Effect of Environmental and Behavioral Interventions on Physiological and Behavioral Responses of Premature Neonate Candidates Admitted for Intravenous Catheter Insertion in Neonatal Intensive Care Units

Shohreh Taheri (1)
Anahita Masoumpoor (2)
Maryam Marofi (3)
Malihe Nasiri (4)

(1) Master of Science in Neonatal Intensive Care Nursing, International Division of Shahid Beheshti University of Medical Sciences, Tehran, Iran.
(2) Phd in Nursing, Pediatric department, Nursing and Midwifery School of Shahid Beheshti University of medical sciences, Tehran, Iran.
(3) Department of Pediatric Nursing, Nursing and Midwifery Care Research Center, School of Nursing and Midwifery, Esfahan University of Medical Sciences, Hezarjrb Ave, Esfahan, Iran.
(4) Phd in biostatistics, Assistant professor , Nursing and Midwifery School of Shahid Beheshti University of medical sciences, Tehran, Iran

Correspondence:
Anahita Masoumpoor
Phd in Nursing, Pediatric department, Nursing and Midwifery School of Shahid Beheshti University of Medical Sciences,
Tehran, Iran,

Abstract

Background and Objective: Many painful procedures including intravenous catheterization are performed in the ward without taking necessary pain-reducing measures. The present study was conducted with the aim to determine the effect of environmental and behavioral interventions on physiological and behavioral responses of preterm infants during intravenous catheterization.

Materials and Methods: In the present clinical trial, 82 infants with gestational age of 30-37 weeks were randomly divided into intervention and control groups. In the preliminary intervention stage, measures such as dimming light and noise, using eye patch and ear plugs, reducing nursing manipulations, and positioning the newborn in fetal position 30 minutes before and 30 minutes after venepuncture were performed for the intervention group, but the control group received only the routine care. Data were collected using NIPS & EDIN Scale, and analyzed in SPSS-20.

Results: No significant difference was observed between the two groups in behavioral responses to pain and stress prior to intravenous catheterization (P>0.05) (P=0.13), but these responses were significantly less in the intervention group compared to the control during and after this procedure (P<0.05). Moreover, no significant difference was observed between the two groups in the mean physiological responses (P>0.05).

Conclusion: Dimming light and noise, reducing nursing manipulations, and fetal positioning during intravenous catheterization effectively reduces neonatal pain.

Key words: Environmental and behavioral interventions, physiological and behavioral responses, intravenous catheterization, preterm infant.

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Introduction

The neonatal period includes the first moment of delivery to one month after birth. At this time, physical changes occur in the body and the infant learns how to respond to many forms of external stimuli (1). Over the past 25 years, the prevalence of premature babies has increased by 30 percent (2). More than 70% of preterm infants admitted to a special care nursery have spent time in a NICU (3). Many years ago, it was thought that babies and infants do not feel pain because of an immature nervous system or they feel less pain than adults. At present, it has been shown that the fiber nerves directing the pain stimulations are formed during embryonic development and in fact, term infants have the same sensitivity to pain as older infants and children do, and premature infants may be more sensitive to pain than full term infants (4). Pain as one of the defensive mechanisms of the body, indicates abnormal conditions in the body, so that relief from the pain is a basic requirement and the right of all people as well as the most important goals of medical science (5). The results of a study on neonates in the neonatal intensive care unit indicated that heel prick blood sampling was the most common procedure (56%), followed by endotracheal suction (26%) and intravenous cannula insertion (8%), and other procedures with fewer percentages included venepuncture, intubation, intramuscular injection, intravenous catheter insertion, peripheral artery catheter placement, infusion catheter, bladder urine sampling, cerebrospinal fluid sampling, and arterial sampling (6). Inadequately managed pain, for whatever reason, leads to long-term physiological, psychosocial and behavioral consequences, and through being aware of stressors that affect the ill child and their family as well as by designing and applying safe and effective interventions to eliminate or reduce stressors, caregivers should focus their attention on non-traumatic care (7). Stress and pain in newborns can lead to many complications such as such as increased hypoxia, elevated cortisol level (8), impaired nervous system development (9) and mental disorders and increased length of hospitalization (10). The infants' responses to pain and stress can be represented in three behavioral, physiological and nervous-chemical ways; however, the intensity and mode of occurrence of these responses depends upon factors such as maternal gestational age, severity of illness, and duration of admission to the neonatal intensive care unit. Behavioral responses to pain and stress in newborns include the following: crying, body movements, facial shrinkage, and decreased or impaired nutrition. Physiological responses to pain and stress in newborns include changes in blood pressure and heart rate, hypoxia, and increased oxygen intake (11). A high percentage of premature infants may experience problems that result in more than 20 days of stay in infants' care units (12). Since infants are unable to meet their needs by oral feeding, one of their basic care needs is to provide care by administering fluids, medicines and nutrition, and for this purpose, intravenous access is essential (13). Angiocath is considered to be the first choice in the newborn baby, which is ideally suited for short-term treatments (14). In this regard, many painful procedures, including intravenous catheters placement, can be performed without the necessary measures to decrease pain (15). On the other hand, frequent intermittent catheterization puts the infant at risk of painful experiences, stress and the risk of infection and inability to control the pain caused by it, causing short and long-term complications for the baby's health (16), including increasing demand on the cardiovascular system, respiratory system, immunosuppression, increased intracranial pressure, which can lead to intravesical hemorrhage, long-term emotional, behavioral and learning disabilities (17). Pain in newborns can be controlled by non-pharmacological methods such as oral sucrose, non-nutritional sucking, breastfeeding, mother/infant skin-to-skin contact (kangaroo care), and music playback during the procedure (18). Furthermore, according to Stevens 2013, non-drug actions such as lactation, hugging, touching, massaging, cold and hot compress, the use of relaxation techniques, such as playing melodies, music and attention deviance, can effectively reduce the infant's pain (19, 20). Although the use of non-pharmacological measures in the control of anxiety is scientifically and culturally accepted, they have been forgotten due to lack of scientific advice in the pediatric wards (21). Nurses as the most important members in the treatment team, play an important role in maintaining the health and well-being of patients (22). Based on the evolutionary model, taking care of these babies allows the health care practitioner to identify the behavioral signs of the baby, such as when the baby needs sleep or is under stress due to manipulation and intervention and design a care plan adapted to his/her characteristics (23). Evolutionary care and support, integrates the evolutionary needs of newborns admitted to the intensive care unit for medical care. Key concepts in evolutionary care include the organized improvement of neuropsychological and physiological behaviors, modifying physical environment such as light, sound and heat to protect the sensory and vulnerable system, in a set of family-centered structures (24). Regarding the long-term hospitalization of premature infants in the neonatal intensive care unit and painful procedures such as intravenous catheter insertion which can cause pain and stress in the newborn, as well as the importance of evolutionary care in reducing pain in infants, this study was aimed to determine the effect of environmental and behavioral interventions on the physiological and behavioral responses of premature neonates during venepuncture procedure.

