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Original Article

Music for pain in healthy neonates

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Abstract

Background The neonatal pain threshold is 30-50% lower than in adults and older children because of immature pain inhibition function in nervous centers. Acute pain in neonates results in behavioral, physiological, and cerebral blood flow changes that may lead to intraventricular bleeding and periventricular leukomalacia. Music is believed to reduce pain perception as it distracts, influencing the parasympathetic and sympathetic nervous system by decreasing pulse rate, blood pressure, and breathing, hence, promoting a relaxed state.

Objective To evaluate effects of music intervention on physiological parameters and pain perception in healthy newborns undergoing a painful medical procedure (immunization injection).

Methods This was a double-blind, randomized control trial study. A recorded instrumental lullaby "Nina Bobo" was given for 5 minutes to the music group and no music for control, prior injection of Hepatitis B0. The evaluation of heart rate and SpO2 were performed at baseline, 30 seconds, and 5 minutes after injection. Pain perception were measured by *Neonatal Infant Pain Scale* (NIPS) at 30 seconds and 5 minutes after injection.

Results Total of 51 subjects were enrolled. There were no difference of SpO2 and NIPS between both music and control groups. Music improved heart rate after 30 seconds and 5 minutes after injection, median 126 (range 55-149) bpm from median 136 (range 78-154) bpm, and even lower than baseline [mean 128.9 (SD 12.5) bpm; P=0.019]. The control showed no improvement of heart rate mean 124,34 (SD 18,45) from 124,73 (SD 18,39); P=0.875. There were no significant differences between the 2 groups.

Conclusion Music is not effective in improving oxygen saturation, heart rate, and is not effective in reducing the degree of pain. **[Paediatr Indones. 2021;61:69-73 ; DOI: 10.14238/pi61.2.2021.69-73]**.

Keywords: *music; pain; neonates; NIPS*

The neonatal pain threshold is 30-50% lower than in adults and older children because of immature descending inhibition function in nervous centers.[1] As the fifth vital sign, pain should be routinely monitored in clinical practice, however, assessing pain in neonates is challenging because they are non-verbal.[2] *The Neonatal Infant Pain Scale* (NIPS) is a multi-dimensional tool with good reliability, validity, and consistency.[3] Acute pain changes neonatal behavior and physiology, in the form of increased heart and respiratory rates, decreased oxygen saturation, as well as changes in cerebral blood flow that can lead intraventricular bleeding and periventricular leukomalacia. Neonatal pain is best managed using a multi-directional approach, conceptualized in a tiered manner from avoidance source of pain, non-pharmacological, to pharmacological therapy. If the pain couldn't be avoided, the next pain management is non

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pharmacological treatment; giving oral sucrose or glucose, skin to skin (kangaroo care, swaddling), non nutritive suck, and music therapy.[4] Finnerty's study showed that music influences the limbic system by evoking emotion and feelings of pleasure that act as a distraction from pain perception, resulting in parasympathetic and sympathetic nervous system responses. Subsequent decreases in pulse, blood pressure, and breathing promote a relaxed state.[5] Several studies have suggested that music can decrease heart rate and pain in preterm and term neonates.[6-8] Lullaby musical structure brings physiological stability and reduce pain by increase serotonin and endorphin and reducing cortisol level. Lullaby could be easily diffrentiated and recognized by infants across cultures.[8]

It is important to find efficient ways to decrease pain in neonates. In order to better assess and manage neonatal pain, we evaluated the effects of musical intervention on physiological parameters and pain perception in healthy newborns who underwent a painful medical procedure, namely, hepatitis B (HB0) vaccination.

Methods

This double-blind, randomized control trial was conducted in newborns at Mohammad Hoesin Hospital, Palembang, South Sumatera, Indonesia in January-February 2020. The inclusion criteria were newborns of gestational age ≥ 34 weeks, hemodynamically stable, requiring the first dose of the Hepatitis B vaccination series, and whose parents or guardians provided informed consent. The exclusion criteria were congenital anomalies, clinical jaundice, and refer otoacoustic emission (OAE) result. The minimum required sample size of 48 was calculated based on a previous study,[9] with non-probability consecutive sampling, then divided into music group and control by 4 block-randomization.

