Measuring pain in neonates during placement of central line catheter via peripheral insertion*

Dimensionamento da dor durante a instalação do cateter central de inserção periférica em neonatos

Medida de la intensidad del dolor durante la instalación del catéter central de inserción periférica en neonatos

Priscila Costa[1], Patrícia Ponce de Camargo[2], Mariana Bueno[3], Amélia Fumiko Kimura[4]

ABSTRACT

Objective: To measure pain in neonates during placement of central line catheter via peripheral insertion by comparing pain at the moment of the introduction of the catheter and pain at the progression of the catheter. **Methods**: This was a descriptive exploratory study with 28 neonates from a large teaching hospital in Sao Paulo city. Data were collected with the Premature Infant Pain Profile (PIPP) 15 seconds prior the initial introduction of the catheter, during the initial introduction of the catheter (30 seconds), and during the progression of the catheter (30 seconds). **Results**: The majority of neonates (59.1%) had a score e" 7 on the PIPP, moderate to high pain intensity, during the initial introduction of the catheter. A greater number of neonates (45.5%) who did not receive analgesic or sedative medication had score e" 7 on the PIPP, moderate to high pain intensity, during the progression of the catheter. **Conclusion**: There is a need for adoption of use of analgesic medication in the neonatal unit, since neonates often undergo invasive and painful procedures.

Key words: Neonatal Nursing; Measurement of Pain; Neonatal Critical Care Unit.

RESUMO

Objetivo: Dimensionar a dor durante a instalação do cateter central de inserção periférica, comparando o momento da punção venosa com a progressão do cateter. **Métodos:** Estudo descritivo exploratório com coleta prospectiva dos dados realizado na unidade neonatal de um hospital-escola de grande porte da cidade de São Paulo. Avaliou-se a resposta dolorosa ao procedimento de inserção do cateter em 28 neonatos utilizando-se a escala *Premature Infant Pain Profile* (PIPP) nas etapas de pré-punção (15 segundos), punção venosa (30 segundos) e progressão do cateter (30 segundos). **Resultados:** O escore PIPP maior ou igual a sete, indicativo de dor moderada a intensa, ocorreu em 13 RN (59,1%) na primeira punção venosa e 10 RN (45,5%) na progressão do cateter do grupo que não recebeu analgésico ou sedativo. **Conclusão:** Os resultados apontam para a necessidade de se adotar medidas analgésicas, uma vez que neonatos internados em unidade de terapia intensiva neonatal são freqüentemente submetidos a procedimentos invasivos e dolorosos.

Descritores: Enfermagem neonatal; Medição de dor; Terapia intensiva neonatal.

RESUMEN

Objetivo: Medir la intensidad del dolor durante la instalación del catéter central de inserción periférica, comparando el momento de la punción venosa con la progresión del catéter. **Métodos:** Estudio descriptivo exploratorio con recolección prospectiva de los datos realizado en la unidad neonatal de un hospital-escuela de gran porte de la ciudad de Sao Paulo. Se evaluó la respuesta dolorosa al procedimiento de inserción del catéter en 28 neonatos, utilizándose la escala *Premature Infant Pain Profile* (PIPP) en las etapas de pre-punción (15 segundos), punción venosa (30 segundos) y progresión del catéter (30 segundos). **Resultados:** El puntaje PIPP mayor o igual a siete, indicativo de dolor moderado a intenso ocurrió en 13 RN (59,1%) en la primera punción venosa y 10 RN (45,5%) en la progresión del catéter del grupo que no recibió analgésico o sedativo. **Conclusión:** Los resultados apuntan que es necesario adoptar medidas analgésicas, ya que los neonatos internados en la unidad de terapia intensiva neonatal son frecuentemente sometidos a procedimientos invasores y dolorosos.

Palabras clave: Enfermería neonatal; Medición del dolor; Terapia intensiva neonatal.

** Study extracted from the monograph presented to obtain the title of Neonatology Nursing Specialist at the Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo - São Paulo (SP), Brazil.*

[1] Nurse at the Newborn Nursery Annex to the Maternity at Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo. São Paulo (SP), Brazil.

