Music therapy and pain management in pediatric patients undergoing painful procedures: A review of the literature and a call for research

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Abstract

Helping pediatric patients cope with painful procedures is a critical element in providing comprehensive medical care. Although pharmacologic agents such as analgesics, sedatives, and amnesiacs can be and often are used, they do not address all the elements of a painful experience and can have undesirable side effects. Because of this, there has been a concerted effort to find non-pharmacologic therapies that can be used to reduce reliance on pharmacologic agents. The use of music to help children and adolescents cope with pain has been the subject of considerable research. In this paper, we discuss the different ways in which music is used in the clinical setting and highlight the unique aspects of music therapy, as contrasted with other music/sound-based interventions, that make it a particularly powerful modality in the care of pediatric patients.

Keywords: Music therapy, pain management, pediatrics, procedural pain, music, complementary and alternative medicine (CAM).

Introduction

Pain should be viewed as more than a physiological, one-dimensional experience. Indeed, the International Association for the Study of Pain (IASP) defines pain as “an unpleasant sensory and emotional experience associated with actual or potential damage, or described in terms of such damage”(1). More broadly, pain can be understood as a complicated phenomenon, including both physiological and psychological components. Psychological components possibly involved in pain perception are fear, anxiety, and stress (2-4). Presner et al (5) state that, “The close relationship between physical pain and contributing psychological factors necessitates that both be managed simultaneously…” (p. 84). Evans, Tsao, and Zeltzer (6) agreed and advocate for
the biopsychosocial model of pain, where the functioning of the body and the mind are both addressed.

Pediatric pain is an area of pain management needing attention. Our understanding of the assessment and management of pain in children is much less robust than our understanding of pain in adults. In fact, the inadequate treatment of pain in children has been the subject of many papers in the health care literature (2-3,7-9). Gerik (8) stated that “…pain remains one of the most misunderstood, underdiagnosed, and undertreated/untreated medical problems, particularly in children” (p. 295). Adult pain is better understood and more effectively managed for several reasons, including the lack of reliable and valid research concerning safe and effective pharmacological interventions (4). This lack of research may be due to the ethical implications of testing health-related interventions on human beings, specifically children (10). In addition, the common assumption that children are resilient and do not experience as much pain as adults has inhibited attention to treating pain in pediatric patients for many years (2).

We know that currently used pharmacological interventions can be risky and have undesirable side effects, and are unable to address the complete pain experience of the pediatric patient (11). For example, sedation is often used to provide comfort and reduce the amount of recall for children who undergo painful procedures. Unfortunately, neuromuscular blocking drugs can have negative withdrawal symptoms and may also accumulate in the body resulting in drug toxicity, interactions with other drugs, or prolonged weakness (12). Additionally, inadequate pain management in children may have long lasting detrimental effects, especially in pain perception, tolerance, and coping skills (9,11).

In an ever changing, increasingly competent world, it is logical and prudent that we pay attention to and research all possibilities for increasing the effectiveness of pain management for children. Such possibilities include the use of complementary approaches integrated into conventional medical practice. A particularly promising approach is provided by music therapy, a wholly safe and cost effective modality (13-14), that can be used in place of or in addition to pharmacologic or other non-pharmacologic interventions.

Music therapy

Music plays a central role in all human cultures. Throughout history, music has been shown to be an integral and ubiquitous part of peoples’ lives, affecting the workplace, leisure activities, socialization, religious celebrations/traditions, and virtually all other aspects of the human experience (15). People of all ages, everywhere, use music in different ways, almost unconsciously, to communicate, gain understanding of their environment, and support or alter their mood (16-17).

Music therapy was first practiced in the United States during WWI, when music was found to address veterans’ physiological and psychological needs. In 1950, music therapy became a profession and in 1998, music therapy organizations in the United States came together to form the current American Music Therapy Association (AMTA) (18). Music therapy can be defined as “…the clinical and evidence-based use of music interventions to accomplish individualized goals…”(19) and “…a systematic process of intervention wherein the therapist helps the client to promote health, using music experiences and the relationships that develop through them as dynamic forces of change” (20).

