Music for Pain and Anxiety in Children Undergoing Medical Procedures: A Systematic Review of Randomized Controlled Trials

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Objective.—The aim of this study was to conduct a systematic review of the efficacy of music therapy (MT) on pain and anxiety in children undergoing clinical procedures.

Methods.—We searched 16 electronic databases of published and unpublished studies, subject bibliographies, reference lists of relevant articles, and trials registries. Two reviewers independently screened 4559 citations and reviewed the full manuscript of 393 studies. Nineteen studies met the inclusion criteria: randomized controlled trial, children aged 1 month to 18 years were examined, music was used as an intervention, and the study measured pain or anxiety. Music therapy was considered active if a music therapist was involved and music was used as a medium for interactive communication. Passive music therapy was defined as listening to music without the involvement of a music therapist.

Results.—The 19 included trials involved 1513 subjects. The methodological quality of the studies was generally poor. Overall, MT showed a significant reduction in pain and anxiety (standardized mean difference [SMD] −0.35; 95% confidence interval [CI], −0.55 to −0.14; 9 studies; N = 704; $I^2 = 42\%$). When analyzed by outcome, MT significantly reduced anxiety (SMD −0.39; 95% CI, −0.76 to −0.03; 5 studies; n = 284; $I^2 = 52.4\%$) and pain (SMD −0.39; 95% CI, −0.66 to −0.11; 5 studies; N = 465; $I^2 = 49.7\%$). There was no evidence of publication bias.

Conclusions.—Music is effective in reducing anxiety and pain in children undergoing medical and dental procedures. Music can be considered an adjunctive therapy in clinical situations that produce pain or anxiety.

KEY WORDS: meta-analysis; music; music therapy; pediatrics; systematic review

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Interventions aimed at improving the health and well-being of children may also cause pain and anxiety. Inadequate pain control during medical procedures can have long-term detrimental effects, especially among very young children.[1] Moreover, children with less anxiety are easier to manage in a clinical setting.[2] Pharmacotherapy has been shown to be effective in reducing some of the pain and anxiety associated with medical procedures but it may come with worrisome side effects.

Music has the potential to obviate or decrease the need for pharmacotherapy. The effects of music on human emotional and physiological responses have been observed.[3] Music can ease pain and anxiety by moving conscious thought away from the symptoms. According to the gate control theory of pain, pain receptors act together to send pain signals to the brain, therefore distractors such as music can block certain pain pathways and diminish the amount of perceived pain.[4] Sessions led by music therapists allow the individual to express feelings of pain and anxiety in healthy ways, such as through improvised songs and playing instruments.[5]

A recent meta-analysis examined the effectiveness of music for pain relief.[6] Although it demonstrated a statistically positive effect in terms of reduced pain and the amount of opioids required, the authors questioned the clinical importance of the findings. The authors recommended further research, specifically evaluating the effect of music therapy (MT) on anxiety. Pain and anxiety are intrinsically linked, as children with higher levels of anxiety will perceive higher levels of pain,[1] and conversely, pain or fear of pain may result in higher anxiety.[7]

The objective of this study was to systematically review the evidence of the effects of active and passive MT on children undergoing painful and anxiety-inducing clinical procedures.

METHODS

Search Strategy

A research librarian developed comprehensive search strategies to identify published studies in MEDLINE, Education Resources Information Center, the Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Online Computer Library Center, Articles First, Répertoire International de Littérature Musicale Abstracts of Music Literature, Computer-Assisted

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Information Retrieval Service System for Music, PsycINFO, Allied and Complementary Medicine Database, EMBASE, Latin American & Caribbean Health Sciences Literature, and Web of Science (search strategies available from authors). Based on evidence that demonstrates an association between significant results and publication,[8] we searched for grey literature in the following resources: doctoral dissertations in musicology, dissertation abstracts, and Online Computer Library Center Proceedings and Papers First. We scanned subject bibliographies, including the Bibliography of Australian Music Education Research, as well as reference lists of relevant studies. We searched for ongoing trials in Current Controlled Trials and the National Research Register.

Study Selection

Studies were screened for relevance by 2 independent reviewers, and potentially relevant studies were retrieved as full manuscripts. Two independent reviewers assessed studies for inclusion by using the following criteria: population aged 1 month to 18 years (studies involving the neonatal age group were excluded; studies were included if the upper age limit exceeded 18 but the majority of patients were ≤18), the study examined a music intervention in the clinical setting, measured pain or anxiety, and was a randomized controlled. Differences were resolved through discussion.

Quality Assessment

Study quality was evaluated using the Jadad scale, which assesses randomization, double blinding, and withdrawals and follow-up.[9] Allocation concealment was assessed as adequate, inadequate, or unclear.[10] Quality assessment was performed independently by 2 reviewers and differences were resolved through consensus.

Data Extraction

Data were extracted using a standardized form that captured 1) the studies' design (parallel/crossover, blinding of outcome assessors), 2) population (age and gender distribution, setting, diagnoses, and treatments), 3) interventions (active vs passive MT, description of therapy, description of control group), 4) outcome measures (validity and reliability), and 5) results. Studies were classified as using active MT if a music therapist was involved and the therapeutic sessions included interactive communication using music as a medium.[11] Passive MT was defined as listening to music—whether recorded or live—without the involvement of a music therapist.[11] Data extraction was completed by the primary author and verified by another reviewer.

Statistical Analysis

Data were combined using a standardized mean difference (SMD), which is an accepted approach in meta-analysis to standardize and combine the results from trials that assessed the same outcome but measured it in different ways[12]; 95% confidence intervals (CI) were calculated. Changes from baseline data were used if available, otherwise final data were used. A random effects model was used because it incorporates statistical heterogeneity that cannot readily be explained[13] and provides a more conservative estimate. In the analysis of anxiety or pain combined, the primary outcome (or first listed) was chosen for studies that reported both outcomes. If studies reported pain and/or anxiety by using multiple measurement tools, the primary outcome (or first listed) was selected for meta-analysis. Studies were included in the meta-analysis if the outcomes they measured were the same or similar enough to be combined and they reported sufficient data. The statistical calculations were produced with RevMan 4.2.8 (The Nordic Cochrane Centre, Rigshospitalet, Denmark).