Method

The present study was a double-blind clinical trial (intervention and control group). The research population consisted of all preterm infants admitted to the neonatal intensive care unit of Alzahra hospital affiliated to Isfahan University of Medical Sciences. The babies who had the criteria for entering the research were identified. Having completed the consent form and being signed by parents, the biographical information form was completed using the medical records of the infant. Biographical data included infant's name, fetal age, birth weight, infant sex, 1 and 5 minutes Apgar score, type of delivery, number of venepuncture attempts, and physiological information form including heart rate, respiratory rate and SpO2. In order to measure pain in infants, a NIPS checklist consisting of 6 options (facial expression, crying pattern, breathing pattern, arm and leg movement and irritability type), was used. The lowest score of pain was zero and the highest score was 7. A score greater than 3 indicated pain (25). Validity and reliability of this tool were confirmed according to Dilli study (2009) (26) and Khodaie studies (2010) (28) (r = 98). To measure the neonatal stress and discomfort, EDIN scale containing 5 items (facial expression, body movements, sleep status, communication with the nurse, and relaxation) ranging from 0 to 15 was employed; its validity and reliability were confirmed by Debillon et al., (2001) (α = 0.92) (28). In order to study the physiological criteria, Saadat Monitoring manufactured by Pooyandegan Rayan-Sanat, Tehran, Iran was used and the equipment was calibrated by medical equipment engineers prior to use. After confirmation by the Ethics Committee coded by IR.SBMU.RETECH.REC.1395.587 and obtaining written permission from the authorities, the researcher visited the Neonatal Intensive Care Unit of Al-Zahra Hospital in Isfahan to collect samples and by explaining the aims of the study for the authorities and staff of the neonatal intensive care unit, sampling was performed. According to the sample size formula, 41 neonates (in each group) were selected for participation in the study and were randomly assigned (colored beads) to two, intervention and control, groups. Then, the environmental and behavioral interventions including closing the eyes of the newborns with an eye patch to decrease light, closing the ears of the newborns with ear plug to reduce the auditory stimuli and fetal positioning using the nests provided by the researcher, were implemented in the ward by the researcher. After 30 minutes of interventions, an intravenous catheter insertion was performed by an experienced nurse while interventions continued. At the same time, another nurse who had a work experience of at least one year in the neonatal ward and knowing how to fill out the measurement tools, completed the checklist 2 minutes prior to the venepuncture, during the venepuncture and 5 minutes later and 30 minutes after the venepuncture while interventions continued. Physiological data and related checklist were completed and samples were taken out after an hour of relevant study. For each studied neonate, no environmental and behavioral interventions were performed in the control group, but all the information gathering and checklists completing procedures were implemented and recorded as the first one. Data analysis was performed using SPSS version 20. In descriptive statistics, descriptive indicators such as mean and standard deviation were reported. The repeated measures analysis of variance was used to compare the two groups at different times. Also, for comparing demographic indices in two groups, independent t-test, Mann-Whitney and Chi-square test were used.

