

## Music benefits on postoperative distress and pain in pediatric day care surgery

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### Abstract

Postoperative effect of music listening has not been established in pediatric age. Response on postoperative distress and pain in pediatric day care surgery has been evaluated. Forty-two children were enrolled. Patients were randomly assigned to the *music-group* (music intervention during awakening period) or the *non-music group* (standard postoperative care). Slow and fast classical music and pauses were recorded and played via ambient speakers. Heart rate, blood pressure, oxygen saturation, glucose and cortisol levels, faces pain scale and Face, Legs, Activity, Cry, Consolability (FLACC) Pain Scale were considered as indicators of response to stress and pain experience. Music during awakening induced lower increase of systolic and diastolic blood pressure levels. The non-music group showed progressive increasing values of glycemia; in music-group the curve of glycemia presented a plateau pattern ( $P < 0.001$ ). Positive impact on reactions to pain was noted using the FLACC scale. Music improves cardiovascular parameters, stress-induced hyperglycemia. Amelioration on pain perception is more evident in older children. Positive effects seems to be achieved by the alternation of fast, slow rhythms and pauses even in pediatric age.

### Introduction

Listening to music is a complex phenome-

non, involving psychological, emotional, neurological, endocrinological and cardiovascular changes.<sup>1,2</sup>

The physiological reaction to music is qualitatively similar in musicians and non-musicians. Although musicians respond better, the response seems not to be influenced by musical preferences. The response may be conditioned by musical style, melody, harmonic structure, rhythm, tempo, but also by verbal content. An arousal effect proportional to the speed of the music is described in the literature: with slower rhythms inducing relaxation; while a pause in the music induces a condition of relaxation greater than preceding the exposure to music.<sup>3</sup>

This evidence leads to the speculation that the music may give pleasure, and perhaps health benefit, as a result of controlled alternation between arousal and relaxation.<sup>4</sup>

According to the National Association for Music Therapy, music therapy (MT) consists of using music to achieve therapeutic objectives: restoration, maintenance, and increase in health, both physical and mental.

In recent years, music has been increasingly used as a therapeutic tool in the treatment of different diseases especially in intensive care medicine.<sup>5-12</sup> More specifically; music has been shown to decrease pain, stress, anxiety and demand for analgesic and anesthetics drugs.<sup>9,11</sup>

Music seems to have measurable benefits on physiological and psychological outcomes in pediatric age. Although infant and children previously exposed to music treatment protocols could be distracted from unpleasant symptoms, calmed during stressful events such as invasive procedures, and less distressed while hospitalized,<sup>13</sup> music listening effects after routinely day surgical procedures has not been established yet in pediatric patients.

The purpose of this study is to better understand the music benefits on postoperative stress and pain response in children.

### Materials and Methods

#### Participants

Forty-two children, aged 3 to 14 years, having day surgical procedures (including orchidopexy, inguinal hernia repair, circumcision) were asked to participate in this study.

Surgery was performed between 8.30 am and 12 am and under general anesthesia, at Pediatric Surgery Unit. Exclusion criteria were: chronic illness, obesity, use of any medications and experience of prenatal music therapy.<sup>14-17</sup> At admission, written and oral consent was obtained from all the children and their parents.

The ethics committee of the Department of

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Key words: music therapy, children, surgery, pain, stress.

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Internal Medicine, University of Pavia, approved the study protocol and the researcher complied with the Helsinki Declaration.

### Design and procedure

At admission, the axiological examination of children included evaluation of height, weight, body mass index. Height measurement was performed using a Harpenden stadiometer, performed with patients in an upright position, without shoes, with their heels together, arms extended down the sides of the body and head positioned parallel to the floor. Weight was made with the children barefooted and wearing light clothes, standing upright in the center of the scale platform with their arms extended down the sides of the body. Body mass index (BMI) was calculated as body weight in kilograms divided by body height squared in meters.

The children were randomly assigned to the *music group* when receiving music interven-

tion during awakening period and to the *non-music group* when children had standard medical care. Randomization was carried out using opaque envelopes, half of which contained a paper that said *music* and half a paper that said *no music*.

Awakening was pursued at the recovery room, in comfortable conditions (*e.g.* temperature, light and noise).

