

The Use of 30% Sucrose and Non-Nutritive Sucking (NNS) to Mediate Neonates' Pain Response from Venous Puncture (Quasi-Experiment in One Private Hospital in Surabaya)

Ni Luh Agustini Purnama^{1*}, Ni Nyoman Wahyu Lestari¹, Dana Kristalisa¹, CH.R. Yeni Suryandari²

Abstract---Pain often occurs in neonates when venous puncture is performed during hospitalization. If pain persists for a long time, it can interfere with the process of growth and subsequent development. Nonpharmacological actions that can be undertaken to minimize pain are by giving 30% sucrose or NNS. The study aimed to identify differences in neonatal pain responses among those who received 30% sucrose and NNS. The research design used was a quasi-experimental post-test only control group design using a consecutive sampling technique; the independent variables were 30% sucrose administration and NNS while the dependent variable was neonatal pain response. The research sample was 36 respondents, namely 12 respondents who received 30% sucrose and 24 respondents who received NNS. The pain scale used was the Neonatal Infant Pain Scale (NIPS). The results showed that the average pain score in the 30% sucrose group was 1.5 and the NNS group was 3.7 with the Mann Whitney nonparametric statistical test $p\text{-value} = 0.006$. There are differences in neonatal pain response obtained with 30% sucrose and NNS. Pain management is very important for neonates considering the adverse effects, so to reduce pain optimally we have to undertake pain management using the 30% sucrose method or the NNS method.

Keywords--- 30% sucrose, NNS, pain, venous puncture.

I. INTRODUCTION

Neonates who fail to pass the transition period are likely to undergo hospitalization, which is likely to involve various invasive measures, one of which is venous puncture for both blood sampling for laboratory examination or catheter vein installation [1]. A venous puncture can cause pain in the neonate and if the pain lasts for a long period it can interfere with the child's growth and development process [2]. The idea that a newborn or premature baby is unable to feel pain due to

¹ Institute of Health Science Katolik St Vincentius a Paulo Surabaya

² Faculty of Nursing, Universitas Airlangga, Surabaya

Corresponding author
Ni Luh Agustini Purnama
Email: niluh_stikvinct@yahoo.com

imperfect nerve growth is wrong, as evidenced at 20 weeks' gestation, when sensory receptors have formed; cortical neurons have developed at 24 weeks of age which give rise to cortical synapses and at 30 weeks of age there has been myelination of the pain path and the development of synapses with sensory fibers, so the newborn baby can immediately feel pain. However, central descending inhibitor control is less developed, so the response to a pain stimulus is greater than in older children and adults [3].

Nurses need to carry out and implement a systematic approach to reducing physical injury due to procedures that cause pain [4]. The effect of this pain can be reduced by paying attention to the principle of atraumatic care, one approach to which is by preventing or reducing physical injury or stress during treatment procedures [5]. In the hospital neonatal care unit, techniques have been applied to reduce pain during venous puncture procedures, using 30% sucrose and Non-Nutritive Sucking (NNS), but no observations have been made about pain response [6].

Neonates who are hospitalized will undergo several procedures that will cause pain. In their study Malarvizhi, Vatsa, Roseline, Nithin, & Paul explained that in the treatment period, 54 neonates who were treated at the NICU had 3283 invasive procedures which resulted in pain. Some procedures that can cause pain are heel lance (55%), endotracheal suctioning (26%) and intravenous insertion (15%). During a preliminary survey of the infants and NICU data obtained, on the first day of treatment intravenous installation was performed on 5 neonates. On the second day, 2 neonates had blood tests, while the others had them carried out on the third day. The average results for the five patients in the first week of treatment were that they had experienced intravenous insertion 3 times and blood collection 2 times for each patient. In NICU, there were 3 patients given 30% sucrose with a pain score of 1-2, while in the infants' room there were 2 patients given NNS with a pain score of 2-3 [7], [8].