[2] Postgraduate student (PhD) at the Escola de Enfermagem da Universidade de São Paulo. São Paulo (SP), Brazil. Nurse at the Newborn Nursery Annex to the Maternity at Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo. São Paulo (SP), Brazil.

[3] Postgraduate student (PhD) at the Escola de Enfermagem da Universidade de São Paulo. São Paulo (SP), Brazil.

[4] Nurse PhD, Professor at the Maternal-Child and Psychiatric Nursing Department, Escola de Enfermagem da Universidade de São Paulo. São Paulo (SP), Brazil.

Corresponding Author: **Priscila Costa**
R. Vicente Quaresma, 128. São Paulo (SP), Brazil.
CEP: 05549-070 E-mail: pricosta84@yahoo.com.br

Received article **11/08/2008** and accepted **27/02/2009**

INTRODUCTION

In the last decades, the technological advances that involve neonatal care in intensive care units (NICU) have enabled greater survival rates and better prognosis of neonates.

On the other hand, the hospitalization of newborn infants in NICU involves several painful procedures. A study demonstrated that two to eight painful procedures per day were performed in neonates with gestational age from 27 to 31 weeks during their first two weeks of life[1].

Health care professionals have been increasingly concerned with the pain generated by these procedures; however, pain assessment protocols have not been introduced in many Brazilian NICUs. In addition to this, the staff is not prepared to use pain assessment tools.

Non-verbalization of pain and the limited capacity to express pain for a prolonged period of time are particular characteristics of newborn infants that hinder pain assessment. The elements of the nervous system required for transmitting the painful stimulus are in function since the 24th week of pregnancy[2], however, analgesic measures and sedation in neonatal care units are still scarce.

Pain exposure is one of the most harmful factors of the extra-uterine environment and pain experienced by neonates can lead to short and long term consequences. Evidences suggest that several stressful and painful events experienced by preterm infants lead to sudden physiologic, structural, and functional changes in the central nervous system. There changes can potentially be permanent. Thus, several sequelaes can occur, including chronic pain and changes in neurobehavioral responses to pain[2].

Neonates admitted at NICUs require, most of the times, infusion of vesicant substances that irritate the venous system if infusions are needed for prolonged periods; therefore, it is important to maintain a safe central venous access.

To ensure an intravascular access for a prolonged period, the placement of Peripherally Inserted Central Catheter (PICC) in neonates has become a frequent procedure in the NICU.

Since pain can produce adverse effects in neonates, pain assessment during PICC placement is needed to further support strategies to prevent and treat neonatal pain during this procedure.

OBJECTIVE

To measure pain in neonates during PICC insertion, comparing pain scores during venepuncture and catheter progression.

METHODS

This is a descriptive, exploratory study, with prospective data collection. The research was carried out in the NICU at Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), a large-sized, tertiary teaching hospital located in the city of São Paulo. Neonates undergoing PICC placement and who were admitted from July to November 2007 were enrolled.

The research project has been approved by the Ethic Research Committee of the institution, and parents or legal guardians were required to give their written consent.

Data were obtained from medical charts of neonates and through bedside observation of newborn infants, at the time of PICC placement, during the stages of venepuncture and catheter progression. Pain was assessed by the Premature Infant Pain Profile (PIPP). This is a composite pain assessment tool composed by seven pain indicators which are distributed into the three dimensions: contextual (corrected gestational age; behavioral state); physiological (magnitude of heart rate increase and drop in oxygen saturation); and behavioral (brow bulge, eye squeeze, and nasolabial furrow). Each indicator receives a score from 0 to 3; the total score of the tool ranges from 18 to 21, depending on the gestational age of newborn infants. Total score equal to or lower than six is considered as no pain or minimal pain and a score greater than 12 is classified as moderate or intense pain. The PIPP was validated for sensibility and specificity and it is adequate to assess pain in newborn infants undergoing procedures and to diagnose pain in full term and preterm newborn infants[3-4].