Records were selected by expert musicians. Six tracks of slow (70-80 beats/min) and fast (140-150 beats/min) classical music were included; two minutes of silence, inserted after the slow and fast music sequence, were also recorded. Music tracks characteristics are reported in Table 1.

Music was played for 20 minutes during awakening, via ambient speakers, in the music group.

Heart rate (HR), blood pressure (BP), oxygen saturation (SpO<sub>2</sub>), glucose and cortisol

levels, faces pain scale (FPS) and Face, Legs, Activity, Cry, Consolability (FLACC) Pain Scale were considered as indicators of physiological response to stressful and pain experience.<sup>18,19</sup>

Few time points including evaluation were considered: i) admission (T0); ii) end of surgical procedure (T1) at recovery room; iii) awakening (T2) at recovery room; iv) re-admission to the Unit (T3). At T0, T1 and T2 and during music exposition the parents were not present.

### Vitals signs

HR, BP and SpO<sub>2</sub> were monitored (Primus, Dräger, Lübeck, Germany) and recorded as following: i) T0 (HR every 2 minutes and BP and SpO<sub>2</sub> every 5 minutes, for 10 minutes. Mean values were used for statistical analysis); ii) T1 (HR every 2 minutes and BP and SpO<sub>2</sub> every 5 minutes, for 10 minutes. Mean values were used for statistical analysis); iii) T2 (HR

every 2 minutes and BP and SpO<sub>2</sub> every 5 minutes, for 20 minutes. Mean values were used for statistical analysis) with the children listening or not listening to music according to their groups.

### Metabolic and endocrinological parameters

Serum glucose at T0, T1 and T2 were measured using the hexokinase-G-6-PDH method (Abbott Diagnostics, Wiesbaden, Germany) with a chemistry analyzer (Architect c-16000); intra- and interassay CVs were 1.98% and 2.15%, respectively, at 4.4 mmol/L and 0.65% and 1.51% at 15.5 mmol/L.

Serum cortisol levels in both groups were measured at T0 between 8.00-9.00, at T1 between 12.00-14.00 pm and at the end of T2 with an immunochemistry analyzer (Immulite 2000 XP, Siemens Healthcare Diagnostics,

**Table 1. Characteristics of music tracks.**

Source	Time (min)	Style	Meter	Tempo (beats/min)	Pulsation perceived (beats/min)	Tonality rhythm	Comments about
<i>Andante Molto</i> A. Vivaldi: Concerto for strings and continuo RV 158, II Andante Molto	2'20"	Baroque	2/4	39	78 (eighth note)	A minor	Pulsations marked in the bass
<i>Silence</i>	2'00"	-	-	-	-	-	-
<i>Suite</i> J. S. Bach: BWV 1010 for cello, Giga	2'38"	Baroque	12/8	144	144	Eb major	Constant density rhythm
<i>Suite</i> E. Grieg Holberg's Rigaudon	3'57"	Romantic	2/2	72	144 (quarter note)	G major	High density rhythm in the first section and low density rhythm in the second section
<i>Andante</i> W. A. Mozart: Eine Kleine Nachtmusik K 525, II Andante	4'07"	Classic	2/2	34	68 (quarter note)	C major	Pulsations marked in the bass
<i>Suite</i> J. S. Bach: BWV 1007 for cello, Preludio	2'38"	Baroque	4/4	70	70 rubato	G major	Constant density rhythm
<i>Silence</i>	2'00"	-	-	-	-	-	-
<i>Allegro</i> A. Corelli: Sonata op.5 n°4, V Allegro	2'20"	Baroque	2/2	79	158 (quarter note)	F major	Alternation between low density rhythm and high density rhythm

**Table 2. Evaluations of vital signs, metabolic and endocrinological parameters and pain scales at time points.**

Time	T0 Admission	T1 End of surgical procedure	T2 Awakening	T3 Re-admission to the Unit
Heart rate	X	X	X	
Blood pressure	X	X	X	
Oxygen saturation	X	X	X	
Glucose levels	X	X	X	
Cortisol levels	X	X	X	
Faces pain scale	X		X	
Face, legs, activity, cry, consolability pain scale	X		X	X

Erlangen, Germany) using a solid-phase competitive method and chemiluminescent tracer; intra- and interassay CVs were 5 and 6.5%, at 8 g/dL. Serum cortisol was used for its ease collection in the post operative period, in respect to salivary cortisol.