Venous puncture should be performed in neonates for intravenous catheter placement or blood sampling. This venous puncture action will result in recurrent pain, especially if it is often performed during the treatment period [9], [10]. The worse the neonate's condition, the more frequently venous puncture measures must be performed for blood sampling [11], [12]. Although neonates cannot express pain, they can show physiological and behavioral responses indicating that they experience pain. If this is allowed to go on then other impacts of pain can occur: impacts of pain that are short-term, namely the existence of significant changes in pulse rate; increase/decrease in blood pressure; increased intracranial pressure; changes in respiratory frequency and increased oxygen demand in neonates [13], [14]. Meanwhile the long-term impacts are poor adaptive function and an increase in future stress response [15].

Nurses as caregivers must manage pain in neonates during venous puncture during treatment. Pain prevention can be achieved by administering sucrose before minor invasive procedures and this is proven to be effective in reducing pain [16], [17]. Another pain prevention that can also be used is the administration of NNS which can also significantly reduce pain during minor invasive procedures that cause pain [18]. The mechanism of sucrose (natural sugar) giving rise to sweetness can produce natural analgesic effects mediated by the body's endogenous opioids [19]. Giving NNS can be used as pain management because the mouth / oral cavity for neonates involves the stimulation of pleasure (oral phase) so it is a distraction technique for the transfer of pain [16]. Therefore, researchers want to make observations about the differences in neonatal pain responses that use 30% sucrose and NNS techniques when venous puncture is performed.

II. METHODS

This study uses a quasi-experimental research design with a post-test only control group, which is a design that reveals a causal relationship by involving 2 groups, namely giving Non-Nutritive Sucking (NNS) and giving 30% sucrose solution. The independent variables in this study were 30% sucrose and NNS and the dependent variable in this study was the neonatal pain response. Based on Budiarto (2008) for difficult cases, the calculation of different tests is $N1: N2 = 1: 2$ [3], so that the number of research samples obtained was namely $N1 = 30\%$ sucrose groups involving 12 samples and $N2 =$ NNS group involving 24 samples. The sampling technique used non-probability sampling (consecutive sampling). The taking of each sample in this study was conducted based on the order in which patients entered every day for a period of 28 days (April 22 to May 19, 2019).

The instrument used was the NIPS (Neonatal Infant Pain Score) scale, used to measure pain in neonates born at less than or full term. The NIPS was first formulated by Lawrence et al. in 1993. The NIPS has been tested for validity by Cong, McGrath, Cusson, & Zhang (2013) namely $R = 0.53-0.84$; $R \geq 0.3$. Wong also states that the NIPS validity test is $0.53-0.84$ [52]. The NIPS has also been tested for validity ($0.53-0.84$) in Devi's study [6]. The reliability test results of the NIPS (parents) by Cong et al. (2013) are $\alpha \geq 0.92-0.97$; $\alpha \geq 0.7$ [5]. Wong (2008) also states that the reliability test of the NIPS is $0.92-0.97$ while in Devi's (2012) research, the alpha Cronbach's = $0.87-0.95$ [5,6]. The parametric statistical test was used by Mann Whitney with SPSS 16.0 software. This research has passed the ethics test at STIKES Catholic St. Vincentius a Paulo Surabaya and has received permission from parents.

III. RESULTS

Characteristics of Research Sites

The study was conducted in one of the hospitals in Surabaya in the maternity room and in the nursery / NICU. The maternity room is a neonatal room, which is a place where healthy newborns are treated with the rooming in the method. The nursery / NICU is on the same floor as the child care pavilion on the 2nd floor. The nursery has a capacity of 14 patients, with 7 non-infectious patients (patients diagnosed with neonatal jaundice, UTI) and 7 patients with infections (such as pneumonia, GED). At NICU there is capacity for 4-6 patients with most diagnoses, namely premature neonates, asphyxia, Respiratory Distress Syndrome (RDS), Meconial Aspiration Syndrome (MAS), Persistent Pulmonary Hypertension of the Newborn (PPHN), Congenital Heart Disease (PJB), Transient Tachypnea of New Born (TTNB). Many neonates in the infirmary will certainly have a venous puncture procedure in their care, either for infusion or blood sampling for routine screening or continuation checks which certainly can cause pain in the neonate during the procedure.

