Music as a treatment for anxiety and/or pain for children during painful procedures:
An Integrative Review

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Abstract

Pain is a subjective, unpleasant sensory experience which is formed and exacerbated by previous memories of pain (International Association for the Study of Pain, 1994; Young, 2005). Personal experiences of pain, which can be caused by childhood medical procedures, can be worsened by the presence of anxiety and anxiety can lead to higher reports of pain (Goodenough et al., 1999; Whitehead-Pleaux, Baryza, & Sheridan, 2006). Pain can begin as early as a day old and if the pain goes unattended, it has been associated with lifelong effects including lower pain threshold, PTSD, medical fear, and avoidance of healthcare (Pate, Blount, Cohen, & Smith, 2010; Rennick, Johnston, Dougherty, Platt, & Ritchie, 2002; Taddio, Shah, Gilbert-MacLeod, & Katz, 2008). An integrative review was performed to examine the state of the literature on using music as a treatment for pain and anxiety in children during painful procedures. A search of CINAHL, PubMed, and EMBASE resulted in eight randomized controlled trials involving music as an intervention with a total of 596 children age 0-18 undergoing a painful procedures. In general, music was seen to be a predictor of decreasing pain and/or anxiety during painful procedures. However, due to the heterogeneous nature of the studies it was difficult to draw definitive conclusions. Future research should focus on larger sample sizes and more consistent methods to answer questions of music’s effectiveness.
Music as a treatment for anxiety and/or pain for children during painful procedures:

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Pain and anxiety are universal experiences that span cultures, sex, and age. Pain is defined as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage” by the International Association for the Study of Pain (1994). The emotional experience that accompanies pain begins early in life and helps to define pain for each individual (Young, 2005). This pain can come from a number of stimuli including pain from medical procedures such as immunizations, blood draws, and/or dressing changes.

Anxiety plays a big role in one’s personal concept of pain (Goodenough et al., 1999). Both anxiety and pain can start as early as infancy. Taddio, Shah, Gilbert-MacLeod, and Katz (2002) found that an infant as early as a day old could have anticipatory distress in relation to an alcohol wipe preceding a heel-stick. A child’s perception of previous painful procedures, even if they were observed to have low stress during the initial painful experience, tends to be distorted upon recall, often resulting in increased subsequent anticipatory distress (Cohen et al., 2001). A high amount of anxiety may occur before returning to a healthcare setting and can lead to a greater pain response (Goodenough et al., 1999). In turn, that pain or anticipation of pain can lead to higher amounts of anxiety (Whitehead-Pleaux et al., 2006).

Children are thought to be the most vulnerable population when it comes to pain (Linhares et al., 2012). Even minor medical procedures can be a source of pain; Jacobson et al. (2001) found that even vaccinations, a routine procedure in the United States, cause a significant amount of distress. Stevens et al. (2011) found that in a 24 hour period in 15 Canadian hospitals, 78.2% of the pediatric inpatients underwent at least one painful procedure with only 28.3% of them receiving a source of pain management for the procedure.
Untreated pediatric pain has been found to have short-term and long-term effects. Pain has many short-term effects including but not limited to increase in heart rate and cardiac output placing strain on the heart, decrease in tidal volume leading to hypoxemia, and decrease in immune response leading to possible infection (Kindler & Polomano, 2010). Long-term effects include lower pain threshold later in life, post-traumatic stress disorder (PTSD), and adult fear and avoidance of healthcare (Pate et al., 2010; Rennick et al., 2002). Pain in infancy has been found to have long-term effects in a study that showed that ex- neonatal intensive care unit (NICU) patients were found to be more pain sensitive in adolescence (Buskila et al., 2003). Adolescents from the pediatric intensive care unit (PICU) were seen to have signs of PTSD and increased medical fears six months after discharge (Rennick et al., 2002). This finding was reinforced by a study showing that the fear and pain experienced by a child significantly predicts the amount of fear, pain, and coping effectiveness they will have as an adult (Pate et al., 2010). Repeated painful procedures as a child can lead to a lifetime of avoidance of medical situations (Pate et al., 2010).

For many painful procedures, there is the option of using a pharmacological agent such as an analgesic or a sedative. Stevens et al. (2011) found that 84.3% of pediatric patients in the hospital receiving a procedure had received an analgesic ranging from a topical agent such as lidocaine to a continuous opioid infusion such as morphine in the last 24 hours. Opioids such as morphine have been known to have many adverse effects such as pruritus, constipation, sedation, dysphoria, and respiratory depression (Zempsky & Schechter, 2003). These are the types of reactions that could be avoided by using non-pharmacologic pain treatments such as music.

