
S3 .TI ( brain* or cereb* or cerebell* or intracran* or intracerebral ) or AB ( brain* or cereb* or cerebell* or intracran* or intracerebral )
S2 .TI ( stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex or SAH ) or AB ( stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex or SAH )
S1 .(MH "Cerebrovascular Disorders+") or (MH "stroke patients") or (MH "stroke units")
Appendix 5. PsycINFO search strategy

Database: PsycINFO; 1806 to July Week 4 2009

1 Music/ (7866)
2 Music Therapy/ (2235)
3 exp Auditory Stimulation/ or acoustic stimulation.mp. (19648)
4 (music$ or rhythmic$ or melod$).tw. (25383)
5 ((auditory or acoustic) adj5 (stimulat$ or cue$)).tw. (4605)
6 (sing or sings or singing or song$. or compose or composing or improvis$).tw. (9531)
7 or/1-6 (52839)
8 cerebrovascular disorders/ or exp cerebral ischemia/ or exp carotid arteries/ or cerebrovascular accident/ or exp brain damage/ or exp embolisms/ or exp cerebral hemorrhage/ or aneurysms/ (29149)
9 (stroke or poststroke or post-stroke or cerebrovascular$ or brain vascular$ or cerebral vas$ or cva$ or apoplexy$ or SAH).tw. (12629)
10 ((brain$ or cerebr$ or cerebell$ or intracran$ or intracerebral) adj5 (isch$emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw. (2795)
11 ((brain$ or cerebr$ or cerebell$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage$ or hemorrhage$ or haematoma$ or hematoma$ or bleed$)).tw. (1149)
12 hemiplegia/ (592)
13 exp paresis/ (126)
14 (hemipleg$ or hemipar$ or paresis or parietic).tw. (2942)
15 exp aphasia/ (12045)
16 (aphasi$ or dysphasi$).tw. (9512)
17 exp head injuries/ (3939)
18 exp Brain Damage/ (20526)
19 ((head or brain$ or cerebral or cranial or craniocerebral or skull) adj5 (injur$ or trauma$ or damage$)).tw. (25819)
20 diffuse axonal injur$.tw. (99)
21 exp ANOXIA/ (1219)
22 exp encephalitis/ (1000)
23 exp meningitis/ (252)
24 exp brain neoplasms/ (899)
25 (anoxi$ or hypoxi$ or encephaliti$ or meningiti$).tw. (5125)
26 ((brain or cerebr$) and (neoplasm$ or lesion$ or tumor$ or tumour$)).tw. (16302)
27 or/8-26 (72335)
28 empirical study.md. (1177004)
29 followup study.md. (31660)
30 longitudinal study.md. (57905)
31 prospective study.md. (9953)
32 quantitative study.md. (396174)
33 “2000”.md. ( Treatment Outcome/Randomized Clinical Trial ) (14862)
34 treatment effectiveness evaluation/ (10973)
35 exp hypothesis testing/ (1992)
36 repeated measures/ (449)
37 exp experimental design/ (40424)
38 placebo$.ti,ab. (22661)
39 random$.ti,ab. (82864)
40 (clin$ adj25 trial$).ti,ab. (14727)
41 (((sing$ or double$ or treble$ or triplet$) adj (blind$ or mask$)).ti,ab. (13966)
42 or/28-41 (1225715)
43 7 and 27 and 42 (874)
44 limit 43 to human (798)
45 (infant$ or neonat$ or child$).tw. (455254)
46 44 not 45 (635)

Music therapy for acquired brain injury (Review)

Copyright © 2010 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
Appendix 6. LILACS search strategy

((([MH] (music$)) or ((music and therapy))) or ((([MH]“MUSIC THERAPY”) ) or (((rhythmic and auditory and stimulation))) or 
(([MH] (“auditory stimulation”)) AND or ((singing or song$)) AND Group=Humans (313)