### Pain scales

FPS was used to measure the child's self-reported pain during 2 phases: at T0 and at T3. This scale consisted of 6 cartoon faces with varying expressions ranging from very happy to very sad. The child rated the pain intensity on a scale, with point 0 being no pain and point 10 being the worst pain.

At T0, at the end of T2 and at T3 the FLACC was used to assess the behavioral reactions to pain. The FLACC pain scale assesses five behavioral areas (facial expression of the child, the position of the legs, activity, crying, and consolability) with scores ranging from 0 to 2 for each item; assessment of behavioral scores was 0=no pain; 1-3=mild pain, 4-6=moderate pain; 7-10=severe pain. All measurements were conducted by the same psychologist that was blind to randomization group. In Table 2 are summarized the measurements of the parameters at time points.

### Anesthesia protocol

After obtaining the written consents from the parents the children were scheduled for surgical procedure. All subjects were in good physical state. Anesthesia was induced with propofol (2-2.5 mh/g) as sedative-hypnotic agent and fentanyl (1-1.5 mcg/kg) as analgesic. After laryngeal mask or tracheal tube positioning, patients underwent volume controlled mechanical ventilation with an inspired mixture of air and oxygen using a closed breathing system (fresh gas flow of 0.75l min<sup>-1</sup> oxygen and 1.5l min<sup>-1</sup> air during anesthesia) adjusted to achieve an end-tidal carbon dioxide of 32-35 mmHg. Anesthesia was maintained via volatile anesthetic based on the administration of Sevoflurane. The Sevoflurane was administered in a 0.75 to 1.25 MAC range. Twenty minutes before the end of intervention, all patients received Paracetamol 15 mg/kg, as analgesic. At the end of the operation the patient was transferred from the theater to the recovery room.

The awakening period started at the stop of Sevoflurane administration and finished when the child was totally conscious.

### Statistical analysis

Continuous variables were described as mean and standard deviation (SD) and categorical variables as counts and percentages. Data were compared between groups with the Student t test or the Mann Whitney U test if continuous and the Fisher exact test if categorical. To test the effects of music on vital

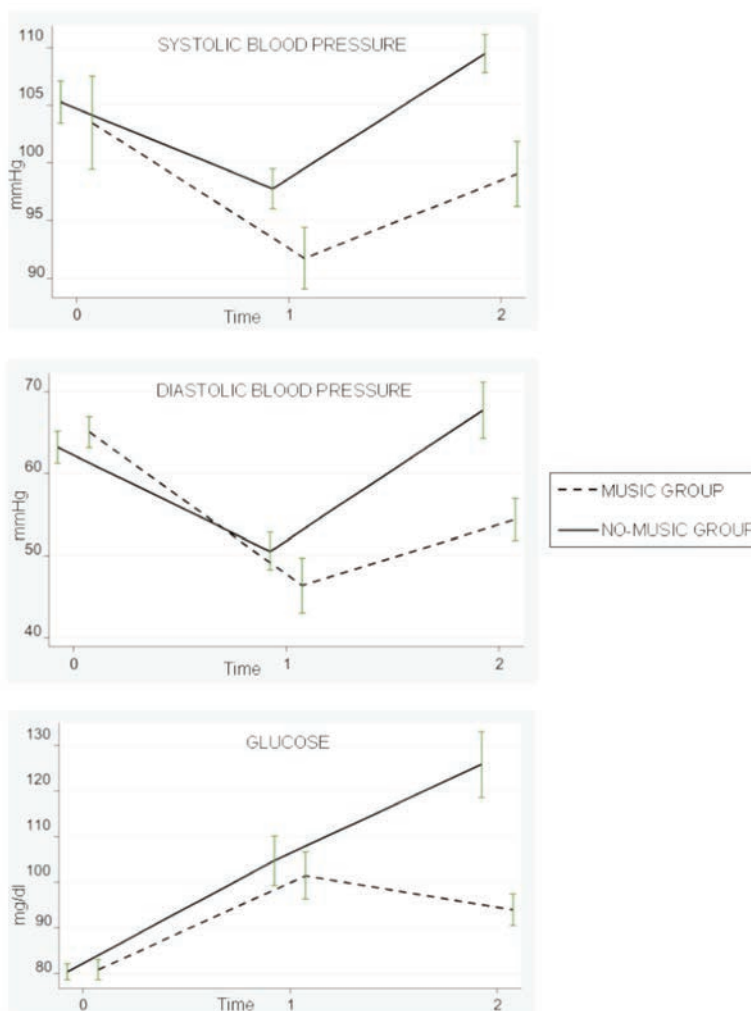
signs, on metabolic and endocrinological parameters in different groups, the mean differences were verified with repeated measures analysis of variance. Probability values less than 0.05 were considered statistically significant. All statistical analysis were performed using SPSS statistical package (SPSS, Chicago IL, USA) and Stata 8.0