Distractions, in general, are commonly used in pediatric care both by parents and healthcare professionals to reduce any pain or distress associated with painful procedures (Koller
& Goldman, 2012). Some common distractions include video games or virtual reality computer games, controlled breathing, guided imagery/relaxation, television watching, and music (Koller & Goldman, 2012). For this study, I will be focusing on the use of music. Music has been shown to increase emotional arousal and pleasure (Salimpoor, Benovoy, Longo, Cooperstock, & Zatorre, 2010), which, in turn, could decrease pain and/or anxiety.

In a systematic review of 19 studies including 1513 subjects from 8 months old to 20 years old experiencing a variety of painful procedures, Klassen, Liang, Tiosyold, Klassen, and Hartling (2008) concluded that music is effective in reducing both anxiety and pain in children though the high level of heterogeneity made it difficult to draw many conclusions. The results showed that multifaceted interventions, more than one type of distraction, can be more effective than music alone. Also, their review differed from past studies by showing a higher effect size for passive music therapy (without a music therapist) versus active music therapy (involving a music therapist interacting with the patient). Some articles showed music as more effective based on observed measures versus self-reported measures. However, it is difficult to synthesize results from different outcome measures across studies and self-report scales are not as reliable in younger children. Nonetheless, the authors concluded, music was more effective when compared to standard of care rather than a control group. (Klassen, Liang, Tjosvold, Klassen, & Hartling, 2008)

Since the last extensive systematic review on this topic included data through 2007, the purpose of this review is to document the state of the literature from 2007-2014 on the use of music for pediatric patients during procedures.
Methods

For this integrative review, I searched CINAHL, PubMed, and EMBASE looking for articles published from 2007-2014. Search terms included music AND (child* or pediatr*) AND (pain* OR anx* OR stress* OR distress* OR effect* OR affect*); 1738 articles were found in the three databases. Studies were filtered using the following inclusion criteria: a) humans; b) randomized controlled trial; c) all children (0-18). After filtering, 170 articles were screened by reading titles and abstracts; 135 were excluded for one or more of the following criteria: a) not exclusive to children; b) did not include a procedure; c) interventions included more than music; d) did not mention the use of music; e) language other than English; f) no mention of a randomized control trial; and g) a literature review. Thirty-five full-text articles were pulled with 15 being read after duplicates were removed. Seven were excluded for: a) music was not the only factor in the intervention group; b) participants over the age of eighteen; c) no control group without music. Eight studies are included in this integrative review.

Results

In this review, eight studies totaling 596 pediatric patients were examined (See Table 1). The subjects’ ages ranged from 0-16 with most participants ranging from 4-12 years old. These studies include a number of procedures: IV insertion, vaccination, cast room procedures, lumbar puncture, dressing changes, acupuncture, and two included venipuncture. Six studies looked at the procedures within an inpatient setting, one was outpatient, and one was a duel inpatient and outpatient study.

To measure pain and anxiety a series of instruments were used. Five studies included physiological measures, the most common of which was heart rate. Other self-report measurements were used in the studies but Wong Baker’s FACES scale was the most common, being used in four out of the eight studies.
The interventions, though all involved music, varied greatly. Music delivery included three studies using headphones as their intervention, two using music docks with no headphones, two using live music, and one that used headphones and no headphones in their intervention. Music was compared to Eutectic mixture of local anesthetics (EMLA) cream, placebos, and standard of care. Music types also varied with Indian instrumental music, American instrumental music, self-selected CD’s, children songs, and lullabies.

Overall, music was found to be a particularly useful intervention to decrease pain, anxiety, and/or distress in children during different procedures. EMLA cream was the only intervention to be seen as more effective during a procedure (Balan, Bavdekar, & Jadhav, 2009).

Discussion

Children experience pain and anxiety during a number of procedures. This pain and anxiety can have both short term and long term effects on a child’s life including increased medical fear, pain in future procedures, and avoidance of future healthcare (Young, 2005; Pate, 2010). Distractions, including music, are used during procedures in hopes to relieve some of that pain and anxiety. As with Klassen, Liang, Tiosyold, Klassen, and Hartling’s (2008) review, music was generally found to decrease anxiety and/or pain in children during painful procedures in the subsequent eight studies from 2007-2014 included in this review.