The I^2 statistic was used to assess for heterogeneity. This measurement describes the percentage of total variation across studies that is due to heterogeneity rather than chance.[14] A value greater than 50% may be considered substantial heterogeneity.[14] The following subgroup analyses were conducted to investigate possible sources of heterogeneity: 1) active versus passive music therapy, 2) self-reported versus observed measurements, 3) type of control group (standard procedure versus other intervention), 4) intervention consisting of music only versus music plus other intervention, 5) Jadad score, 6) blinding of outcome assessor, and 7) language of publication. Deeks' chi-square test was used to test for significant heterogeneity reduction in partitioned subgroups.[15] We conducted sensitivity analyses for variations in effect of MT within a study.

Publication bias was tested visually using the funnel plot[16] and quantitatively using the Begg adjusted rank correlation test[17,18] and Egger regression asymmetry test.[18] The tests were performed using Stata 7.0 (Stata Corporation, College Station, Tex).

RESULTS

Description of Included Studies

Figure 1 shows the flow of studies through the selection process. Nineteen parallel randomized controlled trials were included, with a total of 1513 subjects undergoing a variety of procedures (Table 1). Four non-English studies were included.[19–22] The subjects ranged in age from 8 months to 20 years. Five studies examined active MT,[7,23–26] whereas 14 studies evaluated passive MT.[4,19–22,27–35]

The musical interventions varied across studies, and in some cases, between patients. The type of music included folk,[20,33] contemporary upbeat,[31] popular,[30] relaxing,[26,33] classical,[22,27] lullabies,[4] children's,[7,32,34,35] children's stories,[30] and songs that reviewed preoperative information.[25] In some studies, participants were allowed to select the type of music,[4,26,30] and in one study participants chose between music and an audiobook.[19] In 2 studies, the passive MT protocols included an active component.[29,32] Four studies combined MT with other modalities, including low sensory stimulation,[27] uncertainty reduction,[29] suggestion,[34] and relaxation exercises.[26]

The comparison groups varied across studies. Twelve studies compared MT to standard care.[4,19–21,24–29,32,34]

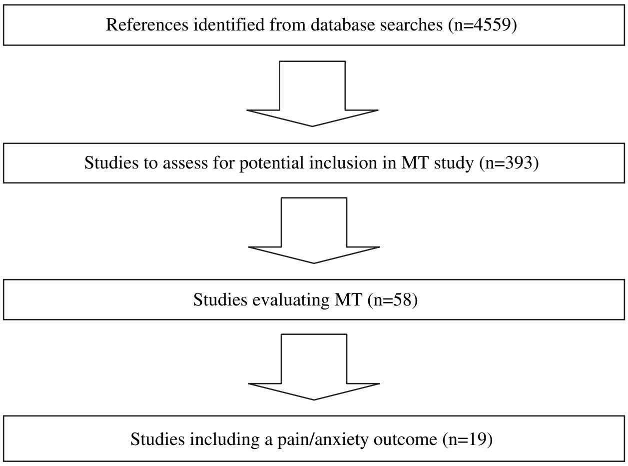

Figure 1. *Flow of studies through the selection process. MT indicates music therapy.*

Six studies compared MT to another active intervention (eg, spoken story[32] or placebo group [ie, headphones without music[22,30,33,34] or conversation with music therapist[7]]). Two studies compared MT to a pharmacological agent.[24,31]

A variety of outcome measures for pain and anxiety were used, with variation in whether the measures had been judged reliable or valid (Table 1). Outcome measures could generally be categorized as self-reported or observed.

The quality of studies was low, with 16 studies receiving a score of 1 on the Jadad scale, 2 studies receiving a score of 2,[7,33] and 1 study with a score of 3.[4] None of the studies reported concealment of allocation. The outcome assessor was blind to the intervention in only 4 studies.[22,24,27,32]

Qualitative Synthesis

Passive MT

Eleven studies of passive MT measured pain. Comparing music videos to standard procedures for colposcopy, Rickert and colleagues[28] found no differences in self-reported pain; however, significant differences were found in observer-reported behaviors indicative of pain and discomfort. Press and colleagues[29] found significantly lower levels of pain for MT combined with "uncertainty reduction" versus standard procedures for venipuncture; however, results were no longer significant after controlling for the effects of age and pain threshold. Several interaction terms were significant: MT resulted in significantly less pain for girls, children with low pain thresholds, and children with low white blood cell counts (<12 000). For intramuscular injections, Hua[20] found a significant difference in pain favoring MT over standard procedures. Fowler-Kerry and Lander[34] found significantly lower pain with MT compared with no MT for immunizations; effects were optimal when MT was combined with suggestion. Megel and colleagues[4] found a decrease in pain for immunizations comparing MT versus standard care when measured with the Observational Scale of Behavioral Distress, but not when measured using the faces scale on the Oucher. Conversely, Noguchi[32] found no effect of MT over standard care on perceived or self-reported pain associated with immunizations. In a study involving intravenous cannulation for outpatient surgery, Arts and colleagues[31] found significantly less pain in the group receiving the pharmacological intervention (a lidocaine-prilocaine emulsion, EMLA cream) compared with groups receiving MT or placebo cream. For dental procedures, 2 studies found a significant reduction in self-reported pain for MT compared with standard procedures,[19,21] whereas 2 studies showed no significant differences in self-reported pain[33] or discomfort[30] for MT versus placebo.

