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Original Research Article

Impact of non-pharmacological pain management technique on physiological parameters and duration of cry among neonates while undergoing heel prick

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ABSTRACT

Background: Neonatal heel pricks cause distress, necessitating effective pain management. Minimizing pain is an ethical responsibility of healthcare providers, ensuring both comfort and compassionate care for neonates. This study evaluates 25% dextrose and expressed breast milk for pain relief by assessing vital parameters and crying duration.
Methods: Quasi-experimental study was conducted among 14 neonates and assigned to two groups i.e. dextrose group (n=7) received 2 ml of 25% glucose, while the expressed breast milk group (n=7) was given 2 ml of expressed breast milk, administered two minutes before the heel prick procedure. Physiological parameters were assessed using physiological assessment proforma at baseline and following the heel prick procedure. Bio-physiological assessment proforma was validated with reliability coefficients of 0.80.
Results: The mean birth weight of neonates was 2920±430 g. The expressed breast milk group had a significantly higher respiratory rate (55.43±2.22 versus 46.57±3.59, p<0.01) and heart rate (150.86±7.01 versus 136.86±3.43, p<0.01) compared to the dextrose group. Oxygen saturation remained similar between both groups (p=0.12). Similarly, 25% dextrose significantly reduced duration of crying compared to the breast milk group. A positive correlation was also observed between heart rate and respiratory rate (0.68, <0.01*) whereas negative correlation was observed between heart rate and oxygen saturation (-0.53, 0.051).
Conclusions: The study demonstrates that 25% dextrose more effectively stabilized the physiological parameters with less crying duration than expressed breast milk while undergoing heel prick.

Keywords: Breastmilk, Dextrose, Heel prick, Neonates

INTRODUCTION

Neonates admitted to neonatal intensive care units (NICUs) are routinely exposed to numerous painful procedures as part of their medical care.[1] Over the past three decades, the concept of pain in neonates was not widely recognized. For the first time, a study highlighted that neonate had not been administered analgesics for any invasive procedures until then. The study ultimately concluded that neonates are capable of perceiving pain, even though they cannot express it subjectively.[2] Additionally, over the past three decades, the issue of pain in neonates has been a topic of debate following the recognition that they might experience it. While some argue that neonates do not feel pain, others suggest that they do. This controversy stems from the immaturity of the neonatal nervous system. However, as more research has identified pain responses in neonates, recent reviews indicate that they are indeed capable of perceiving pain.[3,4] Hospitalized newborns commonly undergo minor invasive procedures in early life, such as immunizations, heel lancing, bilirubin screening, blood glucose tests.[5-8]

Studies have shown that neonates can experience an average of 7 to 17 painful procedures per day, depending on their clinical condition and NICU practices.[9,10] Another study reported that neonates underwent a mean of 16 painful procedures daily, yet only 20.8% of these were managed with any form of analgesia or comfort intervention.[1] Similarly, a study conducted in Netherlands observed a median of 10 painful procedures per day, with just 34% being treated with analgesics or non-pharmacological soothing methods.[11] Another study conducted in Netherlands among ventilated neonates also highlighted that more than half of painful procedures performed on ventilated neonates in NICUs occurred without any pain relief.[12] These commonly performed procedures include heel lances, veni-puncture, endo-tracheal suctioning, and naso-gastric tube insertion.[13] Despite growing awareness, the consistent underuse of pain relief during these procedures reflects a concerning gap in neonatal care.[9,10] This cumulative exposure to untreated pain not only causes immediate distress but may also impact long-term neuro-developmental outcomes.[13]

Exposure to painful stimuli during this crucial phase of brain development can result in long-term epigenetic changes, affecting neurodevelopment, pain regulation, and sensitivity in later life.[14,15] This makes neonates particularly vulnerable to both immediate and long-term adverse effects on brain function and sensory processing.[16,17] However, non-pharmacological analgesic approaches offer a safer and effective alternative for managing procedural pain.

Various studies have increasingly been conducted to assess the effectiveness and safety of various non-pharmacological interventions in neonatal pain management, as they provide high-quality evidence. However, given the vast amount of available data, NICU nurses may struggle to make quick, informed decisions regarding optimal pain management strategies.[18,19] To date, no studies have compared two non-pharmacological pain management techniques among neonates during minor routine procedures, such as heel pricks, in Nepal. Addressing these issues is crucial for improving pain management practices for neonates.

Therefore, this study was undertaken to evaluate the effectiveness of 25% dextrose and breast milk in stabilization of physiological parameters and cry duration in neonates undergoing minor invasive procedures such as heel prick.

METHODS

Research design

This study is a quasi-experimental study with non-equivalent control group pre-test post-test design to evaluate the effectiveness 25D and EBM on physiological parameters and duration of cry while undergoing heel prick procedure.

Participants

A total of 14 neonates were purposively selected and randomly allocated (approximate ratio 1:1) to two intervention groups (25% dextrose group and expressed breast milk group). Sample subjects were term neonates till 28 days of life and admitted to NICU, who are on oral feeds and last oral feed not less than 30 minutes, in the state of wakefulness. Neonates were excluded if they were on mechanical ventilators and receiving sedatives, or congenital anomalies.