Table 1 shows that, of the 36 respondents, most of them were term neonates (UK 38-42 weeks), 66.7% in the 30% sucrose group and 91.7% in the NNS group. Neonates were at most 1 week old (0-7 days), 50% in the 30% sucrose group and 70.8% in the NNS group. The sex of the respondents was 66.7% male in the 30% sucrose group and 58.3% female in the NNS group. The most common medical diagnosis in respondents was neonatal jaundice, which was 41.7% in the 30% sucrose group and 54.2% in the Non-Nutritive Sucking (NNS) group. The venous puncture method performed in the 30% sucrose group was 100% using intravenous puncture and in the NNS group as much as 54.2% used heel pricking. The most common stabbings were once per procedure, namely 75% in the 30% sucrose group and 83.3% in the NNS group. The table also shows that 83.3% of neonates in the 30% group had had venous puncture and 62.5% in the NNS group. Most neonates were

hospitalized for less than 1 week, namely 75% in the 30% sucrose group and 100% in the NNS group and had never been hospitalized before, namely 92.7% in the 30% sucrose group and 100% in the NNS group.

General Data

Table 1. Table of demographic characteristics of neonates receiving 30% sucrose and neonates given NNS during venous puncture at one private hospital in Surabaya from April, 22nd –May, 19th 2019

Characteristics	Group Sucrose 30%		Group NNS		P value
	Σ n=12	%	Σ n=24	%	
Age					0.26
1 week	6	50	17	70.8	
2 weeks	5	41.7	7	29.2	
4 weeks	1	8.3			
GA					0.27
< 38 weeks	4	33.3	2	8.3	
38-42 weeks	8	66.7	22	91.7	
Gender					0.23
Male	8	66.7	10	41.7	
Female	4	33.3	14	58.3	
Diagnosis					0.93
Breast milk jaundice	1	8.3	-	-	
Vitamin K deficiency	1	8.3	-	-	
Icterus neonatorum	5	41.7	13	54.2	
IUGR	-	-	1	4.2	
Neonatus (healthy)	-	-	8	33.3	
Omfalitis	1	8.3	-	-	
PPHN	-	-	1	4.2	
RDS	4	33.3	-	-	
TTNB	-	-	1	4.2	
Method of puncture					0.00
Intravenous stabbing	12	100	11	45.8	
Heel pricking	-	-	13	54.2	
Stabbing total					0.70
1 time	9	75	20	83.3	
>1 time	3	25	4	16.7	
Previous venous puncture					0.32
Yes	10	83.3	15	62.5	
No	2	16.7	9	37.5	
Length of stay					0.23
≤ 1 week	9	75	24	100	
>1 week	3	25	-	-	
Hospitalization history					0.7
Yes	1	8.3	-	-	
No	11	92.7	24	100	

Special Data

Specific data in this study gives the results of neonatal pain scores involving pain management by giving 30% sucrose and NNS. The number of neonates who were observed was 36 divided into 2 groups: 12 neonates who received 30% sucrose and 24 neonates who received NNS. Each neonate was assessed for pain response using the NIPS.

Table 2 shows that the NIPS score in the 30% sucrose group was at most 0 (75%), the interpretation of which is that neonates did not feel pain during venous puncture. Whereas in the NNS group, almost all neonates showed their pain response with the highest NIPS score being 7 (29.2%). This means that the neonate feels severe pain during venous puncture.