Publications related to the translation and validation of the PIPP into Portuguese were not found to date; however, there are Brazilian studies investigating neonatal pain during heel lance[5] and venepuncture[6] by using the PIPP.

On the first stage of data collection neonates were observed for 15 seconds before the beginning of the procedure. During this period, maximum heart rate and minimum oxygen saturation were registered by one of the researchers. Neonates were monitored by a pulse oximeter (Dixtal®) and its sensor was placed on neonates' superior or inferior limbs. In addition, baseline behavioral state was registered. On the second stage, during 30 seconds after venepuncture, neonates were observed and the following indicators were observed: maximum heart rate, minimum oxygen saturation and time in seconds that neonates presented brow bulge, eyes squeeze and nasolabial furrow. These data have been collected in all venous puncture performed until PICC insertion, regardless of the success obtained in catheter placement. On the third stage, 30 seconds after the second stage was finished, indicators of PIPP were observed during catheter progression and data was recorded afterwards. After the end of PICC placement procedure, the length of time of eye squeeze, brow bulge and nasolabial furrow were transformed into percentage to obtain the final PIPP score.

The PIPP was validated to be used at the bedside for the same group of researchers who created it. For this purpose, neonates' painful response to heel lance and venepuncture were assessed by two researchers in the clinical setting and later through video recording by two experts in neonatal facial coding, with excellent inter and intrarater reliability[4], corroborating for

application in the clinical practice.

Data were collected from July to November 2007 and during this period, 44 newborn infants underwent PICC placement. However, only 28 were enrolled by attending the inclusion criteria.

Apgar score ≥ 7 at 1st and 5th minutes after birth and no need of previous surgeries were the inclusion criteria. Addicted mother's infant, infants with congenital anomalies or chromosomic syndromes and neurological symptoms were not enrolled.

Epi Info 3.3.2 was used for descriptive analyses. Data is presented as absolute and relative frequency, central and dispersion measures.

RESULTS

Amongst the 28 newborn enrolled, the majority were preterm infants and corrected gestational age ranged from 28 to 32 weeks (15-53.5%); most of the infants weighted less than 1,500g (20-71.6%); were small for gestational age (14-50.0%), were females (16-57.1%), did not need mechanical ventilation (16- 57.1%) or chest tube (27-96.0%). Placement of the catheter was predominantly performed in the early neonatal period (19- 67.8%) (Table 1).

Table 1. Characterization of neonates undergoing PICC insertion. NICU at HCFMUSP, São Paulo, 2007

Characterization of neonates	N	%
Corrected gestational age (weeks)		
28 – 32	15	53.5
33 – 35	8	28.5
≥ 36	5	18.0
Classification of weight X gestational age		
Small for gestational age	14	50.0
Adequate for gestational age	13	46.4
Big for gestational age	1	3.6
Gender		
Female	16	57.1
Male	12	42.9
Installed devices		
Tracheal tube		
Yes	16	57.1
No	12	42.9
Chest Tube		
Yes	1	4.0
No	27	96.0
Weight on the day of procedure		
< 750g	7	25.0
≥ 750g < 1000g	7	25.0
≥ 1000g < 1500g	6	21.4
≥ 1500g < 2500g	4	14.3
≥ 2500g	4	14.3
Days of life at PICC insertion		
1 to 7	19	67.8
> 7	9	32.2

Pain relief measures and sedation were administered to 6 (21.4%) infants, of which 3 (10.8%) received continuous analgesia and another 3 (10.8%) received sedative before the procedure. The number of venepunctures performed ranged from 1 to 8, with predominance of one puncture (46.4%); mean number of attempts was two, standard deviation 1.4 (Table 2).

The catheter was successfully placed in 24 (85.7%) neonates. Difficulties identified for PICC placement were: obstacle on the progression of the catheter due to venous valves´ closure and vascular fragility with consequent venous rupture and hematoma. Silicon catheters were used in all procedures.