Appendix 7. AMED search strategy

Database: AMED (Allied and Complementary Medicine) 1985 to August 2009
1 music/ or music therapy/ or acoustic stimulation/ (540)
2 (music$ or rhythmic$ or melod$).tw. (1145)
3 (auditory or acoustic) adj5 (stimulat$ or cue$).tw. (86)
4 (sing or sings or singing or song$ or compose or composing or improvis$).tw. (205)
5 4 or 1 or 3 or 2 (1354)
6 exp Cerebral ischemia/ (102)
7 exp Cerebrovascular disorders/ (5456)
8 carotid artery diseases.mp. (2)
9 exp Cerebrovascular accident/ (1505)
10 brain infarction.mp. (12)
11 exp Brain injuries/ (3171)
12 (stroke or poststroke or post-stroke or cerebrovasc$ or brain vasc$ or cerebral vasc$ or cva$ or apoplex$ or SAH).tw. (6235)
13 ((brain$ or cerebr$ or cerebell$ or intracran$ or intracerebral) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw. 
(447)
14 ((brain$ or cerebr$ or cerebell$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage$ or hemorrhage$ or 
haematoma$ or hemotoma$ or bleed$)).tw. (188)
15 hemiplegia/ or exp paresis/ (956)
16 (hemipleg$ or hemipar$ or paresis or paretic).tw. (1925)
17 (aphasi$ or dysphasi$).tw. (587)
18 exp aphasia/ (408)
19 brain damage.mp. (220)
20 ((head or brain$ or cerebral or cranial or craniocerebral or skull) adj5 (injur$ or trauma$ or damage$)).tw. (4671)
21 diffuse axonal injur$.tw. (21)
22 exp Anoxia/ (109)
23 exp Encephalitis/ (22)
24 exp Meningitis/ (27)
25 exp Brain neoplasms/ (118)
26 (anoxi$ or hypoxi$ or encephalit$ or meningiti$).tw. (374)
27 ((brain or cereb$) and (neoplasm$ or lesion$ or tumor$ or tumour$)).tw. (786)
28 or/6-27 (12769)
29 Randomized controlled trials/ (1357)
30 random allocation/ (288)
31 clinical trials/ (1625)
32 Double blind method/ (389)
33 single-blind method/ (1)
34 Placebos/ (504)
35 Research Design/ (1640)
36 Program Evaluation/ (1766)
37 randomized controlled trial.pt. (1384)
38 controlled clinical trial.pt. (69)
39 clinical trial.pt. (1103)
40 multicenter study.pt. (233)
41 evaluation studies.pt. (103)
42 random$.tw. (10474)
43 (controlled adj5 (trial$ or stud$)).tw. (5636)
Appendix 8. Science Citation Index search strategy

<table>
<thead>
<tr>
<th>#</th>
<th>Term</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>94 AND 45 AND 11</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>&gt;100,000</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>&gt;100,000</td>
<td>TS=((control* or prospectiv* or volunteer*))</td>
</tr>
<tr>
<td>56</td>
<td>2,536</td>
<td>TS=((prospective stud*))</td>
</tr>
<tr>
<td>55</td>
<td>6,024</td>
<td>TS=((follow up stud*))</td>
</tr>
<tr>
<td>54</td>
<td>9,689</td>
<td>TS=((evaluation stud*))</td>
</tr>
<tr>
<td>53</td>
<td>41,459</td>
<td>TS=((comparative study))</td>
</tr>
<tr>
<td>52</td>
<td>78,169</td>
<td>TS=((random*))</td>
</tr>
<tr>
<td>51</td>
<td>15,695</td>
<td>TS=((placebo*))</td>
</tr>
<tr>
<td>50</td>
<td>25,464</td>
<td>TS=((Clinical trial*))</td>
</tr>
<tr>
<td>49</td>
<td>548</td>
<td>TS=((single blind method*))</td>
</tr>
<tr>
<td>48</td>
<td>4,496</td>
<td>TS=((double blind method*))</td>
</tr>
<tr>
<td>47</td>
<td>16,727</td>
<td>TS=((Randomized controlled trial*))</td>
</tr>
<tr>
<td>45</td>
<td>24,620</td>
<td>#44 OR #43 OR #42 OR #41 OR #40 OR #39 OR #38 OR #37 OR #36 OR #35 OR #34 OR #33 OR #32 OR #31 OR #30 OR #29 OR #28 OR #27 OR #26 OR #25 OR #24 OR #23 OR #22 OR #21 OR #20 OR</td>
</tr>
<tr>
<td>#</td>
<td>TS</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>#44</td>
<td>#19 OR #18 OR #17 OR #16 OR #15 OR #14 OR #13 OR #12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,467 (anoxi* or hypoxi* or encephalit* or meningit*)</td>
<td></td>
</tr>
<tr>
<td>#43</td>
<td>1,407 (anoxia or encephalitis or meningitis or brain neoplasm*)</td>
<td></td>
</tr>
<tr>
<td>#42</td>
<td>99 (diffuse axonal injur*)</td>
<td></td>
</tr>
<tr>
<td>#41</td>
<td>466 (chronic brain injury)</td>
<td></td>
</tr>
<tr>
<td>#40</td>
<td>332 (chronic brain damage)</td>
<td></td>
</tr>
<tr>
<td>#39</td>
<td>81 (skull fractures)</td>
<td></td>
</tr>
<tr>
<td>#38</td>
<td>7 (traumatic intracranial haemorrhage)</td>
<td></td>
</tr>
<tr>
<td>#37</td>
<td>19 (traumatic intracranial hemorrhage)</td>
<td></td>
</tr>
<tr>
<td>#36</td>
<td>1,607 (closed head injur*)</td>
<td></td>
</tr>
<tr>
<td>#35</td>
<td>1,337 (brain injuries)</td>
<td></td>
</tr>
<tr>
<td>#34</td>
<td>45 (craniocerebral trauma)</td>
<td></td>
</tr>
<tr>
<td>#33</td>
<td>6,984 (aphasi* or dysphasi*)</td>
<td></td>
</tr>
<tr>
<td>#32</td>
<td>5,368 (Aphasia)</td>
<td></td>
</tr>
<tr>
<td>#31</td>
<td>240 (hemiplegi<em>or hemipar</em> or paresis or paretic)</td>
<td></td>
</tr>
<tr>
<td>#30</td>
<td>27 (intracranial haemorrhage)</td>
<td></td>
</tr>
<tr>
<td>#29</td>
<td>12,095 (stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc* or cva* or apoplex* or SAH)</td>
<td></td>
</tr>
<tr>
<td>#28</td>
<td>1 (intracranial artery dissection)</td>
<td></td>
</tr>
<tr>
<td>#27</td>
<td>2 (vertebral artery dissection)</td>
<td></td>
</tr>
<tr>
<td>#26</td>
<td>8 (intracranial vasospasm*)</td>
<td></td>
</tr>
<tr>
<td>#25</td>
<td>150 (intracranial hemorrhage*)</td>
<td></td>
</tr>
<tr>
<td>#24</td>
<td>10 (intracranial Thrombosis*)</td>
<td></td>
</tr>
<tr>
<td>#23</td>
<td>5 (intracranial Embolism*)</td>
<td></td>
</tr>
</tbody>
</table>
Continued