Music therapists must complete a comprehensive curriculum, at a minimum of the bachelors or equivalency level, in an approved music therapy program in order to sit for the Certification Board for Music Therapists (CBMT) examination. This allows them to earn the national credential of Music Therapist-Board Certified (MT-BC), which is required for professional practice. Masters and doctoral level music therapy degrees are also offered. Required areas of study in the education of a music therapist include coursework in music therapy (including clinical practicum); psychology; music; the biological, social, and behavioral sciences; special population needs; and general studies. In addition, the student must complete an internship under the direct supervision of a MT-BC, at a minimum of 900 hours. Common interventions used by music therapists are instrumental/vocal improvisation, singing, playing
Music therapy and pain management in pediatric patients undergoing painful procedures

Music therapy in the medical setting has been used to decrease pain perception (2,21), decrease anxiety and depression (22-23), reduce stress-related cardiovascular and endocrinologic reactions (24), increase relaxation (25), increase “immunologic defenses” (26-27), encourage resolution of grief issues (28) and enhance patient communication (29). Specific research on music therapy and pain management is heterogeneous and multi-faceted. These studies cover a wide range of pain categories including chronic pain, procedural pain, and pre/peri/post-operative pain. This article, however, will focus mainly on pediatric procedural pain.

Music therapy versus other therapeutic music interventions

Many interventions involving music exist in medical settings and in the medical research literature. It is essential to distinguish music therapy from music listening, sound therapy, and other types of therapeutic music interventions. For example, in some hospital settings or research studies, live music is provided by professional musicians/music practitioners (often harpists) in public areas or at a patient’s bedside. This is not considered music therapy, as these experiences do not involve assessment, treatment, evaluation, a therapeutic relationship, and a trained music therapist. Likewise, pre-recorded music may be provided for patient listening by medical professionals in various situations considered stressful for patients. Researchers may refer to these interventions as “passive music therapy” although they can more appropriately be termed “music medicine” interventions. In other words, in order to clearly delineate between music therapy and other music interventions, the term “music medicine” can be used to refer to passive listening interventions that are conducted by medical personnel, not music therapists (3). Again, music medicine is not music therapy, because these practices do not involve a treatment process, a trained music therapy professional, or a therapeutic relationship with the patient that develops through the music. Finally, music therapy is neither sound therapy (wherein a person’s response to a single frequency or amplitude may be examined) nor is it limited to the use of a single musical work, such as Mozart’s Sonata for Two Pianos in D Major (K.448), which is the focus of the popular “Mozart Effect” research (30).

Although music can have therapeutic benefits for patients in medical settings in and of itself, a meta-analysis of the research literature suggests that music therapy as a treatment modality has greater effects on certain dependent variables such as mood, pain, anxiety, and epinephrine levels than music alone. This implies that the goal-directed and interactive nature of music therapy provides a more comprehensive treatment and more effective outcomes compared to passive music medicine interventions (3).

As distinguished from sound therapy and music medicine, music therapy is a uniquely constructed intervention in that the goals of any given session and the methods used to achieve those goals are individualized, based on an assessment of the client’s preferences, abilities, and needs, specifically at the time of the intervention. Therefore, music therapy can be applied to any population, of any age, and with any form or extent of disability. Traditionally, populations served by music therapists have included adults and children with psychiatric disorders, physical disabilities, developmental disabilities, neurological impairments, and speech and hearing impairments (19). Because music therapists are professionals who are able to use music to address a person’s physical, social/emotional, cognitive, and communication needs, it has become clear that individuals with any type of emotion-related problems, such as pain or anxiety, also can benefit from music therapy. Data also support the use of music therapy in the treatment of individuals with such physiologically-based symptoms as nausea and vomiting (3). In addition, music has been shown to increase immune functioning, most likely through inhibition of the stress response that can interfere with immunologic competence (26-27).

Research considerations

In considering the music therapy research literature, it is critical to note that age and background influence
music preferences. In addition, people typically prefer different types of music under different circumstances. This preference is important for study design, and raises the possibility that better pain control might occur if the participant favors the music provided in the intervention (31). This underscores the significance of flexibility and adaptability in any intervention and reinforces the need to use actual interactive music therapy interventions to achieve maximum benefit (6). For example, Arts et al (32) studied the effectiveness of music distraction versus the application of a lidocaine-prilocaine emulsion in children undergoing venipuncture. They found that the music distraction provided was not effective in decreasing pain. Before coming to the conclusion that music as distraction can never be effective, it is critical to note that in this study, music was administered through earphones and was the same for every patient (ages 4-16 years). Unfortunately, the composer/artist or title of the music was not identified in the report, but it is highly unlikely that the preferences of a preschooler would be similar to that of a high school student. In this case, music therapy was not being researched; rather, it was a study of the effectiveness of one particular type of music, or “music medicine”, as distraction to ameliorate pain perception.