Seven studies of passive MT evaluated anxiety. Kain and colleagues[27] showed that a low sensory stimulation intervention was effective in reducing anxiety during the preoperative period. In a comparison of music videos to standard colposcopy, Rickert and colleagues[28] found no significant differences in self-reported trait anxiety but did find significant differences in 3 of the 9 observed behaviors, including less reassurance and fewer procedural explanations required from the physician. In a study of brachial venipuncture, Tibbs[35] found no significant differences in anxiety for MT versus standard care. For dental procedures, 2 studies found a significant effect on physiological and behavioral reactions of anxiety,[19] as well as physician-assessed motor anxiety and self-reported anxiety[21] for MT versus standard procedures, whereas 2 studies showed no significant differences in anxiety[33] or disruptive behavior[30] for MT versus placebo. Although Filcheck and colleagues[30] found no differences in disruptive behaviors between MT and placebo overall or by level of disruptiveness, there was a significant difference among the uncooperative children with respect to disruptive behaviors, crying and complaining, and physical restraint required.

The clinical importance of passive MT was demonstrated in 3 studies. Among children undergoing MRI, Gozal and Gozal[22] demonstrated less use of propofol with MT versus placebo. Kain and colleagues[27] showed greater observed compliance during anesthetic induction. Hua[20] found a significantly larger proportion who cried and refused injection among the standard care group receiving intramuscular injections. Conversely, Aitken and Wilson[33] found no difference in disruptive behaviors and amount of time spent quiet between MT and placebo. Similarly, although Gawronska-Skorkowska and colleagues[21] found significantly lower levels of patient-perceived pain and anxiety during oral surgery for MT versus standard care, this did not translate into differences in behavior, cooperation with a doctor, or comprehension of the orders.

Active MT

Active MT was reported in several studies to be effective in reducing anxiety during the preoperative period . Music therapy delivered the night before and the morning of surgery showed less observer and parent-reported anxiety compared with study groups receiving MT the night before surgery only and with the standard care group.[25] Robb and colleagues[26] showed lower self-reported anxiety in burn patients undergoing surgery with music-assisted relaxation

Table 1. Characteristics of Included Studies

	Clinical Characteristics		Participants				Results	
First Author (Country)	Procedure	Setting	Age, y	Sample size (% male)	Interventions	Outcome Measures	Pain	Anxiety
Aitken 2001[33] (US)	Restorative oral surgery	Children's hospital dental clinic	4–6 y	45 (47%)	1. Folk music, n = 15 2. Relaxing music, n = 15 3. Control intervention (headphones without music), n = 15	1. North Carolina Behavior Rating Scale 2. Venham Picture Scale for self-reported anxiety (reliable) 3. Corah Anxiety Scale for parent reported anxiety 4. Pain (VAS) 5. Heart rate	Mean (SD) scores for VAS*: folk music, 29.4 (32.5); relaxing music, 28.8 (35.7); placebo, 40.0 (41.9); $P = .649$	Mean self-reported anxiety levels (SD) after dental procedure: folk music, 1.6 (2.0); relaxing music, 2.0 (3.0); placebo, 2.0 (2.9); $P = .897$
Arts 1994[31] (Australia)	Intravenous cannulation for outpatient surgery	Operating room	4–16 y; mean 9.7 y	180 (56%)	1. Passive MT†, n = 60; patients received contemporary, upbeat music through headphones 2. EMLA‡ cream, n = 60; emulsion of lidocaine & prilocaine 5% 3. Placebo cream, n = 60; identical to EMLA in appearance, smell, and cosmetic characteristics	1. Faces Pain Scale (validated, reliable) 2. Visual Analogue Toy (validated, reliable) 3. Behavioral comments	Faces Pain Scale (mean): MT, 2.62; EMLA, 1.42; placebo, 2.58; $P = .001$	NA§
Chetta 1981[25] (US)	Elective surgery	Regional hospital	3–8 y	75 (NS)	1. Active MT 1, n = 25; patients received session with MT, duration approximately 20–30 min, evening before surgery 2. Active MT 2, n = 25; in addition to evening therapy, patients received music morning of surgery 3. Control, n = 25; teaching session for preoperative info given in place of MT, duration approximately 20–30 min	1. OBTS‖ (reliable) 2. Predominant Behavior Categories List 3. Parent rating of child's overall anxiety	NA	OBTS (rank sums), 15 s before injection: MT PM only, 819.5; MT PM and AM, 1,209; SC,¶ 821.5; $P < .02$
Filcheck 2004[30] (US)	Restorative dental procedures	Dental clinic	5–12 y; mean 7.9 y, SD 1.8 y	60 (53%)	1. Passive MT group, n = 30; choice of CD played through headphones for duration of dental procedure, patients permitted to change tracks/ volume/CD during procedure 2. Control group, n = 30; received standard dental care, wore headphones to control for attenuation of operatory noises	1. Disruptive Behavior Code 2. Pediatric Dental Clinic Rating Form for acceptability and discomfort, including combined facial and numerical VAS	No significant differences between groups for discomfort (data not presented) No significant differences in overall disruptive behaviors (16.3% MT vs 22% control).	NA