## Results

The 42 children (40 boys and 2 girls; mean age 6.7±4.1 years), were randomly assigned to 1 of the 2 groups: the music group (n=21) or the no-music group (n=21). No significant differences were found between the two groups with respect to age, sex, weight, BMI. Awakening time were slower in music group (P<0.001) (Table 3).

**Table 3. Demographic, auxological and procedural characteristics.**

Characteristics	No-music group (n=21)	Music group (n=21)	P
Age (yrs)	6.8±3.9	6.6±4.4	0.87
Sex (M/F)	19/2	21/0	0.46
Weight (kg)	28.3±15.1	27.7±13.7	0.89
Body mass index (kg/m <sup>2</sup> )	16.9±2.4	17.8±5.2	0.46
Duration of awakening (min)	9.8±3.9	16.04±4.1	<0.001



**Figure 1. Comparison of the blood pressure and glucose levels at admission (Time 0), at the end of surgical procedure (Time 1) and during awakening (Time 2), in music and no-music groups.**

## Vital signs data

**Heart rate.** HR at T0 and T1 were not significantly different ( $P=0.8$ ). At T2 HR was higher compared to T0 and T2 ( $P=0.03$  and  $P=0.01$ , respectively) without no difference between the two groups ( $P=0.15$ ).

**Systolic (SBP) and diastolic blood pressure (DBP).** At T2 decreased SBP and DBP levels were found compared to T0 ( $P=0.008$  and  $P<0.001$ , respectively). At T2 an increase of SBP and DBP levels were noted compared to T1 ( $P<0.001$ ); these were lower in music group ( $P=0.09$  and  $P=0.003$ , respectively; Figure 1).

**Oxygen saturation.** No significant difference between SpO<sub>2</sub> at T0 and T1 was found ( $P=0.48$ ). At T2 SpO<sub>2</sub> decreased significantly respect to T0 and T1 ( $P<0.001$ ), without differences between the two groups ( $P=0.9$ ).

## Metabolic and endocrinological data

**Glucose levels.** Increased levels of glucose at T1 compared to T0 levels were found in both groups ( $P<0.001$ ). The non-music group showed a progressive increasing values of glycemia at T2, while in the music group the curve of glycemia presented a plateau pattern ( $P<0.001$ ); Figure 1.

**Serum cortisol.** T0 cortisol levels were lower than T1 ( $P=0.01$ ) and T2 values ( $P=0.06$ ). A significant decrease at T2 respect to T1 was found ( $P=0.02$ ), without difference between the two groups ( $P=0.6$ ).

## Findings from pain scale

**FPS.** No significant difference was found between no-music and music groups in average faces pain score at T0 ( $P=0.41$ ) and T3 ( $P=0.78$ ).

**FLACC scale.** No-music and music groups showed no significant difference in mean value of FLACC scores at the end of T2 ( $P=0.19$ ) and T3 ( $P=0.79$ ). The improvement in average pain score is higher in music than in no-music group ( $P=0.05$ ).

No difference in pain intensity score was noted between the two groups at the end of T2 ( $P=0.2$ ) and T3 ( $P=0.29$ ). In the music group a higher number of children reported no or mild pain at T3 ( $P=0.008$ ); these patients however resulted to be older than those with moderate or severe pain in the behavioral score ( $P=0.05$ ).

