

## ORIGINAL RESEARCH

## PAIN MANAGEMENT

# The analgesic effect of non-nutritive sucking on neonates during invasive procedures

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## ABSTRACT

**Background & objective:** Neonates admitted and treated in the Neonatal Intensive Care Unit (NICU) often receive painful invasive procedures. In such situations, the treating physicians often find themselves in a fix regarding the use of analgesics to relieve their actual or potential pain. It has been observed that the sucking often distracts the neonates from their mild to moderate pain. We conducted this study to analyze the effectiveness of non-nutritive sucking as an analgesic for neonates who were to receive invasive procedures.

**Methodology:** This experimental study implemented a post-test-only control group design, involving 64 neonates in the NICU, selected using a simple random sampling technique, who were then divided into two groups, with 32 neonates each in a treatment group and a control group. The treatment group was given non-nutritive sucking, while the control group was given standard intervention, then the pain response was measured in both groups. Next, the pain levels of the two groups were compared using the Mann-Whitney U test.

**Results:** The measurement results showed that there was a difference in the mean scores of pain response between treatment and control group, respectively 1.53125 and 5.8125. The P-value of the difference test was 0.00000004252, so that it could be interpreted that there was a significant difference in pain levels between the two groups.

**Conclusion:** On the basis of the results of our study, it is concluded that non-nutritive sucking is an effective method for reducing the pain response in neonates during invasive procedures.

**Keywords:** Infant; Non-nutritive sucking; Neonatal Intensive Care UNIT; Pain; Pain management

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## 1. INTRODUCTION

Neonates are babies less than a month old, in which all systems of their body have to grow and develop.<sup>1-3</sup> Therefore, this phase is very vulnerable period for the baby; especially if they require intensive care in a hospital.<sup>4-6</sup> There are many situations in which a baby might need intensive care; for example, the baby fails to

cry at birth (asphyxia), birth weight is below average weight, aspiration of amniotic fluid mixed with meconium, congenital abnormalities and so on. While undergoing intensive care, neonates might require various invasive procedures, including the insertion of a venous catheter for parenteral therapy, or for drawing venous or arterial blood samples, and so on. All these conditions might be very troublesome for the babies.<sup>7-9</sup>

Several previous studies reported that invasive procedures on neonates in the Neonatal Intensive Care Unit (NICU) can cause stress with a relatively high prevalence and skin damage.<sup>10-12</sup>

<b>Box 1: Percentage and type of painful procedures</b>	
Adapted from: Health Sci Rep. 2022 Mar; 5(2): e533	
<b>Procedures</b>	<b>Percentage</b>
Heel stick	20.71%
Venipuncture	18.41%
Intravenous insertion	16%
Intravenous injection	13.98%
Intramuscular injection	10.35%
Nasogastric tube insertion	8.21%
Nasal CPAP insertion	7%
Lumbar puncture	2.07%
Femoral venous puncture	1.55%
Arterial puncture	1.12%
Chest tube drainage	0.6
<b>Total</b>	<b>100%</b>

A preliminary study conducted in the NICU of Bangil Regional Hospital, Indonesia, using medical record data from August to October 2022, showed that all admitted babies (100%) had to undergo invasive procedures, such as taking blood samples for laboratory tests, intravenous procedures for therapy, intramuscular injections and so on. More than 75% of these babies were given infusions and needed several venous catheter changes according to their physical condition. The average frequency of replacing a venous catheter was three times in twelve days of treatment, or at least once every 3 days according to local standard operating procedures.<sup>13</sup>

Of course, invasive procedures that injure the skin and underlying tissue will have impacts, both in the short and long term. The main short-term impact is pain, which can then have an impact on behavioral changes and physiological changes in babies, such as changes in cardiovascular status, metabolism, intracranial pressure, resulting in increased morbidity and mortality. Meanwhile, long-term impacts that can arise are neurobehavioral disorders, motor disorders, functional disorders, and developmental delays.<sup>14</sup>

Pain must receive immediate and serious attention, so that the pain response can be reduced and complications can be minimized as much as possible.<sup>15</sup> Pain management that can be carried out by nurses independently, safely and does not require high costs, is by non-pharmacological methods.<sup>16-18</sup> Many non-pharmacological methods have been used, such as direct

breastfeeding, the kangaroo method, fixation with swaddling clothes, and also using non-nutritive sucking (NNS).<sup>19-21</sup>

NNS is a baby's oral activity using a pacifier which can stimulate the baby's sucking response without providing nutrition or other food to the baby.<sup>22</sup> There have been previous studies on NNS interventions to reduce pain responses in various settings such as in the postpartum care room,<sup>23</sup> in the ophthalmology care unit<sup>24</sup> and most importantly in the NICU.<sup>25</sup>

We conducted this research on the use of NNS in the NICU with different control variables, including sex, maturity, age, weight, type of invasive procedure and frequency of invasive procedure. Therefore, by enriching these control variables, research was conducted with the aim of analyzing the effectiveness of non-invasive sucking to reduce pain levels in neonates who received invasive treatment in the form of infusion.