Hatem (33) also studied the effects of music (not music therapy) on pain and vital signs in pediatric patients after cardiac surgery. In the music group, patients, aged 1 day to 16 years old, listened to classical music (Vivaldi’s Spring) for 30 minutes through headphones. The control group wore headphones for 30 minutes with no music. Some patients in the control group refused to participate because of the lack of music. Others refused to participate because of distaste for the particular music being played. Participation and, therefore, possibly effect size could have been increased even in this music medicine study if the music provided had at least been music that a participant preferred. In the case of infants, we know that lullabies are usually used to soothe and probably would have been a more appropriate selection for infants (34).

Complementary and Alternative Medicine (CAM). As defined by the National Center for Complementary and Alternative Medicine of the National Institutes of Health, there are five different types of CAM therapies: biologically-based, energy, manipulative and body-based, whole medical systems, and mind-body medicine. Examples of CAM therapies are hypnosis, acupuncture, massage, chiropractic, and Reiki. Music therapy, like other expressive therapies (e.g., art, dance, drama), is considered a mind-body medicine as it focuses on the mind’s ability to ameliorate physical dysfunction and reduce negative symptoms (6).

Pharmacological and CAM collaboration

There is no evidence proving that treating the psychological components of pain perception will fully eliminate the need for pharmacological interventions in all instances. Studies in medical settings do, however, support the need for combined approaches that treat the whole pain experience of the pediatric patient. Kazak et al (35) combined developmentally appropriate psychologic preparation with standard pharmacologic analgesia/sedation for painful procedures. They found that distress immediately before procedures (anticipatory anxiety) is significantly lower among children who receive a combined psychologic-pharmacologic intervention than among those who receive only a pharmacologic intervention. In addition, children receiving a combined approach seemed to require less pharmacologic sedation.

Theoretical implications

The majority of music therapists ascribe to the widely accepted Gate Control Theory of Pain. This theory is based on the premise that painful nerve stimuli need to be processed in the brain in order to be felt. The more a patient attends to a stimulus other than the pain stimulus, the more the brain is flooded with other information that “blocks” the perception of pain reaching the brain (2,5,11,18,36). Music therapy is believed to reduce pain in children because it addresses the three major components of perceived
Music therapy and pain management in pediatric patients undergoing painful procedures

pain: sensory-discriminative, motivational-affective, and cognitive-evaluative. More specifically, music engages the auditory sense; preferred interventions cater to the specific mood of the patient; and cognitive strategies such as imagery, self-statements, or attention grasping devices can be activated in music therapy interventions (5).

Proposed physiological mechanism of action

The mechanism by which music affects pain perception and response has been investigated. Music activity has been shown to synchronize neuronal discharge patterns by incorporating nerve impulses into the musical task (37). This results in neuronal inhibitory effects often associated with the release of gamma-aminobutyric acid (GABA-like effects) on specific physiologic processes whose functional variations are indicators of anxiety, tension, or stress. It has been shown that the central nucleus of the amygdala sends projections to portions of the lower brain stem that control the autonomic nervous system and to the hypothalamic nucleus that is active in controlling secretion of stress-related hormones through the hypothalamic-pituitary-adrenal axis (36,38).

Thus, the proposed mechanism of action is reduction in signaling in the amygdala via changes in activity in the medial geniculate nucleus of the thalamus as musical and other auditory stimuli pass through the final relay station in the sound pathway to the auditory cortex. Reduced signaling in the amygdala, the proposed seat of mood and emotion, is reflected in reduced signaling in the hypothalamus. In turn, the hypothalamus reduces its level of stimulation of the pituitary and endocrine glands, including the adrenal medulla, which secretes epinephrine and norepinephrine, and the adrenal cortex, which secretes cortisol and other glucocorticoids known to affect the autonomic nervous system (36,38).

The autonomic manifestations of music as an anxiolytic and analgesic have been demonstrated clinically in young adult patients undergoing a stressful experience (physical examination) with or without soothing background music. Those exposed to music therapy showed significantly less subjective anxiety, and lower heart rate and blood pressure (39).

Functions of music

Listening to music can enhance a patient’s relaxation, and therefore pain perception, in many ways. Music may serve as a masking agent, where it covers other unwanted background auditory stimuli in the hospital environment. Music may also serve as a distraction from attention on stressful or painful stimuli. Distraction from and masking of unwanted stimuli can create a positive environmental stimulus which can, in turn, cue physiological and psychological responses in the patient, leading to reduced pain perception. In addition, interactive music therapy, which engages the client, can be even more effective than passive music listening since it provides a stimulus for active focus, reducing focus on painful stimuli (18,36).