Intervention

All neonates meeting the inclusion criteria were enrolled as study participants. Neonatal characteristics were collected from both the mother and the newborn. A pulse oximeter was placed on the wrist to record baseline measurements of heart rate (HR) and oxygen saturation (SaO_2). These baseline readings were taken from the standard calibrated monitor of NICU as well as manually by the primary investigator over a period of four minutes.

Following this, each neonate received one of the two interventions either 2 ml of 25% dextrose or 2 ml of expressed breast milk. The 25% dextrose was taken from the vial before the intervention. The expressed breast milk was freshly obtained from the mother just before the procedure. All interventions were administered by an on-duty staff nurse via the sterile dropper. If a neonate vomited immediately after receiving the intervention, then the newborn was excluded from the study.

The primary investigator was blinded to the intervention was unaware of which treatment was administered. After the intervention, a heel prick was performed by the primary investigator using a lancet needle. The entire procedure, from intervention administration to four minutes after the completion of the heel prick, was recorded on camera to ensure accurate documentation of the process.

Outcome measures

Assessment of the outcomes

The physiological parameters of the neonates were assessed by a biophysiological assessment proforma which was developed and validated based on literature and researcher discussion. The primary outcome measure was physiological parameters and secondary outcome was duration of crying. This physiological parameter includes maximum heart rate, and respiratory rate, minimum oxygen saturation. The duration of cry was assessed following the heel prick, the time from the first cry until the neonate stopped crying continuously was measured. This was documented using video recordings to ensure accuracy and consistency in assessing the crying duration. The interclass correlation consistency (ICC) of biophysiological assessment proforma was 0.80. It was

assessed at baseline, immediately after the heel prick, 2 minutes and 4 minutes after the heel prick procedure.

Blinding

The enrolment and assignment of sample subjects were carried out by an on-duty staff nurse, ensuring that the primary investigator remained blinded to the intervention. To maintain blinding, the primary investigator was not present in the room when the intervention was administered and had no role in the allocation of neonates to either group.

The primary investigator was responsible for recording the procedure on video and observing key physiological parameters, including heart rate, oxygen saturation and the duration of crying. After the intervention was administered by the on-duty nurse, the primary investigator performed the heel prick using a lancet needle. This careful separation of roles helped eliminate potential bias and ensured objective data collection.

Statistical analysis

Continuous and categorical data were presented as mean (standard deviation), frequency and percentage, respectively. Student "T" test was used to compare means between the groups. Pearson correlation test was used to observe the relationship between physiological parameters. All data analyses were performed using statistical package for the social sciences (SPSS) version 20.0. The significance level was set at $p<0.05$, with a 95% confidence interval (CI).

RESULTS

Table 1 compares neonatal characteristics between the dextrose and breast milk groups. In both groups, all neonates were within 0–7 days of life (100%), with an equal gender distribution of 57.1% male and 42.9% female. Regarding birth weight, 71.4% of neonates in the dextrose group weighed ≤2500 g, while all neonates in the breast milk group weighed between 2501–3500 g (100%). A similar pattern was observed in current weight, where 71.4% of neonates in the dextrose group weighed ≤2500 g, whereas all neonates in the breast milk group weighed 2501–3500 g. No complications were reported after the intervention in either group (100% had no complications).

Table 2 shows the comparison of mean respiratory rate, heart rate, and oxygen saturation between the dextrose and breast milk groups at baseline and 4 minutes after the intervention. At baseline (pre-test), there were no significant differences between the dextrose and breast milk groups in respiratory rate (p=0.32), heart rate (p=0.12), or oxygen saturation (p=0.12). However, at 4 minutes post-intervention, the breast milk group showed a significant increase in respiratory rate (55.43±2.22 versus 46.57±3.59, p<0.01) and heart rate (150.86±7.01 versus 136.86±3.43, p<0.01) compared to the dextrose group. Oxygen saturation remained stable in both groups, with no significant difference before or after the intervention (p=0.12).

Table 1: Frequency and percentage distribution of neonatal characteristics among intervention and control group.

Variables	Dextrose group, F (%)	Brest milk group, F (%)
Days of life		
0-7	7 (100)	7 (100)
8-28	0	
Gender		
Male	4 (57.1)	4(57.1)
Female	3 (42.9)	3(42.9)
Birth weight (g)		
≤2500	5 (71.4)	0 (0)
2501-3500	2 (28.5)	7 (100)
3501-4500	0 (0)	0 (0)
Current weight (g)		
≤2500	5 (71.4)	0 (0)
2501-3500	2 (28.5)	7 (100)
3501-4500	0 (0)	0 (0)
Complications after intervention		
Yes	0 (0)	0 (0)
No	7 (100)	7 (100)

F: Frequency

Table 2: Comparison of mean and standard deviation of physiological parameters in intervention and control group using student "t" test.