## 2. METHODOLOGY

This research was an experimental study with a post-test only with control group design. The research followed the principles of health research ethics and was approved by the STIKes Mojopahit Health Research Ethics Committee, (No.: 069/KEPK-SM/2023).

The study population was neonates in need of invasive procedures in the NICU of Bangil Regional Hospital, Pasuruan, Indonesia. The sample size was 64 neonates selected using random sampling technique. The inclusion criteria were: a) a good general condition, undergoing treatment in the NICU; b) were calm before invasive action; c) capable to display the sucking reflex; d) breast feeding not possible because of the condition of the mother and/or baby. The exclusion criteria were: a) a respiratory emergency (with a Down Score  $\geq 6$ ), with an endotracheal tube in situ; b); had congenital abnormalities or motor disorders; c) post-operative. The sample was divided into two groups; the treatment group and the control group, each consisting of 32 neonates.

The independent variable was treatment, e.g., the provision of NNS, with 2 categories, treatment given or not given, respectively. When an invasive procedure was carried out in the form of a venipuncture, the treatment group was given NNS to suck for 2 min before; while the control group followed daily standards, namely not being given NNS.

The dependent variable was the pain response in neonates when invasive procedures (venipuncture) was performed. Thus, in both groups pain responses were measured using the Neonatal Infant Pain Scale (NIPS), which includes 6 indicators; e.g., facial expressions, crying, breathing patterns, arm movements, leg

movements, and alert status. From the scoring results, the categories of no pain, mild-moderate pain (non-pharmacological pain management with re-assessment at the 30th minute), and severe pain (pharmacological and non-pharmacological pain management with re-assessment at the 30th minute) would be obtained, with a total of the maximum score was 7.

To ensure equality between the two groups, a test for equality of sex, age, maturity, body weight and frequency of invasive procedures on neonates was carried out using the Chi-square test because the data was categorical. Next, the Mann-Whitney U test was carried out to compare the level of pain between neonates who were and were not given NNS.

### 3. RESULTS

To ensure equality in the two groups, Chi-square test was carried out which includes four aspects; sex, age of the neonates, maturity of the neonates based on gestational age at birth and birth weight of the neonates. The results of the Chi-square test for the four variables showed  $P > 0.05$ , so it could be interpreted that there were no differences between the two groups (Table 1).

The results of measuring the pain response in the two groups showed that there was a significant difference in the mean scores of pain response between the groups that were given and not given NNS, respectively 1.53125 and 5.8125. In the pain level range of 0 to 7, it appears that the difference in the mean pain scores of the two groups was quite large. It was seen that neonates who received NNS had a much lower level of pain than neonates who did not receive NNS. The results of the Mann-Whitney U test showed that there was a significant difference in pain response scores between the groups given and not given, as indicated by the p value = 0.000000004252 (Table 2). The results of this analysis show that providing NNS is actually able to divert the neonate's attention from the pain stressor caused by invasive procedures.

**Table 1: Demographic characteristics of the two groups**

Neonates characteristics		Given NNS	Not given NNS	P-value
Sex	Male	20 (63)	17 (53)	0.4623
	Female	12 (37)	15 (47)	
Age (days)	0-7	25 (78)	28 (88)	0.3464
	8-28	7 (22)	4 (12)	
Gestational age (weeks)	< 37	23 (72)	22 (69)	0.3533
	37-41	9 (28)	8 (25)	
	> 42	0 (0)	2 (6)	
Birth weight (gram)	> 2500	8 (25)	4 (13)	0.4550
	1500-2500	16 (50)	22 (68)	
	1000-1500	7 (22)	5 (16)	
	<1000	1 (3)	1 (3)	

*Data presented as n (%)*

**Table 2: Comparative mean scores of pain response**

Statistics	Given NNS	Not given NNS	P-value*
Mean pain score	1.53125	5.8125	0.000000004252
Standard deviation	0.87931	1.119836	
Minimum-Maximum	0-3	3-7	
Range	3	4	

*\*(Mann-Whitney U test)*

Thus, it can be said that NNS is effective in reducing the pain response in neonates who receive invasive procedures.