Critique of literature

Although the majority of the studies found music to be helpful in decreasing pain and/or anxiety, not all showed the same effect. One study by Whitehead-Pleaux, Zebrowski, Baryza, and Sheridan (2007) found music to not be a factor in decreasing pain, anxiety, or heart rate during four procedures observed. However, this study had a number of limitations, including a
small sample size of nine participants with some participants using analgesics to supplement the music and the observation of four procedures at three different sites with no control groups.

Heart rate, used as a measurement in five studies, was shown to have differing outcomes; three studies found a decrease in heart rate for the music group while the other two did not find a significant decrease. All interviews of participants and observers showed a consensus that music was helpful in decreasing anxiety and pain even if the physiological data did not match.

For four of the studies, it was not possible to blind the observers due to the music being live or played without headphones (Balan et al., 2009; Caprilli, Anastasi, Grotto, Scolo Abeti, & Messeri, 2007; Hartling et al., 2013; Liu et al., 2007). This limitation in design may affect the validity of the results of the study.

For two of the studies (Hartling et al., 2013; Ó. Kristjánsdóttir & G. Kristjánsdóttir, 2011) the participants showed little or no pain/distress during the procedure with or without music. Hartling et al. (2013) did a secondary analysis of the data by removing the children with no distress, and found the remaining participants’ distress decreased with the use of music. This suggests that not all children experience significant pain and anxiety, but if they do, music can be helpful.

**Limitations of this review**

The limitation of this review was the lack of articles available on the topic in the last seven years. Within the limited number of studies reviewed there was a large amount of heterogeneity. The differences in settings, procedures, subjects, measurements, types of music, and music delivery methods make it difficult to draw conclusions about the best practices related to the use of music during painful procedures. Without consistency in the designs, interventions,
and measurements of the studies, it is challenging to determine which factors are contributing to the results.

**Implications for future research and clinical practice**

For future research, it would be beneficial to have larger samples with more homogenous methods and controls. Studies should focus on keeping interventions and measurements similar across ages and procedures in order for specific changes in practice to be indicated. Studies should assess the different factors (for example, types of music, setting, ages, delivery of music, time music is played) alone and together in relation to identify if music is effective and if so, which types of patients benefit most and and how should we deliver the music. While EMLA cream proved to be more effective than music in reducing pain and anxiety in one study (Balan et al., 2009), EMLA cream takes 60 minutes to produce adequate analgesia, which is not always available before a procedure (Krauss, 2001). Music may be a more effective treatment when this time is not available.

**Conclusion**

Through the review of eight studies including 596 children from age 0-18 during seven different procedures, music appears to be effective in treating pain and anxiety for some children during specific procedures. However, more definitive and clinically directive conclusions are difficult to reach with the large amount of heterogeneity amongst the studies. More studies with rigorous methods need to be developed in order to clarify the types of patients and procedures for which music should be used in addition to the most effective types of music and delivery methods.
References


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Appendix A

Table 1
Details of included studies

<table>
<thead>
<tr>
<th>Title</th>
<th>First Author, Date</th>
<th>Procedures</th>
<th>Setting</th>
<th>Subject s</th>
<th>Interventions</th>
<th>Measurements</th>
<th>Methodology</th>
<th>Results</th>
<th>Critique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can Indian Classical Instrumental Music Reduce Pain Felt During Venipuncture?</td>
<td>Balan, 2009</td>
<td>Venipuncture</td>
<td>Inpatient tertiary care in Mumbai</td>
<td>5-12 y</td>
<td>* Local Anesthetic (LA) group [Eutactic mixture of local anesthetic agents (EMLA)] n=50</td>
<td>* Visual Analogue Scale (VAS)</td>
<td>* Indian instrumental classical music was played with headphones for 15 mins before, throughout, and 5 mins after the procedure</td>
<td>* VAS scores were lower at all time points in LA group compared to placebo and music group though the results were not always statistically significant</td>
<td>* Only one type of music was used with no options for the participants</td>
</tr>
<tr>
<td>Study Title</td>
<td>Author(s)</td>
<td>Setting</td>
<td>Participants</td>
<td>Methods</td>
<td>Findings</td>
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<tr>
<td>Interactive music as a Treatment for Pain and Stress in Children During Venipuncture: A Randomized Prospective Study</td>
<td>Caprilli, 2007</td>
<td>Children's Hospital in Italy</td>
<td>* 4-13 y&lt;br&gt; * Mean age= 4.8&lt;br&gt; * 50 males &amp; 58 females</td>
<td>* Music group [live music] n=54 &lt;br&gt; * Control group n=54 &lt;br&gt; * Amended Form of the Observation Scale of Behavioral Distress &lt;br&gt; * FACES (Wong Baker Scale) &lt;br&gt; * Two musicians played and sang to the patient from the waiting room to the procedure room and back to the waiting room &lt;br&gt; * Two observers recorded the measurements before, during, and after the blood draw</td>
<td>* Music showed to be statistically significant in affecting a child's distress score and a child's pain score &lt;br&gt; * No differences were found between genders &lt;br&gt; * Age was found to negatively relate to pain and anxiety scores &lt;br&gt; * Children under 7 reported more stress</td>
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### Music to Reduce Pain and Distress in the Pediatric Emergency Department A Randomized Clinical Trial