Parameters	Dextrose group	Expressed breast milk group	P value
Respiratory rate			
Baseline	46.86±4.59	44.86±2.26	0.32
4 min	46.57±3.59	55.43±2.22	<0.01
Heart rate			
Baseline	137±3.69	140.57±4.27	0.12
4 min	136.86±3.43	150.86±7.01	<0.01
Oxygen saturation			
Baseline	99.57±0.78	98.71±1.11	0.12
4 min	99.57±0.78	98.71±1.11	0.12

Values denote mean±standard deviation; statistically significant at p<0.05

Table 3 compares the mean crying duration (in seconds) between the intervention and control groups across two sessions. In both sessions, neonates who received the intervention 25% dextrose had a significantly shorter crying duration compared to those who received or expressed breast milk. The intervention group had a mean crying duration of 73.14±26.47 seconds, while the control group had 112.85±17.99 seconds, indicating the effectiveness of the intervention in reducing pain while undergoing heel prick.

Table 3: Comparison of mean and standard deviation of duration of cry in intervention and control group.

Groups	Duration of cry (mean±SD)
Dextrose group	73.14±26.47
Expressed breast milk group	112.85±17.99

Values denote mean±standard deviation

Table 4 shows correlations between respiratory rate, heart rate, and oxygen saturation in pre-test and post-test phases. In the pre-test, correlations were weak and not statistically significant (p>0.05). Post-test, respiratory rate and heart rate showed a significant moderate positive correlation (0.68, p<0.01). Oxygen saturation had a stronger negative correlation with heart rate (-0.61, p=0.021), while its correlation with respiratory rate (-0.53, p=0.051) was near significance.

Table 4: Correlation between physiological parameters.

Variables	Heart rate	Respiratory rate
Respiratory rate		
Pretest	0.13,0.64	1
Post-test	0.68, <0.01*	1
Oxygen saturation		
Pre-test	-0.32, 0.25	-0.15, 0.58*
Post-test	-0.53, 0.051	-0.61, 0.021*

Pearson's correlation test, *statistically significant at p<0.05

DISCUSSION

Heel prick is a routine procedure in neonates during their hospitalization in NICUs, often resulting in pain and discomfort. Pharmacological measures, such as opioids, are commonly administered for pain management in intensive care settings. However, there is a lack of widespread and effective pain relief interventions for less critically ill neonates. Consequently, identifying a simple and acceptable method for enhancing comfort is imperative for both medical and ethical reasons. An optimal pain management strategy for neonates should be user-friendly, well-tolerated, minimally invasive, have a rapid onset of action, and exhibit minimal adverse effects. The study shows that 25% dextrose is more effective in stabilization of physiological parameters caused by heel prick.

Vital parameters like heart rate, and oxygen saturation are key indicators of neonatal physiological stability. They help assess intervention effectiveness, detect early distress, and ensure well-being. During painful procedures like heel pricks, fluctuations in these parameters provide valuable insights into neonatal pain and comfort. The findings of this study are consistent with research in Telangana, India which compared expressed breast milk and 10% dextrose during heel prick.[20] Their study found that pre-procedure heart rate was significantly higher in the expressed breast milk group (p=0.0482), while heart rate at four minutes post-procedure was significantly lower in the dextrose group (p=0.02043). However, this study contrasts with study conducted in Imphal, which found no significant difference in post-procedure heart rate between expressed breast milk and oral glucose (p=0.110).[21] Similarly, study conducted in Turkey reported no significant differences in baseline vital signs between groups, with both groups showing increased heart rate and decreased oxygen saturation post-procedure (p>0.05).[22]

Duration of crying is another crucial indicator of neonatal pain and discomfort; as prolonged crying reflects heightened distress. Along with physiological parameters, it plays major role in evaluating the effectiveness of pain management interventions. Observing changes in crying duration helps to understand the neonate's response to painful stimuli, assess their comfort level, and make informed decisions about improving neonatal care. The present study findings showed the less duration of crying in the intervention group which is similar to the findings of the study by Chauhan et al conducted in India which showed more crying duration in expressed breast milk group i.e. 4.20±3.31 minutes compared to 25% dextrose i.e. 5.32±0.11 minutes.[23] In-addition, similar findings can be seen in another study conducted in India which showed 74.80±10.96 seconds of crying duration in dextrose group compared to expressed breast milk group i.e. 104.56±9.16 seconds.[24]

Limitations

The study focused on the term neonates and exclude the preterm neonates <37 weeks gestation, and hence, effectiveness in those preterm who undergo more painful and repeated procedures are lacked.

CONCLUSION

Physiological parameters such as heart rate, respiratory rate and oxygen saturation including duration of cry are key indicators of neonatal physiological stability and pain perception. This study highlights the significance of these parameters in evaluating the effectiveness of non-pharmacological pain management interventions during minor invasive procedures like heel prick. Findings suggest that interventions such as 25% dextrose and expressed breast milk help in stabilization of physiological parameters, as evidenced by shorter crying duration. Incorporating such safe and cost-effective strategies in neonatal care can enhance pain management practices, ensuring better comfort and well-being for newborns.

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