Table 2. Results of neonatal pain scores for those receiving 30% sucrose and neonates given NNS during venous puncture at one private Hospital in Surabaya from April, 22nd –May, 19th 2019

Pain score	Pain management				Σ	
	Sucrose 30%		NNS		Σ	%
	Σ	%	Σ	%		
0	9	75	3	12.5	12	33.3
1	0	0	4	16.7	4	11.1
2	0	0	3	12.5	3	8.3
3	0	0	3	12.5	3	8.3
4	0	0	1	4.2	1	2.8
5	1	8.3	0	0	1	2.8
6	1	8.3	3	12.5	4	11.1
7	1	8.3	7	29.2	8	22.2
Total	12	100	24	100	36	100

Table 3. Overview of neonatal pain scores for those who received 30% sucrose and neonates given NNS during venous puncture at private Hospital in Surabaya from April, 22nd- May, 19th 2019

Group	N	Pain score		
		Mean	Std. Deviation	Minimum-maximum value
Sucrose 30%	12	1.5	2.74	0-7
NNS	24	3.7	2.73	0-7

Based on Table 3, it can be seen that the average neonatal pain score in the group receiving NNS (3.7) was higher than the average neonatal pain score in the group receiving 30% sucrose (1.5). The results showed that the average pain score in the 30% sucrose group was 1.5 and in the NNS group, it was 3.7 with the Mann Whitney nonparametric statistical test p-value = 0.006

IV. DISCUSSION

This study investigated the neonatal pain response to 30% sucrose during venous puncture. In the study, the results showed that of the group that received 30% sucrose, which included 12 neonates, who received an NIPS score of 0 there were 9 (75%) neonates and those who received a NIPS score of 5-7 totaled 3 (25%) neonates, which means that most neonates did not feel pain during venous puncture [2] indicating that the administration of sucrose solution is a recommended technique for reducing pain in neonates. The results of this study are in line with [6]; researchers argue that the sweet taste caused by sucrose can divert attention from neonates when receiving a pain stimulus and can still be felt long enough that the transfer of pain can still be maintained. Also, this sweet taste can result in the release of beta-endorphin which is an endogenous opiate produced by the body itself which is similar to morphine so that it can inhibit the pain stimuli felt by the neonate [7].

In the study, 3 neonates showed pain responses with an NIPS score > 4 despite getting 30% sucrose. Data showed that the 2 neonates had been inpatients for more than 1 week and 1 neonate had been hospitalized before. One of the factors that can affect pain in neonates is the experience of previous pain and the severity of the illness [18]. Based on the data above, the researchers believe that if the illness is severe, the neonatal care period will also be long; it is likely that many invasive procedures are performed, in these circumstances, such as frequent infusion/ blood sampling, orogastric tube placement or even endotracheal tube placement so that the pain stimulus will often be experienced by these neonates. Due to the frequent invasive procedures, the neonate will experience a traumatic process due to recurrent pain that makes him/her feel uncomfortable (often looks alert and awake if he feels something is bothering him), physical stress (the presence of a

puncture, often stowing). The experience of continuous pain during the neonatal period is likely to cause increased distress and a stronger negative response during the procedure which results in pain in the future. Neonatal pain response that receives NNS during venous puncture

In this study the results obtained in the group that received NNS, which included 24 neonates, showed that 7 (29.2%) neonates had the highest NIPS scores of 7 and 5 neonates including venous puncture using the heel pricking method. The results showed that most neonates showed pain responses during venous puncture. This is not in line with research conducted by [12] which states that NNS can be used as pain management because the oral area for neonates stimulates pleasure (oral phase) so that it can be used as a distraction technique to reduce pain experienced. Based on observations, researchers argue that this high score can be influenced by the length of the procedure carried out, by having to pump (pressing the feet periodically) so that blood can come out onto filter paper/examination paper, and must do a strong leg stowing so that the blood sample is right on the examination paper. This is supported by research conducted by [14] which proves that sampling through heel pricking shows more pain response than intravenous pricking.