<table>
<thead>
<tr>
<th>#</th>
<th>#</th>
<th>TS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>TS=</td>
<td>((intracranial arteriovenous malformation*))</td>
</tr>
<tr>
<td>11</td>
<td>TS=</td>
<td>((intracranial arterial disease*))</td>
</tr>
<tr>
<td>12</td>
<td>TS=</td>
<td>((hypoxia-ischemia))</td>
</tr>
<tr>
<td>13</td>
<td>TS=</td>
<td>((cerebrovascular trauma))</td>
</tr>
<tr>
<td>14</td>
<td>TS=</td>
<td>((brain infarction))</td>
</tr>
<tr>
<td>15</td>
<td>TS=</td>
<td>((cerebrovascular accident))</td>
</tr>
<tr>
<td>16</td>
<td>TS=</td>
<td>((carotid artery disease*))</td>
</tr>
<tr>
<td>17</td>
<td>TS=</td>
<td>((brain ischemia))</td>
</tr>
<tr>
<td>18</td>
<td>TS=</td>
<td>((basal ganglia cerebrovascular disease))</td>
</tr>
<tr>
<td>19</td>
<td>TS=</td>
<td>((cerebrovascular disorder*))</td>
</tr>
<tr>
<td>20</td>
<td>TS=</td>
<td>((cerebral vascular accident))</td>
</tr>
<tr>
<td>21</td>
<td>TS=</td>
<td>((melodic intonation therapy))</td>
</tr>
<tr>
<td>22</td>
<td>TS=</td>
<td>((sing OR singing OR song OR sings OR improvis*))</td>
</tr>
<tr>
<td>23</td>
<td>TS=</td>
<td>((acoustic cue*))</td>
</tr>
<tr>
<td>24</td>
<td>TS=</td>
<td>((auditory cue*))</td>
</tr>
<tr>
<td>25</td>
<td>TS=</td>
<td>((auditory stimulat*))</td>
</tr>
<tr>
<td>26</td>
<td>TS=</td>
<td>((acoustic stimulat*))</td>
</tr>
<tr>
<td>27</td>
<td>TS=</td>
<td>((acoustic stimulation))</td>
</tr>
<tr>
<td>28</td>
<td>TS=</td>
<td>((rhythmic* OR melod* OR music*))</td>
</tr>
<tr>
<td>29</td>
<td>TS=</td>
<td>(music)</td>
</tr>
<tr>
<td>30</td>
<td>TS=</td>
<td>(music therapy)</td>
</tr>
</tbody>
</table>
Appendix 9. CAIRSS search strategy