Table 2. Use of analgesic and sedatives, frequency of venepuncture attempt and success obtained at PICC placement. NICU, HCFMUSP, São Paulo, 2007

Variables	N	%
Analgesic Use		
Yes	3	10.8
No	25	89.2
Use of sedative		
Yes	3	10.8
No	25	89.2
Frequency of venepuncture		
One	13	46.4
Two	7	25.0
Three	6	21.4
Four or over	2	7.2
Success obtained in catheter placement		
Yes	24	85.7
No	4	14.3

The frequency of PIPP scores indicative of pain (≥ 7) was 20 (71.4%) neonates. Data were analyzed separately for neonates receiving sedation or analgesia (group A) and with no sedatives or analgesics prescribed (group B).

The mean PIPP score obtained during first venepuncture attempt was 7.8, during second attempt was 8.0, and 6.5 on the third .

The PIPP score ≥ 7 has been identified in most neonates on the first venepuncture, indicating moderate to intense pain in the two groups (Table 3).

The mean PIPP scores obtained during catheter progression was 6.9 on the first attempt, 7.7 on the second, and 8.5 on the third.

Table 3. PIPP score obtained at venepuncture for PICC placement. NICU, HCFMUSP, São Paulo, July to November, 2007

PIPP	1st. Puncture		2nd Puncture		3rd. Puncture	
Score	A	B	A	B	A	B
≤ 6	2	9	2	3	2	1
7 to 12	4	10	2	7	1	3
≥ 13	-	3	-	1	-	-
Total	**6**	**22**	**4**	**11**	**3**	**4**

A = With analgesia or sedation
B = Without analgesia or sedation

Table 4. PIPP score obtained at intravenous progression of PICC. NICU, HCFMUSP. São Paulo, July to November, 2007

PIPP Score	1st. Progression (n=28)		2nd. Progression (n=6)		3rd. Progression (n=2)	
	A	B	A	B	A	B
≤ 6	3	12	-	2	-	-
7 to 12	3	8	2	2	1	1
≥ 13	-	2	-	-	-	-
Total	**6**	**22**	**2**	**4**	**1**	**1**

The majority of newborns had PIPP score ≥ 7 on the first attempt of PICC progression and the frequency was similar in both groups (A and B) (Table 4).

The use of PIPP to assess pain in procedures is adequate because it considers newborns' gestational age. Generally, the challenge of assessing pain in lower gestational age infants is greater due to their inability to sustain behavioral responses to pain, especially facial expression4.

DISCUSSION

Half of the infants enrolled were extremely low birth weight newborns, most of them presented anatomical and physiological immaturity which is common in this population. These infants are more likely to present complications prematurity such as bronchopulmonary dysplasia, retinopathy of prematurity, intraventricular hemorrhages, growth restriction, among others[3].

Data presented in this study is similar to previous data, reported in a study conducted in 2006 at the same NICU: gestational age was lower than or equal to 32 weeks in most of the neonates (54.0%), mean 32.2 weeks; the majority of the infants weighted less than 1,500g (72.3%), mean weight 1,289 kg. Mean postnatal age at the time of PICC placement was 4.3 days[7].

In a prospective cohort study carried out in a NICU at Saudi Arabia, mean gestational age of the neonates was 27.7 weeks, weight was 1,040g and mean postanatal age at the time of PICC placement was 12.6 days[8], that is, during the second week of life. In the present study, PICC placement had early clinical indication.

The hospitalization of critically ill newborn infants involves the performance of numerous therapeutic invasive procedures. The vesicant characteristics of some fluid components needed for vital support makes the peripheral venepuncture a painful, iatrogenic, and stressful procedure both for infants and for the health care team. Late indication of PICC placement makes newborn infants a target for several venepunctures to administer fluids and prescribed medications, which contributes to damage the venous system, hindering venous access and catheter progression. Thus, it reduces the options of venous sites to place the catheter.

At the time of insertion 46.4% of the newborn infants underwent PICC insertion in the first three days of life (mean 9.1 days) and the procedural success is related to the ability of accessing venous system.

A retrospective study enrolling 351 neonates undergoing PICC placement carried out in a Brazilian private hospital showed that 39.6% of the catheters were inserted between the forth and seventh days of life and 32.4% from 1st to 3th days of life[9].