The procedure was done in the rooming-in ward with 40dB of background noise. A portable pulse oximeter (perfusion index 0-20%, 30-250 bpm level, accuracy 70-99%±2%) was attached to the subject's toe, and baseline heart rate (HR) and oxygen saturation (SpO_2) were noted. Headphones were placed on the subject (50 mm diameter earpieces sized for neonatal comfort, moving circle sound principle, 20-20.000Hz frequency response, 1.6% distortion, 32 Ω impedance, and 105dB sensitivity) 5 minutes prior to the HB0 intramuscular injection (Uniject, Biofarma). A recorded, instrumental Indonesian lullaby "Nina Bobo" by Uwa and Friends (45dB) was played for the music group from a smartphone, until 5 minutes after the injection. The control subjects wore headphones but without the lullaby. The procedure was recorded with a 10.2 megapixel *Sony Exmor R CMOS* sensor digital camera. The HR and SpO_2 were noted at baseline, as well as 30 seconds and 5 minutes after intervention. The NIPS score was evaluated from the video by three observers. The pain scale divided into no pain (score 0-2), and pain (score 3-7).All subjects, observers, and researcher were blinded as to group identity.

Data analyses were performed using *SPSS ver. 22.0*. Normally distributed data were presented in mean and standard deviation, and abnormally distributed data were in median and min-max. Music and pain responses were analyzed by Chi-square and Mann-Whitney tests. A P value <0.05 was considered to be statistically significant. This study was approved by Universitas Sriwijaya Research Ethics Committee.

Results

Of 72 newborns in our hospital from January to February 2020, 21 were excluded due to questionable OAE results (3), OAE not done (3), and moving to other wards (15). Hence, 51 newborns were enrolled, 25 in the music group and 26 in the control group. The characteristics of subjects were similar in both groups and are shown in **Table 1**. The majority of subjects were female and full term. The multivariate analyses showed that gender (P=0.492) and gestational age (P=0.952) were not confounders.

No significant differences of baseline outcome measures were observed between the music and control groups. At 30 seconds after the HB0 injection, the music group HR increased from mean 128.9 to median 136, while the control group HR had a smaller increase from mean 124.7 to 126.1. However, these changes were not statistically significant (P=0.386). At 5 minutes after injection, the music group median HR dropped significantly to 126, which was lower than baseline HR (P=0.019). But the music group HR was not significantly different from that of the control group at 5 minutes (P=0.356) (**Figure 1** and **Table 2**). There were no significant differences in SpO_2 from 0-5 minutes within either the music or control groups (P=0.191 and P=0.195, respectively) nor between the groups (P=0.172) (**Table 2**). While both groups had decreased SpO2 at 30 seconds, the music group had less of a reduction than the control group, although the differences were not significant. At 5 minutes, oxygen saturation in the control group went back to baseline level, but the music group further desaturated to median 94 (range 76-99)%, which was even lower than at baseline (P=0.191).

The NIPS tool revealed no significant differences in pain between groups, but more music subjects had no pain compared to controls (40% vs. 23.1%, respectively; P=0.317) at 30 seconds. In contrast, at 5 minutes after injection, more control subjects had no pain than the music group (80.8% *vs.* 72%, respectively; P=0.683) (**Table 2**).

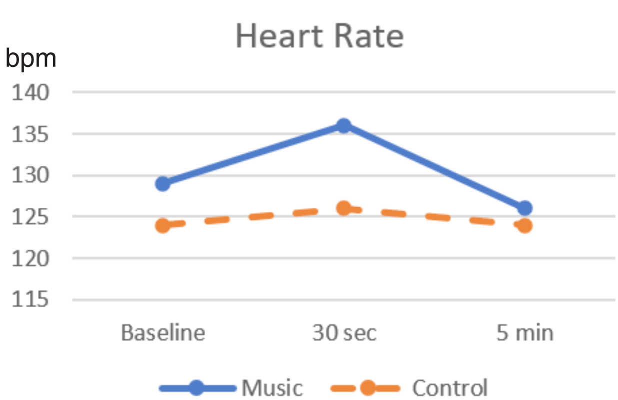

Figure 1. Heart rate (beats per minute) before pain (baseline), in pain (30 sec after injection), and pain adaptation (5 minutes) after music intervention

Discussion

Pain management is a growing concern, especially in neonates who cannot verbalize their discomfort. Multiple lines of evidence revealed that newborns and neonates feel more pain compared to children and adults, as evidenced by robust physiologic parameters and behavioral changes.[2] Hence, cost-effective, applicable, and non-invasive modalities are needed to provide pain reduction. Although there is preliminary evidence of a therapeutic benefit from music, studies investigating the effects of music in early life have produced equivocal results, probably due to the variation in type of music used (instrumental, voice, or both, live or recorded), duration of exposure, and different outcomes measured.[5,9] Further study

Table 1. Clinical characteristics of subjects

Characteristics	Music (n=25)	Control (n=26)
Gender, n (%)		
Female	13	16
Male	12	10
Gestational age, n (%)		
Full term	21	22
Preterm	4	4