Entrainment

Entrainment mechanisms refer to the process first defined in physics by which two independently functioning oscillators, with different vibrational rates or frequencies (periods) time lock with each other, creating one shared period (2). Entrainment has been demonstrated in physiology, psychology, neurorehabilitation and music therapy (2). In music therapy, entrainment has been investigated as a process to reduce pain. During entrainment, the therapist matches the patient’s pain perception with appropriate music stimuli, such as rhythm, pitch, tempo, timbre, and other musical elements. The therapist carefully attends to the patient’s changing pain perception and adapts the musical elements accordingly, guiding the patient’s pain through the music from a painful to a soothing state (2,40). Rider (27) showed music entrainment to be effective in reducing pain in patients with spinal cord injuries. Bradt (2) also showed that music entrainment can greatly reduce pain intensity in postoperative pediatric patients.

Music therapy and pain management

Distress and specifically procedural pain have been shown to decrease with the use of music therapy.
Malone (41) found that music therapy interventions before, during, and after invasive medical procedures may decrease distress in pediatric patients. Additionally, Noguchi (42) found that self-reported pain in addition to signs of distress were lower for pediatric patients receiving music therapy than those patients receiving a spoken story intervention or standard care. In sum, music therapy can reduce psychologically and physically harmful symptoms of anxiety, which in turn, can reduce perceived pain.

**Reviews of literature/meta-analyses addressing procedural pain and music therapy**

In 2005, Dileo and Bradt (3) published a book on music therapy that includes a meta-analysis of studies with medical populations and recommendations for future studies and research in this area. Of the 183 studies included in the analysis, 11 applied directly to pediatrics. Out of 40 different dependent variables analyzed, pediatric pain was the specific focus of three studies. In contrast, 43 studies on pain in adult/all age groups, including but not limited to surgery, cardiology, cancer/terminal illness/HIV, and OB/GYN, were incorporated into the meta-analysis. The three studies that specifically addressed pediatric pain did show that music therapy made a positive difference, but none had an overall significant effect size. Noteworthy is Dileo and Bradt’s (43) finding that music therapy interventions, in general, clearly had a greater effect than music medicine interventions. Overall, the authors advocate for more music therapy-specific studies to create a fairer representation of the effects of “music therapy” compared to “music medicine” in the literature and to help increase our understanding of the reliability and validity of true music therapy interventions for pediatric pain. They also recognize that, even though better collaboration between researchers in terms of methodologies, approaches, and outcome measures are needed, music therapy itself is “…tailored to the individual needs of a client (as determined by assessment), and as such, are difficult to ‘standardize’ across subjects for experimental research purposes…” (p. 78).

In a review of CAM interventions and pediatric pain, Tsao and Zeltzer (44) also reported that more research is needed in all areas of music therapy and pediatric pain in order to be confident in its effectiveness. Specifically, more research that follows the guidelines of the American Psychological Association Dissemination of Psychological Procedures (APA Task Force) is needed to deem music therapy an Empirically Supported Therapy (EST). Guidelines require that research include at least two independent research groups, demonstrating that the intervention condition is better than the control condition. Components of study design that will help assure better research methodology include use of a treatment manual, clearly defined populations with specific criteria for inclusion, identification of a specific problem to be addressed, valid and reliable outcome measures, and appropriate analysis of data. If these guidelines are followed, an intervention may be labeled “efficacious.” Tsao and Zeltzer also argued that there is an essential need for research that shows music therapy is more effective than other kinds of auditory distraction. Despite their lack of strong support for music therapy and pediatric pain, the authors do agree that research in music therapy interventions for pediatric injection pain, for example, is promising. In addition, they advocate for the use of music therapy in conjunction with other CAM interventions such as hypnosis, relaxation, and guided imagery to create a multi-layered effect. They hypothesize that such a multi-faceted approach will increase the effectiveness of all the CAM and pharmacological interventions involved. This may also have the effect of better documenting how much music therapy is preferred over other modalities as well as to judge its feasibility.

More recently, in 2008 Klassen et al (11) systematically reviewed randomized controlled trials for music and pediatric pain and anxiety during medical procedures. This study was created mainly as a reaction to a meta-analysis published in 2006 by Cepeda et al (13) on music and pain. Cepeda et al. found the data supporting the effectiveness of music to relieve pain in pediatric patients to be inconclusive, partly because of the myriad of confounding variables (e.g., different assessment tools, protocols, designs) between studies, and partly because they only researched physical pain. They did, however, advocate for the combination of music therapy and other non-pharmacological therapies to treat pediatric
Music therapy and pain management in pediatric patients undergoing painful procedures

Music therapy and actual music therapy interventions were also supported as being safe, inexpensive, and easily adaptable to the medical setting.