### 4. DISCUSSION

All invasive procedures performed on patients cause a pain response,<sup>26</sup> including neonates who receive infusion procedures. Pain resulting from this invasive procedure is classified as nociceptive pain which involves nociceptors due to tissue damage at the site of invasion. It needs to be understood that nociceptive pain is part of the body's defense mechanism, which is a warning that something has happened that damages tissue integrity, but it often bothers the patients, especially those who have a low pain threshold.<sup>27</sup> Pain management, with both pharmacological and non-pharmacological methods is often required.<sup>28</sup> NNS is one of the options for non-pharmacological methods that can be applied very easily and very cheaply.<sup>29</sup>

For neonates, the mouth is the main instrument for receiving stimulation and pleasure, therefore NNS is an intervention to minimize pain.<sup>30</sup> In our study, the pain felt by the neonates given NNS was much lower than the pain felt by the other group, because they focused their

attention on the stimulation received through their mouths. This shows that NNS is an effective non-pharmacological method for reducing pain in babies, as has been proven in previous research in various settings such as postpartum care rooms,<sup>23</sup> ophthalmology care units,<sup>24</sup> intensive care units<sup>25</sup> and so on.

NNS is a sucking action that is not accompanied by food intake, which is often used as a method to calm babies.<sup>31</sup> Various studies have shown that it is effective in reducing the pain response in babies, especially during invasive procedures such as blood sampling, drug injections and so on.<sup>32</sup> The mechanism behind the analgesic effect of NNS is not fully understood, but it is believed that it stimulates the release of endorphins, which are the body's natural analgesics, and can distract the baby from pain. In addition, it can help stabilize heart rate and blood oxygenation, which can be disrupted due to pain. Research also shows that the combination of NNS with the administration of sweet solutions, such as sucrose, can further increase the analgesic effect on babies during invasive procedures.<sup>33</sup>

Although many studies on NNS have been carried out on babies, this research attempts to control the influence of several confounding factors, the first of which was to homogenize the confounding factors by setting them as inclusion criteria, namely that the type of invasive action is limited specifically to infusions only. Apart from that, it also ensures the homogeneity of several other factors through an equality test between the treatment group and the control group before carrying out a comparison test. The factors in question include sex, age of the baby, gestational age when the baby was born (maturity) and the baby's weight. Of course, by homogenizing these confounding factors, more accurate results can be obtained by minimizing the biases. It is hoped that these more accurate results will further convince units providing neonatal care that NNS is very important for improving the quality of services, especially those related to invasive procedures.

Seeing the effectiveness of NNS in reducing the pain response as described above, this intervention deserves to be promoted massively, especially in relation to invasive procedures on babies in hospitals. To promote the use of NNS, the first step is to provide comprehensive education to healthcare staff regarding the benefits and techniques for implementing NNS. Studies have shown that NNS can be effective in reducing pain during invasive procedures in neonates, especially as measured by infant-specific methods such as NIPS or perhaps other methods to assess effectiveness. Furthermore, it is important to integrate NNS into standard patient care protocols, including training for nurses and physicians on how to implement NNS safely and effectively. Additionally, its use as a

non-pharmacological pain management should be well documented in the patient's medical record to ensure continuity of care and ongoing evaluation of outcomes. With a multidisciplinary approach and commitment to evidence-based practice, promotion of NNS can improve the comfort and quality of care for neonates undergoing invasive procedures in hospital settings.<sup>30</sup> To decide whether it is a priority program, it must go through accurate methods, for example USG (urgency, seriousness and growth),<sup>34</sup> difficulty-usefulness pyramid (DUP),<sup>35-38</sup> quadrant of difficulty-usefulness (QoDU)<sup>39,40</sup> or others.

## 5. CONCLUSION

Based on the results of this research, it can be concluded that non-nutritive sucking is an effective method for reducing the pain response in neonates during invasive procedures.

## 6. Data availability

Data presented in this study can be available on a fair request to the corresponding author or first author.

## 7. Acknowledgment

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## 8. Conflict of interest

All authors declare no conflict of interest.

## 9. Author's contribution

TR: Conception; data collection; data management; data analysis; draft writing; manuscript development; submission  
 TP, NF: Conception; data collection; data management; data analysis; manuscript writing  
 HSWN: data analysis; draft writing; manuscript development; review; editing; submission

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