Repeated exposure to several potentially painful procedures leads to stress, greater metabolic expenditure, and depletion of energy reserves, hindering weight gain, delaying neonates' recovery, and worsening their clinical conditions.

Less than half of the neonates (13-46.4%) underwent only one venepuncture. The frequency of punctures ranged from one to eight. Success in PICC insertion depends on the ability of the professional who performs the procedure and also of the conditions of the venous system and catheter material available[10].

Data also showed that only three (10.80%) newborns received continuous analgesia due to another indication rather than pain relief related to the procedure. The same percentage of newborns received sedatives "in bolus" before the procedure in an attempt to reduce newborn agitation and the procedure failure. Midazolan was the sedative administered to the neonates and fentanyl citrate was analgesic continuously infused.

Although pain relief is one of the purposes of clinical care, adequate analgesia in patients that cannot verbally express pain is frequently ignored in clinical settings. It does not fulfill one of the rights of children and adolescents which is not to feel pain[11].

The difficulty to recognize pain in the neonatal period is one of the major hurdles to control pain at NICU. Specific analgesic or anesthetic treatment for smaller procedures, such as venepunctures or heel lances, is not often used. The main indications for the use of analgesia at NICU are: mechanic ventilation (44.0%) and postoperative period (20.0%)[12]. As for the use of fentanyl citrate, the main concern is related to adverse respiratory effects due to the continuous infusion in chronically ventilated preterm neonates; also, the absence of long term benefits suggests that routine use cannot be recommended. Midazolam has been used as a sedative in mechanically ventilated preterm infants. A systematic review published at the Cochrane library[13] concluded that there are not enough data to encourage the use of midazolam, due to the lack of benefits demonstrated and to the concern in increasing the risk of negative neurological outcomes.

Despite the benefits of therapeutic interventions and routine procedures performed in neonatal units, they can involve potential or effective risks. In unstable premature infants, pain is harmful from both physiological and behavioral point of view. Preterm infants can have a limited or altered ability to organize themselves and to respond properly to painful stimulus caused by procedures. Any

routine or therapeutic procedure and the environment can act as stressful agents to neonates[14].

Data from Tables 3 and 4 show that the frequency of painful response increased from the first to the second venepuncture, as well as from the first to the second attempt to insert the catheter on infants who did not receive analgesia or sedation.

A study with 54 newborn infants[15], whose mean gestational age was 27 weeks, assessed pain during the PICC placement. Neonates were divided into two groups: control group (placebo) and experimental group (tetracaine gel 4%). Newborn infants presented mild pain and mean PIPP scores of 10.8 in the first minute (experimental group) and 11.7 (control group). There was no statistically significant difference between the groups. In the study, pain assessment occurred at every minute, from the first to the fifth. Mean gestational age was lower than that found in the present study.

A double-blind, controlled, randomized clinical trial[16], included 49 neonates (26 in the experimental group with the use of tetracaine gel applied on the skin, and 23 in the control group that received Eucerin cream, placebo). Gestational age ranged from 27 and 41 weeks. Both anesthetic and Eucerin cream were applied 30 minutes before the insertion of PICC catheter. PIPP was used for pain assessment. The results showed that tetracaine gel did not present significant analgesic effect during PICC insertion.

Despite knowledge on the harmful effects of pain and long term stress, pain relief measures in neonates are not commonly used when routine painful procedures are performed. The introduction of tools to assess neonatal pain clearly demonstrates the concern in establishing a systematized and effective control of pain[17].

FINAL CONSIDERATIONS

One of the difficulties to conduct this study was related to pain assessment during data collection, because in the PICC placement is necessary the use of aseptic technique and to drape the newborn infant with sterile towel, hindering visualization of their facial expression.

Pain relief strategies for neonates should be a goal for health care professionals, especially non-pharmacological methods to relieve pain generated by procedures avoid worsening the clinical condition. Repeated painful exposure can lead to harmful consequences to neonates.