**Hartling, 2013**

- **IV placement**
- **Pediatric Emergency Department in Canada**

<table>
<thead>
<tr>
<th>Music group [used instrumental music picked out by the music therapist through an iPod dock] n=21</th>
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</thead>
<tbody>
<tr>
<td>* Average age= 6.29</td>
</tr>
<tr>
<td>* 26 males &amp; 13 females (3 not recorded)</td>
</tr>
<tr>
<td>* 12 identified as an ethnic minority</td>
</tr>
<tr>
<td>* Standard Care n=21</td>
</tr>
</tbody>
</table>

- **Observational Scale of Behavioral Distress-Revised (Collected via videotape)**
- **Child-reported pain by the Faces Pain Scale-Revised**
- **Heart Rate**
- **Parent Satisfaction (Likert Scale)**
- **Health care provider satisfaction (Likert Scale)**
- **Ease of performing the procedure**
- **Parental anxiety**

- **Obtained pre-procedural self-reported pain and parent completed the State Trait Anxiety Inventory (STAI)**
- **Music was turned on as the nurse set up**
- **Self-reported pain and STAI was collected after the first attempt at placement**
- **After IV placement, the parent completed the satisfaction questions about procedure and the researcher collected child's post self-reported pain score.**

- **When removing children with no distress from the data, there was a significantly less increase in distress from before to after the procedure in the music group**
- **Pain scores were higher among the standard care group with no difference in heart rates.**
- **The differences between parent satisfaction between groups was not statistically significant**
- **Health Care Providers recounted the procedure as easier for the music group**

- **Could not blind staff or participants to the study**
- **As personnel learned more about the study, some parents were encouraged to sing to their child**
### Randomized Clinical Trial of Musical Distraction with and without Headphones for Adolescents’ Immunization Pain

**Kristjánsson, 2011**

- **Polio Immunization**: Primary School
- **Age**: 13-15 y
- **Gender**: 63 males & 55 females
- **Musical Distraction**:
  - With Headphones: n=38
  - Without Headphones: n=31
- **Standard Care**: n=39
- **Pain Measurement**: 10 cm Visual Analogue Score
- **Anxiety Measurement**: 10 cm Visual Analogue Score
- **Questionnaires**: Based on the WHO-EURO cross-nation study series of health-related behaviors in school children measurements
- **Participants**: Listened to music 2-3 minutes before and after the immunization.
- **Results**: Adolescents receiving musical distraction were 2.8 times more likely to experience “no pain” than standard care.
- **Additional Notes**: The pain that was reported was very low.