Although most of the neonates who received NNS experienced pain during venous puncture, 3 neonates had an NIPS score of 0. This result is in line with research conducted by [17] which proves that administration of NNS in neonates who had infusion performed had lower pain scores than neonates without the administration of NNS. Researchers believe the distraction technique using NNS can be used as an alternative for pain management; the advantages of NNS are widely available / easily available, practical preparation can be undertaken for procedures that are not scheduled and can be done with neonates who are undergoing total fasting. This is supported in the research from [1] that the provision of NNS was proven to be more able to reduce the pain response in neonates compared to the treatment of kangaroo methods. The provision of NNS can also be done by providing comfort to the neonate by swaddling when performed; this can also reduce the pain response as proven in [15]. A drink could also be provided beforehand so that the neonate feels full so he is more comfortable and calm when the action is undertaken. It is hoped that by following these actions the distraction technique of NNS can be maximizes so that neonates show a minimal pain response. Differences in neonatal pain responses for those receiving 30% sucrose and NNS during venous puncture were considered.

Based on the Mann Whitney statistical test with a significance level of $\alpha = 0.05$, $p = 0.006$ was obtained, so that a significant difference was obtained in the neonatal pain response in the group receiving 30% sucrose and the neonatal group receiving NNS. The mean rank of NIPS score in the group that received 30% sucrose (1.5) was smaller than in the group that received NNS (3.7). This showed that the administration of sucrose at 30% could do more to reduce the pain response in neonates during venous puncture. According to [13], the analgesic effect of sucrose is that it can result in the release of beta-endorphin which is an endogenous opiate produced by the body itself that is similar to morphine; this hormone binds to the receptors in the brain and regulates the regulation of perceived pain stimulus.

Based on the data above, the researcher believes that this difference may be due to a weakness in this study, namely the venous puncture method performed in the 2 groups was not equal; in neonates who received 30% sucrose, none of them had blood taken through the heel prick. From the observations of researchers on neonates who had 30% sucrose, neonates looked calm and relaxed when the venous puncture was performed while still showing a response to sucking / tasting the sweetness in their mouth even though there was no NNS in their mouth. meanwhile, in neonates who had NNS, even though they already had NNS 2 minutes before venous puncture was performed, when the neonate first felt pain in his/her body

he/she no longer wanted to retain the sucking reflex, even though he/she had been helped to maintain the position for NNS to stay distracted; most neonates rejected it and kept crying. To reduce the pain response in neonates optimally, a 30% sucrose method or an NNS method can be used. If 30% sucrose is difficult to obtain or not available then NNS can be as the first choice for pain management in neonates.

V. CONCLUSION

Most neonates (75%) who received 30% sucrose showed no pain response at all indicated by an NIPS score of 0. As many as 29.2% of neonates who received NNS showed a severe pain response with an NIPS score of 7. There was a difference in neonatal pain responses for those who had 30% sucrose and those who had NNS, whereby 30% sucrose solution was more effective in reducing pain response in neonates when venous puncture was performed.

CONFLICT OF INTEREST

The authors declare there was no conflict of interest in this study.