Fowler-Kerry 1987[34] (Canada)	Immunizations	Community health clinic	4.5–7 y; mean 5.5 y	200 (50%)	1. Combined distraction-suggestion, n = 40; music suitable to children played through headphones, children told experimenter was there to help 2. Distraction, n = 40; music suitable to children played through headphones 3. Suggestion, n = 40; children told experimenter was there to help 4. Control, n = 80; divided into 2 groups, neither received distraction or suggestion, one group wore headphones	1. 4-point VAS	VAS, mean adjusted for age (SD): distraction + suggestion, 1.07 (1.02); distraction, 1.34 (1.14); suggestion, 1.59 (1.13); control, 1.78 (1.14); significant main effect for distraction ($P = .007$)	NA
Gawronska-Skorkowaska 2002[21] (Poland)	Oral surgery	Dental clinic	7–14 y	130 (54%)	1. Passive MT, n = 100; recorded music 2. Control group, n = 30; standard procedure	1. Patient attitude 2. Mental state, evaluated by doctors 3. Subjective self-evaluation	Pain self-reported as low, middle, high MT: low (64%), middle (34%), high (2%); SC: low (40%), middle (43%), high (17%); $P < .01$	Anxiety self-reported as low, middle, high MT: low (58%), middle (37%), high (5%); SC: low (30%), middle (40%), high (30%); $P < .001$
Gozal 1998[22] (Israel)	MRI††	Hospital	8 mo–10 y	40 (53%)	1. Passive MT, n = 20; "Four Seasons" by Vivaldi through headphones, w/ propofol intervention 2. Control, n = 20; headphones w/out music, 1–2 mg/kg of propofol plus 6 mg/kg per hour drip, additional propofol given (0.5 mg/kg) if needed	1. Total dose of propofol, mg/kg 2. Duration of procedure, min 3. Opening of eyes, min 4. Time in recovery room, min	Total mean dose of propofol (SD): MT 5 ± 2.17 mg/kg; placebo, 6.5 ± 2.14 mg/kg; $P = .03$	NA
Hua 1997[20] (China)	Intramuscular injection	Clinic	3–5 y	145 (53%)	1. Passive MT, n = 78; folk music via headphones before, during, and after injection 2. Control, n = 67; standard injection procedure	1. Observation of pain	Levels of pain, n/N: MT, no pain 46/78; painful but acceptable 28/78; cry (intolerant to pain) 10/78; SC, no pain 10/67; painful but acceptable 21/67; cry (intolerant to pain) 36/67; $P < .001$	NA
Kain 2001[27] (US)	General anesthesia for outpatient surgery	Hospital	2–7 y		1. Low sensory stimulation, n = 33; Bach on CD player, lights dimmed, talking kept to minimum, monitors at quiet setting 2. Control, n = 37; no change in OR‡‡ routine	1. mYPAS§§ (validated, reliable) 2. ICC|||| (validated, reliable)	NA	Mean change (SD) in anxiety scores from holding area to introduction of anesthesia mask: MT, 2.9 (18.8); SC, 21.7 (22.1); $P = .0003$

(*Continued*)

Table 1. (*Continued*)

First Author (Country)	Clinical Characteristics: Procedure	Clinical Characteristics: Setting	Participants: Age, y	Participants: Sample size (% male)	Interventions	Outcome Measures	Results: Pain	Results: Anxiety
Kain 2004[24] (US)	General anesthesia and elective outpatient surgery	Hospital	3–7 y	123 (65%)	1. Active MT group, n = 51; RMT¶¶ in waiting room for 20–30 min and in OR until completion of induction of anesthesia 2. Midazolam group, n = 34; oral midazolam 0.5 mg/kg 30 min before surgery, up to max of 20 mg 3. Control group, n = 38; not offered midazolam or MT	1. mYPAS (validated, reliable) 2. ICC (validated, reliable)	NA	Mean (SD) change in anxiety from baseline to introduction of mask: MT, 19.1 (25.1); SC, 21.3 (27.3); midazolam, 4.7 (22.6)
Kaluza 2002[19] (German)	Dental procedures requiring local anesthesia	Dental clinic	6–16 y; mean 10.7 y	60 (48%)	1. Passive MT, n = 30; choice of music or audiobook through headphones 2. Control, n = 30; normal dental procedure	1. Questionnaire Measuring Anxiety at the Dentist (validated, reliable) 2. Fear Scale, similar to STAIC*** (validated, reliable) 3. Rating Scale for Cooperative & Anxious Behavior in Children (reliable) 4. Three-Level Pain Intensity Scale	Self-reported pain (%): MT, strong (0), light (20), none (80); SC, strong (10), light (63), none (27); $P < .0001$	Cognitive-emotional reactions to fear (STAIC), mean change pre-post procedure (SD): MT, 0.6 (1.1); SC, 0.9 (1.2), not significant
Megel 1998[4] (US)	Immunizations	Pediatric clinic	3–6 y; mean 4.5 y, SD 0.5 y	99 (49%)	1. Passive MT, n = 50; musical and verbal lullabies, children chose selection, listened by headphone, parental presence required 2. Control, n = 49; standard vaccination procedure, parental presence required	1. Faces scale on the Oucher (validated) 2. OSBD††† (validated, reliable) 3. Blood pressure and heart rate	OSBD, total distress score (over four phases): MT, 22.36; SC, 35.32; $P = .023$	NA
Noguchi 2006[32] (US)	Immunizations	Clinic	4–6 y; mean 4.6 y, SD 0.7 y	64 (59%)	1. Passive MT, n = 21; patients listened to musical story via headphones, answered questions about story 2. Placebo therapy, n = 21; patients listened to spoken story via headphones, answered questions about story 3. Control group, n = 20; standard immunization procedures	1. OSBD (validated, reliable) 2. Faces Pain Scale (validated, reliable)	Overall OSBD, mean score (SD): MT, 4.64 (4.82); spoken story, 5.10 (3.78); SC, 6.12 (4.64); $P > .05$	NA