Klassen et al (11) expanded on the meta-analysis by Cepeda et al (13) by incorporating more studies, including anxiety as a variable in the pain experience of the pediatric population, and limiting their research to procedural pain. Their results do not indicate for which specific procedures music therapy is best suited, but they do find that “music is effective in reducing anxiety and pain during clinical procedures in children and youth” (p.126). Again, more studies are needed to show the differences in effectiveness between music therapy and music medicine studies. In sum, Klassen et al (11) supported the use of music therapy in the medical setting, especially in terms of reducing the amount of pharmacological intervention needed.

Another report focusing on music therapy in treating pediatric pain is a review by Evans, Tsao, and Zeltzer (6) in late 2008, that explored the use of CAM therapies in general, and procedural pain in the pediatric population. These researchers found that music therapy and hypnosis are the most common modalities discussed in the literature. Most of the music therapy studies have involved pain associated with injections, blood draws, and burn treatment, all with positive results. Evans, Tsao, and Zeltzer (6) also supported the use of music therapy over passive music interventions, citing the significance of assessment and patient preferred music in increasing compliance and effectiveness in interventions. They agree with previously mentioned authors that further research is needed in music therapy, specifically randomized controlled trials comparing music therapy with standard care/no care and using blind raters in order to solidify the evidence that music therapy should be considered a standard treatment option with this population.

Advocating for the use of music therapy in pediatric pain

Support for using music therapy interventions in treating pain both in the medical setting and in general is common in the medical literature. Crean (12) believed that music therapy has a place in the pediatric intensive care unit. Avers, Mathur, and Kumat (45) supported the use of music therapy as an integral part of treating the pediatric population, specifically to complement the use of pharmacologic interventions in order to reduce the stress, and therefore pain, response in patients. Berlin (46) stressed the positive impact that music therapy has during invasive procedures in the emergency department.

Resources

Texts by Loewy (47) and Robb (48) both represent excellent resources. Loewy’s (47) book on music therapy and pediatric pain includes several chapters on successful approaches to assess and treat various kinds of pediatric pain. Similarly, Robb (48) provides a compilation of articles on research and evidence-based practice for music therapy and pediatric healthcare, which includes research and clinical examples for several types of pain and other medical issues treated with music therapy. In their book on model programs, Standley and Walworth (14) provide a cost/benefit analysis of hospital/university partnerships for medical music therapy (the use of music therapy in medical settings, not to be confused with “music medicine”), interdisciplinary collaboration, and internships. In a related article, Walworth (49) presents an analysis of a cost-effective program that specifically focuses on using music therapy for procedural support.

Additionally, Stouffer, Shirk, and Polomano (50) provide practice guidelines for music therapy interventions in pediatrics. In sum, collaboration between music therapists and hospital staff is feasible and can be achieved through in-service presentations and observation of the results of interventions.

Conclusions

Music has a definite place in treating pediatric procedural pain. Research has shown that music listening (recorded and live) and actual music therapy interventions can reduce perceived pain in pediatric
patients. These interventions are cost-effective, safe, and feasible.

We propose that music interventions can be understood as three tiered, with recorded music at the bottom, live music listening in the middle, and music therapy at the top. All music interventions can have a positive effect on the patient, but benefits increase at higher tiers because the goals become both more comprehensive and also more individualized. Listening to recorded music may not just distract or mask, but also engage a patient, especially if the music is preferred by the patient. This occurs because music, unlike noise, is an intentional and organized stimulus consisting of at least melody, rhythm, and form, allowing for attending and engagement on many levels (31,36). Live music interventions in music medicine by non-music therapists (e.g., musicians or music practitioners) may provide soothing, relaxing, and possibly healing environments, but do not provide an assessment process or focus the goals/objectives of the intervention based on the patient’s needs, nor do they solicit interaction with the patient (51-52). Actual music therapy interventions are based on individual client needs and, therefore, goals vary depending on those needs. Music therapists work with the client to assess preferences and needs in order to create goals and, thus, interventions that address those goals. Also, music therapists have the ability to improvise and adapt the music/intervention to the client’s state in the moment, thereby keeping the patient engaged in the interaction with the music and the therapist. For example, in the case of pain management, music therapists are able to appropriately address anticipatory anxiety, procedural pain/anxiety, and the physical/psychological aftermath of the procedure by regularly assessing and adapting the intervention. This focused connection provided by the specifically chosen interventions in the therapeutic relationship between therapist and client makes music therapy an exceptional treatment modality (47).

References


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