Findings

The results indicated that the mean gestational age of infants was 33.3 ± 2.2 weeks and the mean weight of newborns was 1871.2 ± 547.32 g. There was no statistically significant difference between the mean 1 and 5 minutes Apgar score and the mean number of venepuncture in the two groups [Table 1]. The fetal age of all subjects was 33 weeks.

Table 1: Frequency distribution of neonatal demographic variables in both intervention and control groups

Variable		Intervention group (n=41)	Control group (n=41)	P-value
Gestational age (week)		33.5 ± 2.2	33.1± 2.2	43%
Birth weight (g)		1974 ± 58.6	1768.94 ± 514.04	10%
Sex	Female	41.15 (n=17)	58.5 (n=24)	12%
	Male	58.5 (n=24)	41.5 (n = 17)	
1 minutes Apgar		6.04	6.4	37%
5 minutes Apgar		8.1	8.3	10%
Type of delivery	Cesarean section	90.2 (n = 37)	85.4 (n = 35)	50%
	Normal	9.8 (n = 4)	14.6 (n = 6)	
Number of venepuncture attempts		1.2	1.3	46%

The mean heart rate in both groups was initially found to be increased during venepuncture and then decreased over time ($P < 0.05$), but the results showed that there is no significant difference between the mean heart rate at different times between the two groups ($P > 0.05$) [Table 2]

Table 2: Comparison of mean heart rate at different times between the two groups

Time	Intervention group		Control group		P-value[1]
	Mean	Standard deviation	Mean	Standard deviation	
2 minutes before venepuncture	15.09	17.1	149.9	18.8	79%
During the venepuncture	153.5	17.8	155.7	17.9	57%
5 minutes after the venepuncture	148.3	16.5	147.3	16.3	79%
30 minutes after the venepuncture	145.2	17.2	141.8	16.4	35%
P-value	0.008		<0.001		

The mean of respiratory rate in the intervention group was 59 and in the control group 58. Although the mean respiratory rate was higher in the intervention group, the results showed that there was no statistically significant difference in the respiratory rate over time in both groups (p> 0.05) [Table 3]

Table 3: Comparison of mean respiratory rate at different times between the two groups

Time	Intervention group		Control group		P-value[2]
	Mean	Standard deviation	Mean	Standard deviation	
2 minutes before venepuncture	59.07	7.1	58.6	4.9	75%
During the venepuncture	59.12	7.1	58.9	5.1	86%
5 minutes after the venepuncture	59.10	7.02	59.11	5.1	99%
30 minutes after the venepuncture	50.14	58.7	58.7	5.1	70%
P-value	0.93		0.51		

The mean of arterial oxygen saturation in the intervention group was 94.875 and 94.7 in the control group. Although the mean of arterial oxygen saturation in the intervention group was higher, the results showed that there was no statistically significant difference in the mean arterial oxygen saturation during venepuncture in both groups (p> 0.05) [Table 4].

Table 4: Comparison of mean SP02 at different times between the two groups

Time	Intervention group		Control group		P-value[3]
	Mean	Standard deviation	Mean	Standard deviation	
2 minutes before venepuncture	95.1	2.3	94.7	3.5	50%
During the venepuncture	94.8	2.6	94.7	3.2	88%
5 minutes after the venepuncture	94.9	3.4	94.6	4.6	75%
30 minutes after the venepuncture	94.7	2.9	94.8	2.7	92%
P-value	0.81		0.51		

There was no statistically significant difference between the mean pain intensity score in the neonates two minutes before the venepuncture and 30 minutes after the venepuncture between the intervention and control groups (p> 0.05). However, the mean score of pain in the intervention group was significantly less than the control group during the venepuncture and 5 minutes after the venepuncture (p <0.05) [Table 5].

Table 5: Comparison of mean pain intensity at different times between the two groups

Time	Intervention group		Control group		P-value[4]
	Mean	Standard deviation	Mean	Standard deviation	
2 minutes before venepuncture	0.5	0.09	0.6	0.1	0.41
During the venepuncture	0.8	0.1	3.04	0.2	<0.001
5 minutes after the venepuncture	0.4	0.09	1.6	0.2	<0.001
30 minutes after the venepuncture	0.3	0.08	0.7	0.2	13%
P-value	0.12		<0.001		

There was no significant difference between the mean severity of stress and discomfort scores in the neonates two minutes before the venepuncture in two intervention and control groups (p = 0.13). However, the mean of stress and discomfort scores in the intervention group was significantly less than the control group during and 5 and 30 minutes after the venepuncture (p <0.05) [Table 6].