Press 2003[29] (Israel)	Venipuncture	Pediatric emergency department	6–16 y	94 (61%)	1. Passive MT, n = 48; along with music played through headphones, patients received comforting words from nurses before procedure 2. Control, n = 46; nurses provided usual care for reducing child's pain and distress	1. VAS combined with Faces Pain Scale (validated)	VAS with Faces Pain Scale, mean (SD): MT, 2.8 (2.0); SC, 3.8 (2.9); $P < .05$; controlling for age and pain threshold, $P = .9$ MT resulted in significantly less pain in girls, kids with low pain thresholds, and kids with WBC§§§<12,000	NA
Rickert 1994[28] (US)	Colposcopy	Gynecological clinic	13–20 y; mean 16.5 y	30 (0%)	1. Passive MT, n = 15; music videos played on monitor, subjects could not choose 2. Control, n = 15; regular colposcopy procedure	1. 25-s partial interval coding system 2. STAI‖‖‖ (validated, reliable) 3. Self-reported pain and discomfort	MT group showed "significantly fewer body movements indicative of pain and discomfort ($P < .003$)"; no difference in self-reported pain	MT group "required less reassurance from the physician ($P < .05$) and required fewer procedural explanations from the physician" ($P < .007$); no difference in self-reported state anxiety
Robb 1995[26] (US)	Burn patients undergoing surgery	Hospital	8–20 y	20	1. Active MT, n = 10; relaxation instruction/music choosing session evening before, MT morning until induction of anesthesia, MT in recovery room 2. Control group, n = 10; received standard preoperative procedures, no MT	1. STAIC (validated, reliable) 2. Blood pressure 3. Respiratory rate 4. Heart rate 5. Temperature (oral)	NA	STAIC, mean postintervention scores: MT, 27.9; SC, 34.4; $P = .04$
Robb 2003[23] (US)	Bone marrow transplant	Hospital	9–17 y	6 (33%)	1. Active MT, n = 3; 6 one-hour sessions over 3 weeks with RMT, standardized protocol 2. Control group, n = 3; board/video/card game activity	1. STAIC (validated, reliable) 2. CDI¶¶¶ (validated, reliable)	NA	No summary statistics; results presented by patient
Tibbs 1991[35] (US)	Brachial venipuncture	Hospital	3–5 y	30 (63%)	1. Passive MT, n = 15; 15-min tape-recorded instrumental and vocal music 2. Control group, n = 15; standard procedures, no MT	1. Children's Coping Strategies Checklist, intrusive procedures (reliable)	NA	Total stress-related behaviors: MT, 358; SC, 363; $P = .84$

(*Continued*)

Table 1. (*Continued*)

	Clinical Characteristics		Participants				Results	
First Author (Country)	Procedure	Setting	Age, y	Sample size (% male)	Interventions	Outcome Measures	Pain	Anxiety
Whitehead-Pleaux 2006[7] (US)	Burn patients undergoing donor site dressing change	Pediatric burn center	6–16 y	14 (36%)	1. Active MT, n = 8; children chose music before procedure, therapist played guitar and sang during procedure 2. Control group, n = 6; music therapist interacted verbally, offered support and distraction	1. FACES Pain Scale (validated, reliable) 2. Nursing Assessment of Pain Index (reliable) 3. Fear Thermometer (reliable) 4. Respiratory rate 5. Heart rate	FACES Pain Scale, mean (SD) during procedure: MT, 8.43 (2.34); placebo, 5.33 (3.74); $P = .181$ NAPI,**** mean (SD) during procedure: MT, 9.69 (1.6); placebo 4.58 (2.75); $P = .02$ favoring placebo	Fear thermometer (self-reported), mean (SD) during procedure: MT, 9.79 (3.08); placebo 3.75 (0.82); $P = .002$ favoring placebo

*VAS indicates visual analogue scale.
†MT indicates music therapy.
‡EMLA indicates a lidocaine-prilocaine emulsion.
§NA indicates not assessed.
||OBTS indicates observed behavior time-sampling.
¶SC indicates standard care.
††MRI indicates magnetic resonance imaging.
‡‡OR indicates operating room.
§§mYPAS indicates Yale Preoperative Anxiety Scale.
||||ICC indicates induction compliance checklist.
¶¶RMT indicates registered music therapy.
***STAIC indicates State-Trait Anxiety Inventory for Children.
†††OSBD indicates Observational Scale of Behavioral Distress.
§§§WBC indicates white blood cell.
||||||STAI indicates State-Trait Anxiety Inventory.
¶¶¶CDI indicates Children's Depression Inventory.
****NAPI indicates Nursing Assessment of Pain Index.