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REFERENCE

- [1] W. Shalish *et al.*, "Assessment of Extubation Readiness Using Spontaneous Breathing Trials in Extremely Preterm Neonates," *JAMA Pediatr.*, 2020.
- [2] E. H.L. *et al.*, "A one-day 'Helping Babies Breathe' course improves simulated performance but not clinical management of neonates," *Resuscitation*, 2013.
- [3] W. qiong LE, Z. nan Wang, P. Chen, Y. ling Hu, and J. Li, "[Second hearing screening model in neonates who failed the first screening].," *Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi*, 2011.
- [4] Roppolo L. *et al.*, "Use of a multi-disciplinary team to develop an agitation protocol and educational curriculum for emergency medicine residents to reduce violence in the emergency department," *Acad. Emerg. Med.*, 2017.
- [5] J. Fuijkschot, T. Antonius, P. W. Meijers, and S. Vrancken, "Neonatal subgaleal haemorrhage; a potential life-threatening extracranial haemorrhage. [Dutch]rDe subgaleale bloeding bij de neonatus; een potentieel levensbedreigende extracraniele bloeding," *Ned. Tijdschr. Geneesk.*, 2008.
- [6] R. Sevenich *et al.*, "High-pressure thermal sterilization: Food safety and food quality of baby food puree," *J. Food Sci.*, 2014.
- [7] M. S. Masule, M. Arbabi, P. Ghaeli, M. Hadjibabaie, and H. Torkamandi, "Assessing cognition, depression and anxiety in hospitalized patients during pre and post-Bone Marrow Transplantation," *Iran. J. Psychiatry*, 2014.
- [8] C. C. Yates, A. J. Mitchell, L. M. Lowe, A. Lee, and R. W. Hall, "Safety of noninvasive electrical stimulation of acupuncture points during a routine neonatal heel stick," *Med. Acupunct.*, 2013.
- [9] K. C. Harris *et al.*, "Should early extubation be the goal for children after congenital cardiac surgery?," *J. Thorac. Cardiovasc. Surg.*, 2014.
- [10] P. Brass, M. Hellmich, L. Kolodziej, G. Schick, and A. F. Smith, "Ultrasound guidance versus anatomical landmarks for subclavian or femoral vein catheterization," *Cochrane Database of Systematic Reviews*. 2015.
- [11] M. Catteruccia *et al.*, "Persistent pulmonary arterial hypertension in the newborn (PPHN): A frequent manifestation of TMEM70 defective patients," *Mol. Genet. Metab.*, 2014.
- [12] B. K. Aydin *et al.*, "Permanent neonatal diabetes mellitus: Same mutation, different glycemic control with sulfonylurea therapy on long-term follow-up," *JCRPE J. Clin. Res. Pediatr. Endocrinol.*, 2012.

- [13] M. Mongiovi, V. Fesslova, G. Fazio, G. Barbaro, and S. Pipitone, "Diagnosis and Prognosis of Fetal Cardiomyopathies: A Review," *Curr. Pharm. Des.*, 2012.
- [14] C. M. *et al.*, "Persistent pulmonary arterial hypertension in the newborn (PPHN): A frequent manifestation of TMEM70 defective patients," *Mol. Genet. Metab.*, 2014.
- [15] S. E., W. L., J. R., and M. T., "[Influence of selected factors on the treatment and prognosis in newborns with gastroschisis on the basis of own experience].," *Med. Wiek Rozwoj.*, 2013.
- [16] A. S. Nimbalkar, A. R. Dongara, A. G. Phatak, and S. M. Nimbalkar, "Knowledge and attitudes regarding neonatal pain among nursing staff of pediatric department: An Indian experience," *Pain Manag. Nurs.*, 2014.
- [17] A. Squillaro, E. M. Mahdi, N. Tran, A. Lakshmanan, E. Kim, and L. I. Kelley-Quon, "Managing Procedural Pain in the Neonate Using an Opioid-sparing Approach," *Clinical Therapeutics*. 2019.
- [18] 6(1). <http://doi.org/10.1186/s13613-015-0104-6> Deye, N., Vincent, F., Michel, P., Ehrmann, S., Da Silva, D., Piagnerelli, M., ... Laterre, P.-F. (2016). Changes in cardiac arrest patients's temperature management after the 2013 "TTM" trial: Results from an international survey. *Annals of Intensive et al.*, "Community health care worker knowledge and management of pre-eclampsia in Mozambique," *Int. J. Gynecol. Obstet.*, 2015.
- [19] S. A., M. E.M., T. N., L. A., K. E., and K.-Q. L.I., "Managing Procedural Pain in the Neonate Using an Opioid-sparing Approach," *Clin. Ther.*, 2019.