## Discussion

Surgery is one of the most stressful events. Stressors activate the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system. During stress, the HPA axis stimulates the adrenal cortex to secrete cortisol, to

support and stimulate cardiovascular and inflammatory response.<sup>20-22</sup> Listening to music could offer a wide range of therapeutic effects, such as helping patients to relax, enhancing sedation and relieving anxiety and pain.<sup>13</sup> Music evokes desired emotional and stress responses that serve as distraction from unpleasant stimuli.<sup>23</sup>

Music induces physiological cardiovascular changes even in absence of conscious reactions. The subconscious autonomic response is independent of music preferences or previous training and involves respiration and cardiovascular parameters. Sympathetic nervous system response leads to a decrease in adrenergic activity. It induces altered status of consciousness delayed neuromuscular arousal. This relaxation response is manifested by physiologic indicators like decrease in heart rate, blood pressure, metabolic rate, oxygen consumption, respiratory rate, skeleton muscle tension, gastric acidity and motility and sweat gland activity.

Our study showed the positive impact of the music on blood pressure, postoperative glucose levels and pain experience in children undergoing day surgery procedures.

During awakening, the music group reported a lower increase of the DBP and SBP levels. The current findings confirm the benefits of music in reducing the sympathetic nervous system stress response.<sup>24</sup>

Music may stimulate physiological responses.<sup>3,4,23</sup> This response seems to be strictly related to the music characteristics (tempo, style, harmonic and rhythmic structure), sequence and presence of other stimuli (such as colors, lights, sounds). Cardiovascular, respiratory and autonomic systems also respond to different genres of music, order of presentation and short interpolated pauses. Music induces an arousal effect, predominantly related to the tempo.<sup>3,4</sup>

Autonomic response is synchronized with music. Slow or meditative music can induce a relaxing effect particularly evident during pauses. In adults, the same effect has been achieved by alternating faster and slower rhythms or pauses.<sup>3</sup> The use of the same method has led to a positive response in our report. Due to the different blood pressure and heart rate in childhood ages, it would be more convenient to use different music characteristics. Further studies are needed to define the most useful style of music with more benefits according to the child's age.

Our results also document how glucose response after surgery is linked to music influence. This finding seems to have a possible impact on the stress-induced hyperglycemia (SIH). SIH is a transient condition, characterized by insulin resistance and an up regulated hepatic gluconeogenesis (in part through of cortisol) that occur during stressful situations

such as trauma, surgery, stroke and sepsis.<sup>24-27</sup> The improvement of SIH may have a positive impact on patients' risks of infection and complications.

As reported, cortisol levels increase quickly following surgical incision and remain elevated during and after surgery.<sup>28</sup> Studies of the effect of music on cortisol levels before, during and after surgery have had mixed results.<sup>15,29-31</sup> We showed that serum cortisol levels were higher in the immediate postoperative care compared to values found before surgical procedure. Music played for almost 20 minutes after surgery, does not influence the decrease of cortisol levels during awakening. The effect of music was probably less evident due to the high intraindividual biological variability of cortisol, although its gluconeogenic effect was found to be reduced in music group. To understand the real benefit of music on the cortisol response necessitates more than one measurement of its levels 24 hours post operatively.

Even though total pain scores were similar between music and no-music groups, a distinct reaction to pain in music group was noted using the behavioral FLACC scale. These results, which seem to be influenced by a wide age range, may confirm the pain gate control theory. Music may act as a distracter by blocking pain pathways thus diminishing the amount of perceived pain.<sup>32,33</sup>

Caprilli *et al.* have previously reported that age, but not gender, was found to have a significant effect on behavioral distress during venipuncture.<sup>9</sup> In our study, an high number of boys is present and the gender was not included as a covariate in statistical analysis. A further evaluation including a more homogenous sample, could be useful to define any difference on music benefits on postoperative distress and control pain between males and females.

## Conclusions

Music seems to improve postoperative cardiovascular parameters. While benefits on pain control are not so evident, positive effects on hyperglycemia stress-induced are relevant. According to previous reports in adults, relaxing effect are also achieved in children by the alternation of fast, slow rhythms and pauses.

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