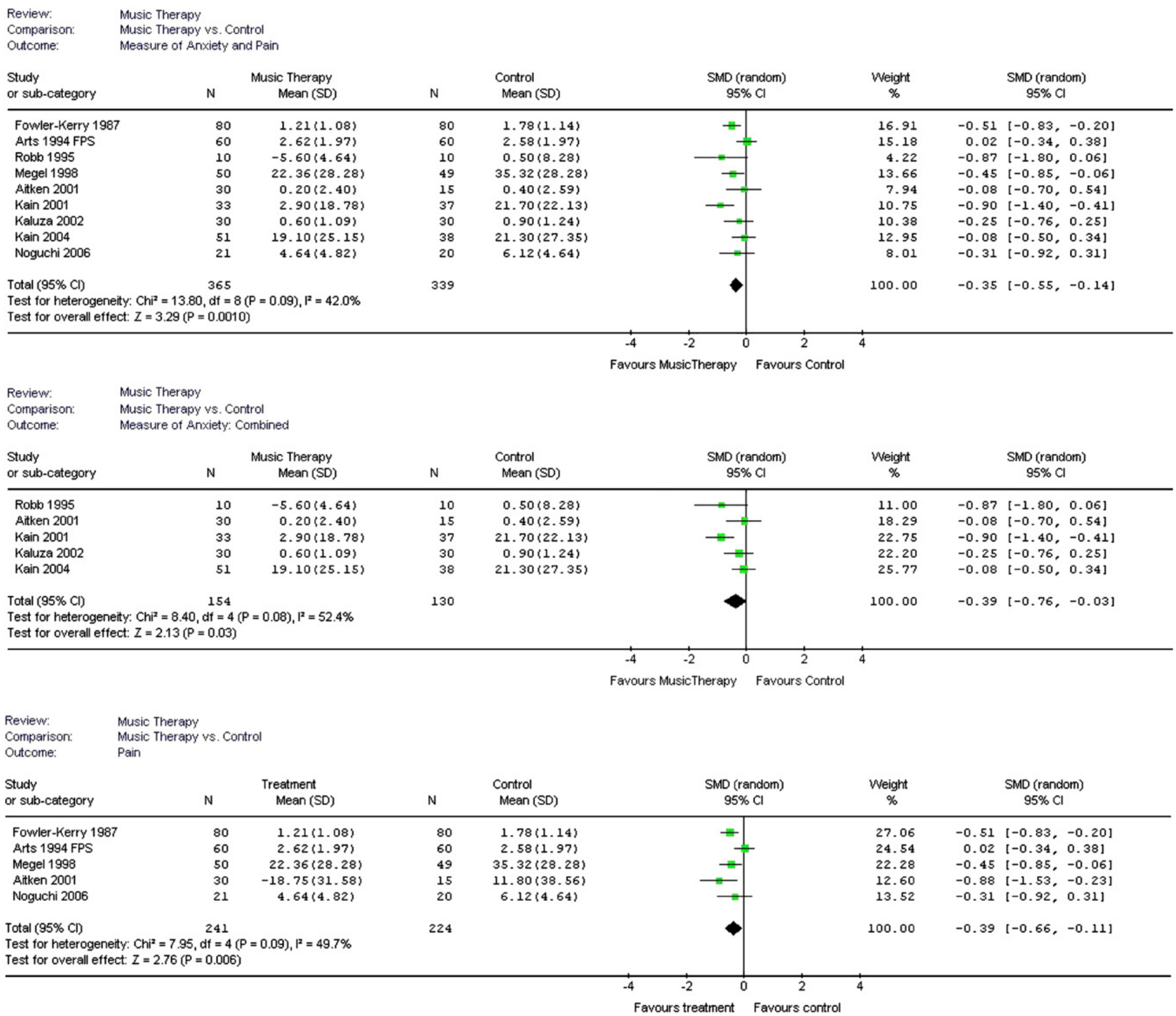

Figure 2. *Metagraphs of music therapy for anxiety and pain among children and youth.*

versus standard preoperative interventions. Among children undergoing general anesthesia for outpatient surgery, Kain and colleagues[24] found that midazolam was more effective in reducing anxiety compared with MT or standard care; however, they noted a significant therapist effect where effectiveness was seen with one music therapist but not the other. A study of 6 children undergoing bone marrow transplants showed trends favoring MT, but no definitive conclusions could be made because of the small sample size.[23] In a study of 14 burn patients undergoing donor site dressing changes, observed distress during the procedure was lower for the placebo group; there were no significant differences between the study groups in self-reported pain during or after the procedure.[7] The authors reported the results as inconclusive because of the small sample size and higher baseline anxiety levels in the experimental group.

No data demonstrated any clinical importance for active MT. Conversely, Kain and colleagues[24] showed that in children undergoing anesthesia for outpatient surgery, the midazolam group was the most compliant during induction of anesthesia compared with the control and MT groups, which were similar.

Quantitative Synthesis

A pooled estimate of pain or anxiety from 9 studies significantly favored MT over control (SMD −0.35; 95% CI, −0.55 to −0.14; N = 704; $I^2 = 42\%$; Figure 2). Subgroup analyses (Table 2) showed a significant effect for passive MT but not for active MT, although the latter estimate was based on only 2 studies. A significant effect was observed for MT versus standard procedures but not compared with another active intervention or placebo. Results for studies that used observed measurements were significant for MT; the result for studies that used self-report measurements favored MT but was not significant. A subgroup analysis by the nature of the intervention showed a stronger effect for MT combined with other modalities compared with MT only; there was negligible heterogeneity in either subgroup. Compared with the lower quality studies (Jadad score 1), the higher quality study (Jadad score 3) showed a larger effect size, although this difference may be due

Table 2. Subgroup Analyses of Music Therapy for Pain and Anxiety on Children and Youth

Variable	Subgroup	No. of Studies	No. of Participants		Point Estimate	95% CI*	Heterogeneity		*P* value†
			Music	Control			Degree	I^2 (%)	
Type of music therapy	Active	2	61	48	−0.36	−1.10 to 0.37	Substantial	56.5	.49
	Passive	7	304	291	−0.36	−0.59 to −0.13	Moderate	45.6	
Comparison group	Standard procedure	7	275	164	−0.44	−0.65 to −0.24	Moderate	23.5	.02
	Other	2	90	75	0	−0.31 to 0.31	Negligible	0	
Outcome	Self-reported	4	180	165	−0.29	−0.65 to 0.07	Substantial	55.4	.49
	Observed	5	185	174	−0.40	−0.67 to −0.12	Moderate	39.5	
Outcome assessor blind	Yes	3	105	95	−0.43	−0.94 to 0.09	Substantial	67.9	.61
	No	6	260	244	−0.31	−0.54 to −0.09	Moderate	31.6	
Jadad score	1	8	315	290	−0.33	−0.57 to −0.10	Moderate	47.9	.54
	3	1	50	49	−0.45	−0.85 to −0.06	NA‡	NA	
Intervention	MT§ only	6	242	212	−0.18	−0.37 to 0.01	Negligible	0	.004
	MT plus other‖	3	123	127	−0.64	−0.90 to −0.39	Negligible	0	
Language	English	8	335	309	−0.36	−0.59 to −0.13	Moderate	48.8	.72
	Non-English	1	30	30	−0.25	−0.76 to 0.25	NA	NA	

*CI indicates confidence interval.
†Deeks' chi-square.
‡NA indicates not applicable.
§MT indicates music therapy.
‖Music plus other intervention.

to chance. There was a slightly larger effect size for English publications compared with the one non-English study, but this difference is not necessarily statistically significant. Pooled results for studies where the outcome assessor was not blind (6 studies) remained significant, whereas studies where the outcome assessor was blind (3 studies) did not show a significant effect. According to the Deek's chi-square test, heterogeneity was significantly reduced for subgrouping based on the comparison group (standard procedures vs other; $P = .02$) and MT with other modalities versus MT only ($P = .004$).