2. Brain damage [as a phrase] OR cerebral trauma [as a phrase] OR brain neoplasm? [as a phrase] (61)
4. cerebrovascular disorder? [as a phrase] OR brain ischemia [as a phrase] OR cerebrovascular accident [as a phrase] (3)
5. intracranial hemorrhage? [as a phrase] OR stroke OR poststroke (17)
6. post-stroke [as a phrase] OR cva OR cereb? Thrombosis [as a phrase] (15)
7. brain thrombosis [as a phrase] OR brain embolism [as a phrase] (0)
8 hemiplegi? OR paresis OR paretic (1)
9. Aphasi? OR dysphasi? (61)

Appendix 10. Proquest Digital Dissertations search strategy

(music) OR ((music therapy)) OR ((rhythmic auditory stimulation)) OR ((acoustic stimulation)) OR ((rhythmic auditory cueing)) OR ((auditory stimulation)) AND (stroke OR head OR brain OR intracranial OR cerebrovascular) (543)

Appendix 11. ClinicalTrials.gov search strategy

music OR (music therapy) OR singing OR song OR songs OR (rhythmic auditory stimulation) OR (rhythmic auditory cueing) OR (acoustic stimulation) OR (acoustic cueing) OR melody OR melodic (247)

Appendix 12. Current Controlled Trials search strategy

music OR (music therapy) (26)

Appendix 13. National Research Register search strategy

(music OR (music therapy) OR (rhythmic auditory stimulation) OR (rhythmic auditory cueing) OR (acoustic stimulation) OR (acoustic cueing) OR melodic) AND (stroke OR poststroke OR cerebrovascular OR (brain ischemia) or (brain infarction) OR (brain injur$) OR intracranial OR aphasi$ OR dysphasi$ OR hemiplegi$ OR paretic OR paresis OR (head injur$) OR (brain trauma) OR (brain damage) OR encephalitis OR meningitis OR (brain tumor) OR (brain neoplasm) OR (brain tumour)) (145)

Appendix 14. Rehab Trials.org

music (0)
music therapy (0)
rhythmic (0)
Auditory stimulation (0)
Acoustic stimulation (0)
Melodic (0)
Appendix 15. Indexes to Theses

(music OR (music therapy) OR (rhythmic auditory stimulation) OR (rhythmic auditory cueing) OR (acoustic stimulation) OR (acoustic cueing) OR melodic) AND (stroke OR poststroke OR cerebrovascular OR (brain ischemia) or (brain infarction) OR (brain injur$) OR intracranial OR aphas$i OR dysphas$i OR hemiplegi$s OR paretic OR paresis OR (head injur$s) OR (brain trauma) OR (brain damage) OR encephalitis OR meningitis OR (brain tumor) OR (brain neoplasm) OR (brain tumour)) (1) (music OR (music therapy) OR (rhythmic auditory stimulation) OR (rhythmic auditory cueing) OR (acoustic stimulation) OR (acoustic cueing) OR melodic) AND (stroke OR brain OR head OR cerebrovascular OR intracranial) (14)

Appendix 16. The Specialist Music Therapy Research Database

The database is no longer functional. However, archives of dissertations and conference proceedings were handsearched

HISTORY

Review first published: Issue 7, 2010

10 July 2008 Amended Converted to new review format.

CONTRIBUTIONS OF AUTHORS

Protocol
- Background, objectives, criteria for considering studies: Bradt, Magee, Dileo, Wheeler (approved by McGilloway)
- Search strategies, methods: Bradt (reviewed and approved by Magee, Dileo, Wheeler, McGilloway).

Review
- Searches: Bradt, Wheeler, Magee, McGilloway
- Trials selection: Magee, Bradt, Wheeler (Dileo, in case of disagreement)
- Interrater reliability (trial selection): Bradt
- Development of coding form: Bradt
- Data extraction: Bradt and trained research assistant
- Quality assessment of trials: Bradt and Dileo
- Data entry: Bradt
- Data analysis: Bradt and Dileo
DECLARATIONS OF INTEREST
Four of the review authors (JB, CD, WM, BW) are music therapists. Wendy Magee is involved in the design, conduct and publication of studies, of which one (Magee 2006) it is currently in the Ongoing studies section. Barbara Wheeler was involved in one study that was considered for this review (Nayak 2000), but it was subsequently excluded.

SOURCES OF SUPPORT

Internal sources
• No sources of support supplied

External sources
• State of Pennsylvania Formula Fund, USA.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW
The following journal was added for the handsearching: Japanese Journal of Music Therapy.