Table 2. Comparison of HR, SpO2, and NIPS between groups

Group			Music (n=25)	Control (n=26)	OR (95%CI)	P value
Mean/median (SD/range) HR, bpm	0		128.9 (12.5)	124.7 (18.4)		0.343**
	30"		136 (78-154)	126.1 (19.9)		0.386*
	5'		126 (55-149)	124.3 (18.4)		0.356*
	P		†0.019	‡0.875		
Median SpO_2, % (range)	0		97 (85-99)	96 (87-99)		0.098*
	30"		96 (72-99)	94 (89-99)		0.576*
	5'		94 (76-99)	96.5 (86-99)		0.172*
	P		†0.191	†0.195		
NIPS, n (%)	30"	No pain	10 (40)	6 (23.1)	OR 2.22 (0.66-7.48)	0.317***
		Pain	15 (60)	20 (76.9)		
	5'	No pain	18 (72)	21(80.8)	OR 0.61 (0.16-2.27)	0.683***
		Pain	7 (28)	5 (19.2)		

*Mann-Whitney, **independent T-test, ***Chi-square, †repeated measures ANOVA, ‡Friedman is needed to address these diversities so that music intervention can be properly assessed and compared using evidence- based approaches.

Our study had several limitations. We used a fingertip pulse oximeter placed on the neonates' toes, so it might have lacked sensitivity because of neonate movement, compared to a handheld or table top type placed on the ankle or wrist. Also, the interrater agreement value was low (Kappa=0.2-0.4) for the NIPS evaluation because no training was done to standardize the assessment.

There were no statistically significant differences in baseline clinical characteristics of gender, gestational age, or physiological parameters, indicating that subjects were homogenously distributed between groups. While in pain condition OR 2.222 (95%CI 0.66 to 7.48) showed that the music group were 2.2 times more likely to feel no pain compared to control, even though not statistically significant. Similarly, a previous study showed that music group was not significantly had better heart rate and SpO2 than the control group, (160.95 bpm and 95.2% vs. 174.75 bpm and 91.9%, respectively), but not significant.10 Another study also used a lullaby to decrease pain in preterm infants supported with nasal CPAP.

While in pain, no significant differences between the control and intervention groups were observed with regards to heart rate and SpO_2, similar to our study. On the other hand, mean NIPS score was lower in the music group compared to control [5.17 (SD 0.92) and 5.67 (SD 0.81), respectively (P=0.000)].[11] The result is consistent with the gate control theory by Melzack and Wall12 who suggested that pain impulse can be controlled and inhibited by defense mechanism activity of sensory neurons and descendent neuron fibers from the brain. Music works as a distraction to prevent nociceptive neuron signals from entering the brain, also affecting the limbic system that regulate mood and emotions, leading to increased comfort and relaxation,[5] hence, reduced pain perception.

Interestingly, the HR in the music group decreased further from baseline compared to the control group (P=0.019), suggesting that music makes neonates relaxed and comfortable, hence, slowing the heart rate. In contrast, the music group SpO_2 after 5 minutes was lower than at 30 seconds and at baseline (P=0.191). A previous study used live lullabies sung by parents instead of recorded music. The heart rate and SpO_2 in their music group were not better than in the control group in the 4^{th} (3 minutes after injection) or 5th periods (silent period).[13] This observation may have been because the music intervention increased the proportion of a quiet alert state, which is associated with the autonomic nervous system and pain score. The quiet alert state is a positive state of increased awareness arising from stimulation while in the quiet state,[14] hence, the heart rate of our music group was higher and oxygen saturation lower than those of our control group.

Another possible reason for our finding no significant differences in pain and physiological parameters between groups was that subjects only heard 10 minutes of music, compared to 20-60 minutes in other studies.[8,13,15] There has been no specific recommendation regarding optimal duration of music therapy for pain in neonates, to our knowledge. In addition, we used an instrumental recording of an Indonesian lullaby (Nina bobo), while other studies recommended that music therapy be done by a certified therapist, sung by a woman, with live music better than recorded, music type matched to culture, and familiar since the intrauterine period.[8,13,15,16] Music therapy for pain could be given as adjuvant therapy, as music alone did not decrease pain compared to music therapy and breastfeeding.[5]

In conclusion, our randomized, placebo-controlled study shows no relevant effect of music to improve oxygen saturation or heart rate, and decrease pain score, both while in pain and after pain (pain adaptation). Subjects in the music group showed better pain control while experiencing pain. We suggest further study with a larger sample and involving several centers to generate greater power to generalize conclusions, music given as adjuvant therapy for pain, with various types of live music. The table top or handheld pulse oximeter with infrared tip placed on the neonate wrist or ankle would minimize the tool bias. Furthermore, future studies could use a one-dimensional facial pain scale or a single competent observer could assess pain, to reduce interrater variability. If the assessment is done by several observers, they should be trained and scores standardized to achieve good interrater agreement.

Conflict of Interest

None declared.

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