### A Randomized Prospective Study of Music Therapy for Reducing Anxiety During Cast Room Procedures

**Liu, 2007**

- **Cast Room Procedures**: Including: Cast Removal, Cast Application, Suture Removal, and Pin removal
- **Age**:
  - Music Group: 0-10 y, Average age for music group=5.6
  - Standard Care: Average age for no music group=5.9
- **Heart Rate Measurement**: Heart rates were recorded for 15 second intervals for one minute in the waiting room and immediately after.
- **Pulse Oximeters**: Placed on the children in the waiting room.
- **Heart Rates**: Recorded for 15 second intervals for one minute in the waiting room and immediately after.
- **Other Comparisons**: Not statistically significant.
- **Randomization**: Done by clinical day rather than patient.
- **Additional Notes**: The standard care group started out with lower heart rates.
| Music Therapy to Reduce pain and Anxiety in Children with Cancer Undergoing Lumbar Puncture: A Randomized Clinical Trial | Nguyen, 2010 | Lumbar Puncture | Hospital | * 7-12 y | * 25 males & 15 females | * Music group [with headphones listened to traditional Vietnamese music or children songs] n=20 | * Control group [headphones with no music] n=20 | * Numeric Rating Scale (NRS) | * Spielberger State-Trait Anxiety Inventory (STAI) | * Heart Rate | * Blood Pressure | * Oxygen saturation | * Respiratory Rate | * Interviews | * Headphones were used (with or without music) starting 10 minutes before the start of the LP | * All measurements were taken immediately before the start of the procedure | * The NRS, HR, BP, SpO2, and RR were recorded throughout the procedure | * The STAI was recorded immediately after the end of the procedure. | * The interviews (only 10 participants from each group) were taken immediately after consent and after intervention | * Pain scores for the music group during and after the procedure were significantly lower than the control group | * Anxiety scores were also significantly lower for the music group before and after the procedure | * HR and RR were significantly lower during the procedure for the music group while the SpO2 and BP did not differ between groups | * Interviews showed children in music group liked this LP experience over last stating being calmer, less fearful, and less pain. | * Did not state how often they took measurements during the procedure | * STAI is only validated for adults | * Earphones can be uncomfortable in some positions | * Control group was informed of the study’s purpose and therefore knew they could have but did not receive the music |
**Exploring the Effects of Music therapy on Pediatric Pain: Phase 1**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Setting</th>
<th>Age</th>
<th>Intervention</th>
<th>Outcome</th>
</tr>
</thead>
</table>
| Dressing change, suture removal, stent down, and donor site dressing change. | Outpatient clinic, reconstructive unit, and the acute care unit | 7-16 y | *Music group (Music therapist played the guitar and sang to the patients requested genre and included improvised songs on encouragement) n=9* | *Before the start of the procedure, a pulse oximeter was placed on the participant's finger while the Fear Thermometer and FACES scale were recorded.*  
*The music was start 5 minutes before the beginning of the procedure.*  
*During the procedure, the HR, SpO2, and behavioral distress was assessed at two-minute intervals by the research assistant.*  
*After the procedure, the music therapist left and the Fear Thermometer and FACES scale was re-administered and recorded.*  
*Interviews were completed within 48 hours of the procedure.* |

- **Wong Baker FACES Scale**  
- **Nursing Assessment of Pain Index**  
- **The Fear Thermometer**  
- **Heart Rate**  
- **SpO2**  
- **Interviews with subject, parent/guardian, nurses, and music therapist**

*The data did not show lower anxiety or pain scores for the music group vs the control group nor did it lower their HR or raise their SpO2.*  
*There was data to support that participants engagement in the music reduced behavioral distress with the older children (specifically 15 y.o.) benefiting the most.*  
*The interviews yielded that most participants believed music therapy "somewhat" helped to relieve their anxiety and "a lot" helpful in reducing pain.*  
*The observers (parents, nurses, and music therapists) reported the music therapy being helpful in reducing both anxiety and pain.*

*Small sample size receiving different types of procedures.*  
*There is no control group mentioned in the paper so it is unclear what they compared their data to.*  
*Some participants received pain medication as well as music therapy*
| Effects of music on anxiety and pain in children with cerebral palsy receiving acupuncture: A randomized controlled trial | Yu, 2009 | Acupuncture unit in a Children’s Hospital in China | * 2-12 y  
* 36 males & 24 females  
* Average age for music group = 8.26  
* Average age for no music = 7.87 | * Music group [participant selected 10 children voiced songs from songs provided by the research team and listened through headphones] n=30  
* Control group [listened to a blank disc with headphones] n=30 | * Modified Yale preoperative anxiety scale for children's anxiety (mYPAS)  
* Children's hospital of eastern Ontario pain scale (CHEOPS)  
* Wong-Baker FACES  
* Mean Arterial Pressure (MAP)  
* Heart Rate  
* Respiratory Rate | * Patients were brought in the procedure room and were given the headphones to listen to the music or blank disc  
* The needles were inserted and remained for the 30 minutes.  
* The nurse with assistance from the parents completed the scales before and during the procedure  
* The mYPAS, CHEOPS, and FACES (completed by nurse, parent, and child) were taken at baseline, 1 and 30 min post-intervention  
* MAP, HR, and RR were monitored before intervention, at 15 minutes, and at 30 minutes after intervention by pulse oximeter. | * Data showed a significantly lower mYPAS score in the music group at the 30 min mark compared to the control group with no difference being found at baseline and 1 min  
* No significant difference was found using the CHEOPS and FACES scales  
* MAP and HR in the music group were significantly reduced from 1 to 30 minutes vs the control group while there was no apparent reaction to RR | * The measurement tools have not been validated for children |