Table 6: Comparison of mean stress score at different times between the two groups

Time	Intervention group		Control group		P-value[5]
	Mean	Standard deviation	Mean	Standard deviation	
2 minutes before venepuncture	0.3	0.08	0.5	0.1	0.13
During the venepuncture	0.4	0.09	2.7	0.2	<0.001
5 minutes after the venepuncture	0.1	0.05	1.5	0.2	<0.001
30 minutes after the venepuncture	0.05	0.03	0.7	0.2	<0.001
P-value	0.10		<0.001		

Discussion

There are many studies worldwide about some of the environmental interventions (light and noise reduction), neonatal physiological and behavioral responses (heart rate, respiratory rate and arterial oxygen saturation) and various pain assessment methods, but no research has been found in relation to the effect of environmental and behavioral interventions on the physiological and behavioral responses of premature infants candidates for intravenous catheter insertion admitted to the neonatal intensive care unit. The results of this study showed that although the average heart rate in the two groups was different and was firstly increased during the venepuncture and was decreased over time, no significant difference was found between the mean heart rate at different times between the two groups. The mean respiratory rate and arterial oxygen saturation were higher in the intervention group, but these changes did not show a statistically significant difference in any of the two groups over time. The results of this study are in line with Marilyn's study 2013 (29) in Canada as well as the study by Jacques Sizun (30) in France in 2002. The results of this study showed significant physiological changes (mean SpO2 and heart rate) among newborns with evolutionary care before and after weighing compared with the control group, but the rate of hypoxic attacks was decreased significantly, which was in line with the results of studies by Johnston et al. (31) and Taheri et al. (32) in 2007-2008. In terms of heart rate and respiratory rate, the results of this study were consistent with the study of Taheri et al., but did not have an agreement on the amount of arterial oxygen saturation. This discrepancy can be due to the difference between the procedures conducted in the study. The results of this study are consistent with the results of the study by Slevin et al. (33) in 2000. In addition, the results of this study are consistent with the results of the research by Abdeyazdan et al. (34) (2013), for the respiratory rate, but are inconsistent in terms of oxygenation rate. This discrepancy in outcomes can be attributed to the difference between the interventions in the study. The results of this study are not consistent with the results of the study by Celine Catelin and colleagues (35) in France in 2005. Their study showed that the implementation of environmental and behavioral interventions such as (closing baby's eyes and ears, non-nutritious diet, kangaroo and family-centered care, shaking the baby and putting the baby in a fetal position) during the weighing process resulted in significant changes in physiological criteria; it suggests that these interventions have led to a decrease in respiratory rate and a decrease in heart rate, and an increase in arterial oxygen saturation, which can be due to the low number of samples in each group (15 neonates for each group). However in the recent study, increasing the number of neonates in each group (n = 41) as well as different procedures in the study could be the reasons for discrepancy in the results. Regarding the embryo's position, the results of this study are not consistent with the results of the study by Reyhani et al. (2011) in Mashhad (36). This discrepancy can be attributed to individual differences, demographic characteristics of infants, providing different nursing care in infants' intensive care units and different fetal age. Moreover, the results of this study are not consistent with the results of the study by Nasimi et al. (2014) in Mashhad (37). This discrepancy can be due to the different procedures conducted in the study; these studies have been done using an invasive procedure during a venepuncture, while the study by Nasimi et al., has been conducted with normal procedures in the ward. Other results obtained from this study also showed that there was no significant difference between the mean score of pain in newborns 2 minutes before venepuncture and 30 minutes after venepuncture between the intervention and control groups ($p > 0.05$); but the mean score of pain in the intervention group was significantly less than that of the control group during and 5 minutes after the venepuncture ($p < 0.05$). Additionally, there was no significant difference between the mean stress intensity and discomfort in the neonates 2 minutes before the venepuncture between the intervention and control groups ($p = 0.13$), but the mean score of stress and discomfort in the intervention group was significantly less than that of the control group during as well as 5 and 30 minutes after the venepuncture. The results of this study were in line with the results of the study by Celine Kathleen et al. (2005). Also, the results of this study are consistent with the results of the study of Reyhani et al. (2011) implying that the fetal position decreased the pain intensity of newborns in the intervention group compared to the control group.

Conclusion

According to the results, we can conclude that there are no environmental and behavioral interventions that affect the physiological and behavioral responses of the premature infant, so further research is recommended. Given the advantages of reducing pain and stress during the intravenous catheters insertion in premature infants, their low cost, the lack of specific equipment and the need for evolutionary care, it is recommended to use these interventions in order to decrease the pain of premature neonates during painful procedures including venpuncture.

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