REFERÊNCIAS

1. Johnston CC, Collinge JM, Henderson SJ, Anand KJ. A cross-sectional survey of pain and pharmacological analgesia in Canadian neonatal intensive care units. Clin J Pain. 1997;13(4):308-12.
2. Mitchell A, Brooks S, Roane D. The premature infant and painful procedures. Pain Manag Nurs. 2000;1(2):58-65.
3. Goulart AL. Assistência ao recém-nascido pré-termo. In: Kopelman BI, Santos AMN, Goulart AL, Almeida MFB, Miyoshi MH, Guinsburg R, editores. Diagnóstico e tratamento em neonatologia. São Paulo: Atheneu; 2004.
4. Ballantyne M, Stevens B, McAllister M, Dionne K, Jack A. Validation of the premature infant pain profile in the clinical setting. Clin J Pain. 1999;15(4):297-303.
5. Freire NB, Garcia JB, Lamy ZC. Evaluation of analgesic effect of skin-to-skin contact compared to oral glucose in preterm neonates. Pain. 2008;139(1):28-33.
6. Serpa AB, Guinsburg R, Balda R de C, dos Santos AM, Areco KC, Peres CA. Multidimensional pain assessment of preterm newborns at 1st, 3rd and 7th days of life. Sao Paulo Med J. 2007;125(1):29-33.
7. Camargo PP. Procedimento de inserção, manutenção e remoção do cateter central de inserção periférica em neonatos [dissertação]. São Paulo: Escola de Enfermagem da Universidade de São Paulo; 2007.
8. Tawil KA, Eldemerdash A, Hathlol KA, Laimoun BA. Peripherally inserted central venous catheters in newborn infants: malpositioning and spontaneous correction of catheter tips. Am J Perinatol. 2006;23(1):37-40.
9. Coutinho M. Procedimento de inserção e manutenção do cateter CCIP. In: III Encontro Científico de cateteres - GECAT do Hospital e Maternidade São Luiz, 2007, Nov 21; São Paulo (SP), Brasil. São Paulo: Grupo de Estudos em Cateteres/Hospital São Luís; 2007
10. Crawford M, Soukup SM, Woods SS, Deisch P. Peripherally inserted central catheter program. Nurs Clin North Am. 2000;35(2):349-60. Review.
11. Presidência da República Federativa do Brasil. Conselho Nacional dos Direitos da Criança e do Adolescente. Direitos da Criança e do Adolescente Hospitalizados. Resolução 41/95. Brasília: CONANDA; 1995.
12. Prestes ACY, Guinsburg R, Balda RCX, Marba STM, Rugolo LMSS, Pachi PR, et al. Freqüência do emprego de analgésicos em unidades de terapia intensiva neonatal universitárias. J Pediatr (Rio J). 2005;81(5):405-10.
13. American Academy of Pediatrics Committee on Fetus and Newborn; American Academy of Pediatrics Section on Surgery; Canadian Paediatric Society Fetus and Newborn Committee, Batton DG, Barrington KJ, Wallman C. Prevention and management of pain in the neonate: an update. Pediatrics. 2006;118(5):2231-41. Erratum in: Pediatrics. 2007;119(2):425.
14. Ahn Y. The relationship between behavioral states and pain responses to various NICU procedures in premature infants. J Trop Pediatr. 2006;52(3):201-5.
15. Lemyre B, Sherlock R, Hogan D, Gaboury I, Blanchard C, Moher D. How effective is tetracaine 4% gel, before a peripherally inserted central catheter, in reducing procedural pain in infants: a randomized double-blind placebo controlled trial [ISRCTN75884221]. BMC Med. 2006;4:11.
16. Ballantyne M, McNair C, Ung E, Gibbins S, Stevens B. A randomized controlled trial evaluating the efficacy of

tetracaine gel for pain relief from peripherally inserted central catheters in infants. Adv Neonatal Care. 2003;3(6):297-307.

17. Bueno M, Kimura AM, Pimenta CAM. Avaliação da dor em recém-nascidos submetidos à cirurgia cardíaca. Acta Paul Enferm. 2007;20(4):428-33.