We conducted a sensitivity analysis for the following variations in the effects of MT observed within the trials to ascertain the full potential of MT. One study showed a therapist effect; in our primary analysis, we used data for both therapists combined. Another study showed a differential effect for different types of music (folk and relaxing instrumental); in our primary analysis, we combined the data for the 2 MT groups. In the sensitivity analysis, we included the data for only the therapist[27] and the type of music[33] that showed a stronger effect in terms of the point estimates. The pooled estimate of −0.39 (95% CI, −0.59 to −0.2) indicated a slightly stronger effect of MT on reducing pain and anxiety and reduced the heterogeneity ($I^2 = 30.3\%$).

No publication bias was apparent from the funnel plot (available from authors on request). Neither Begg's adjusted rank correlation test ($P = .917$), nor Egger's regression asymmetry test ($P = .651$) showed significant asymmetry.

Data from 5 studies that compared anxiety among patients receiving MT versus control (Figure 2) showed a significant reduction for MT (SMD 0.39; 95% CI, −0.76 to −0.03; N = 284); however, there was substantial heterogeneity in this estimate ($I^2 = 52.4\%$). Meta-analysis of 5 studies that examined pain significantly favored MT (SMD −0.39; 95% CI, −0.66 to −0.11; N = 465), although heterogeneity was moderate ($I^2 = 49.7\%$; Figure 2).

DISCUSSION

Our results show that music is effective in reducing anxiety and pain during clinical procedures in children and youth. The results are supported by a qualitative synthesis of all 19 relevant studies and meta-analysis of 9 of the studies. Although the data included in this review did not allow us to conduct subgroup analyses for certain variables, other research suggests that the findings may be especially relevant to important subgroups that demonstrate higher baseline pain and anxiety levels, such as very young[30,31,34] or ill children.[29]

There was substantial clinical heterogeneity. The form of the interventions, clinical scenarios, outcome measures, and control groups varied across studies. The results do not definitively indicate for which procedures MT will be most beneficial; in fact, other factors appear to be driving the effect more so than the clinical scenario. For instance, subgroups of multifaceted interventions and music alone showed no statistical heterogeneity. Our analyses indicate that multifaceted interventions that included the use of music may be more effective than music alone. This supports the theoretical basis of distraction and its effect on perceived pain.

Although a previous meta-analysis[36] indicated higher effect sizes for active over passive MT, our results did not concur. The difference may stem in part from less tangible variations in how active MT is delivered. For example, one study found a considerable difference of effect between 2 therapists using identical protocols.[24] Active MT may have more value in less acute clinical scenarios. For instance, one study examining MT in treating anxiety in bone marrow transplant patients spanned approximately 2 weeks.[23] Although the evidence was inconclusive due to the small sample size, the trends favored MT. The value of passive versus active MT has important practical implications, because passive MT is easier to administer, less expensive, and not as time consuming.

There was some suggestion that MT had more of an effect on observed versus self-reported measures of pain and anxiety. This result may stem from bias introduced by the different outcome measures used. Outcome measures of anxiety varied immensely from study to study. Pain measures were slightly less variable. Observational methods of pain are generally validated and show good inter-rater reliability, but their discriminant validity is in question. However, self-report scales of pain, although reliable and valid among older children, show bimodal distribution with younger children, indicating that they may not have the cognitive ability to grade pain on a scale.[31,32,37]

One of the variables that had an important impact on reducing heterogeneity was the nature of the control group. Music therapy showed a stronger effect when compared with standard care versus other interventions, including a placebo. This evidence supports the existence of a placebo effect, for instance, the use of headphones alone, without any noise or music, may have some effect on pain and anxiety.

A previous review of MT questioned the clinical importance of the reviews findings. The effect sizes from our meta-analysis would indicate that MT has small-to-moderate effects.[38] The clinical implications were demonstrated in less use of sedatives and greater compliance.

This review was methodologically rigorous and comprehensive (eg, we did not limit our search or inclusion by language or publication status). However, the validity of the results may be limited by the methods of the primary studies. This may be an artifact of the nature of the intervention in that double blinding for such interventions is difficult. Future studies should ensure—as a minimum—blinding of the outcome assessors, adequate concealment of allocation, and use of control interventions similar to the treatment (eg, headphones without sound or with recorded stories).

The heterogeneity across studies in terms of clinical scenarios, interventions, and outcomes limits implications around how and when to apply music in practice. Additional studies within particular clinical scenarios or for similar procedures are required to evaluate the utility of music for specific applications and populations. To optimize comparisons across studies, there is a need for consistency in outcomes and how these are measured. Finally, there was wide variation across the studies in the type of music (eg, folk music, lullabies, classical) and how it was delivered (eg, recorded, live, as part of a multifaceted intervention). Further research is needed to elucidate the effect of these different facets of the intervention.

In conclusion, there is evidence to support the use of music for children who are undergoing painful or anxiety-provoking clinical procedures. Our results show that passive MT is as effective as active MT. There is considerable heterogeneity in the interventions studied, although our results suggest that music may be more effective when part of a multifaceted intervention aimed at distracting the patient from the painful or anxiety-provoking stimuli. Music as an adjunctive intervention demonstrates clinical importance in reducing the amount of pharmaceutical interventions needed.

REFERENCES

1. Young KD. Pediatric procedural pain. *Ann Emerg Med*. 2005;45: 160–171.
2. Schreiber KM, Cunningham SJ, Kunkov S, Crain EF. The association of preprocedural anxiety and the success of procedural sedation in children. *Am J Emerg Med*. 2006;24:397–401.
3. Crowe BJ. *Music and Soulmaking: Toward a New Theory of Music Therapy*. Lanham, Md: Scarecrow Press; 2004.
4. Megel ME, Houser CW, Gleaves LS. Children's responses to immunizations: lullabies as a distraction. *Issues Compr Pediatr Nurs*. 1998; 21:129–145.
5. Peters JS. *Music Therapy: An Introduction*. Springfield, Ill: Charles C. Thomas; 2000.
6. Cepeda MS, Carr DB, Lau J, Alvarez H. Music for pain relief [review]. *Cochrane Database Syst Rev*. 2006;2:CD004843.
7. Whitehead-Pleaux AM, Baryza MJ, Sheridan RL. The effects of music therapy on pediatric patients' pain and anxiety during donor site dressing change. *J Music Ther*. 2006;43:136–153.
8. Higgins JPT, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions 4.2.5*. Available at: http://www.cochrane.org/resources/handbook/hbook.htm. Accessed December 3, 2007.
9. Jadad AR, Moore A, Carroll D, et al. Assessing the quality of reports of randomized clinical trials:is blinding necessary. *Control Clin Trials*. 1996;17:1–12.
10. Schulz KF, Chalmer I, Hayes RJ, Altman DG. Empirical evidence of bias: dimensions of methodological quality associated with estimates of treatment effects in controlled trials. *JAMA*. 1995;273:408–412.
11. Michel DE, Pinson J. *Music Therapy in Principle and Practice*. Springfield, Ill: Charles C. Thomas; 2005.
12. Egger M, Smith GD, Altman DG, eds. *Systematic Reviews in Healthcare: Meta-Analysis in Context*. London, England: BMJ Publishing Group; 2001.
13. Deeks JJ, Higgins JPT, Altman DGe. Analysing and presenting results. *Cochrane Handbook for Systematic Reviews of Interventions 4.2.5.* Available at: http://www.cochrane.org/resources/handbook/hbook.htm. Accessed December 3, 2007.
14. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327:557–560.
15. Deeks JJ, Altman DG, Bradburn MJ. Statistical methods for examining heterogeneity and combining results from several studies in meta-analysis. In: Egger M, Davey-Smith G, Altman DG, eds. *Systematic Reviews in Health Care*. London, England: BMJ Publishing Group; 2001:300.
16. Light RJ, Pillemer DB. *Summing Up: The Science of Reviewing Research*. Cambridge, Mass: Harvard University Press; 1984.
17. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics*. 1994;50:1088–1101.
18. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. 1997;315:629–634.
19. Kaluza G, Margraf-Stiksrud J, Wnuk P. Original Studies–does the use of music or audio books reduce anxiety in children and adolescents?–A randomized clinical intervention trial. *Dtsch Zahnarztl Z*. 2002;57: 406–410.
20. Hua XP. The effects of music in relieving pain for children receiving intramuscular injection [in Chinese]. *J Nurs Sci*. 1997;12:135.
21. Gawronska-Skorkowska J, Zienkiewicz J, Majkowicz M, et al. Music therapy before and during oral surgeries as a positive relaxing influence on the young patients. *Ann Acad Med Gedanen*. 2002;32: 161–172.

22. Gozal D, Gozal Y. Classical music during magnetic resonance imaging in children under propofol sedation. *Cahiers D'Anesthesiol*. 1998; 46:387–389.
23. Robb SL, Ebberts AG. Songwriting and digital video production interventions for pediatric patients undergoing bone marrow transplantation, part II: an analysis of patient-generated songs and patient perceptions regarding intervention efficacy. *J Pediatr Oncol Nurs*. 2003;20:16–25.
24. Kain ZN, Caldwell-Andrews AA, Krivutza DM, et al. Interactive music therapy as a treatment for preoperative anxiety in children: a randomized controlled trial. *Anesth Analg*. 2004;98:1260–1266.
25. Chetta HD. The effect of music and desensitization on preoperative anxiety in children. *J Music Ther.* 1981;18(2):74–87.
26. Robb SL, Nichols RJ, Bishop BL, Rutan RL, Parker JC. The effects of music assisted relaxation on preoperative anxiety. *J Music Ther.* 1995; 32:2–21.
27. Kain ZN, Wang SM, Mayes LC, et al. Sensory stimuli and anxiety in children undergoing surgery: a randomized, controlled trial. *Anesth Analg*. 2001;92:897–903.
28. Rickert VI, Kozlowski KJ, Warren AM, et al. Adolescents and colposcopy: the use of different procedures to reduce anxiety. *Am J Obstet Gynecol*. 1994;170:504–508.
29. Press J, Gidron Y, Maimon M, et al. Effects of active distraction on pain of children undergoing venipuncture: who benefits from it? *Pain Clin*. 2003;15:261–269.
30. Filcheck HA, Allen KD, Ogren H, et al. The use of choice-based distraction to decrease the distress of children at the dentist. *Child Fam Behav Ther.* 2004;26:59–68.
31. Arts SE, Abu-Saad HH, Champion GD, et al. Age-related response to lidocaine-prilocaine (EMLA) emulsion and effect of music distraction on the pain of intravenous cannulation. *Pediatrics*. 1994;93:797–801.
32. Noguchi LK. The effect of music versus nonmusic on behavioral signs of distress and self-report of pain in pediatric injection patients. *J Music Ther.* 2006;43:16–38.
33. Aitken J, Wilson S. Audio distraction as a behaviour management technique for pediatric dental patients [abstract]. *Pediatr Dent*. 2001;23:166.
34. Fowler-Kerry S, Lander JR. Management of injection pain in children. *Pain*. 1987;30:169–175.
35. Tibbs PA. *Changes in Stress-Related Behaviors of Hospitalized Preschoolers During a Brachial Venipuncture Procedure with and Without a Music Therapy Program: A Replication* [dissertation]. Jackson, Miss: The University of Mississippi Medical Center; 1991.
36. Standley JM. Music research in medical/dental treatment: meta-analysis and clinical applications. *J Music Ther.* 1986;23:56–122.
37. Belter RW, McIntosh JA, Finch AJ, Saylor CF. Preschoolers' ability to differentiate levels of pain: relative efficacy of three self-report measures. *J Clin Child Psychol*. 1988;17:329–335.
38. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. New York, NY: Academic Press; 1977.