

## The Efficacy of Developmental Care Interventions in Procedural Pain Management in Neonates in NICU

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### Abstract

**Introduction:** Neonates treated in the intensive care unit (NICU) are exposed to painful and stressful procedures. Repeated exposure to painful experience has been linked to lower developmental scores, impaired growth, less optimal brain development, and later alterations in pain related behavior and perceptions.

**Objectives:** To relieve neonatal pain and manage neonatal stress during medical procedures by practicing developmental care interventions.

**Materials and Methods:** From 01/11/2017 to 28/02/2018, pain was assessed in 40 neonates during routine blood sampling, in a prospective randomized crossover trial. Mean gestational age was  $33,6 \pm 3,9$ ;  $34,1$ : 26 - 42 weeks and mean birth weight was  $2100 \pm 820$ ;  $2032$ : 635 - 3600 gr. Developmental care interventions used in this study were: non-nutritive sucking via a pacifier, breast milk, incubator cover, nesting and massage. Pain was assessed using the ALPS-Neo Pain and Stress Assessment Scale.

Blood sampling was performed twice, the first time without developmental care interventions and the second time it was performed using developmental care pain relief methods.

**Results:** The results showed significant differences between the control and the intervention stages in terms of pain scores during sampling time. Mean pain score in the intervention stage was significantly ( $1,65 \pm 0,6$ ;  $2$ : 1 - 3) less than that in the control stage ( $4,55 \pm 0,5$ ;  $5$ : 3 - 5) ( $p = 0,011$ ).

**Conclusions:** Based on the findings, developmental care interventions reduce pain, facilitate blood sampling and neonates are less sensitive to painful stimuli. Non-pharmacological strategies that are typically embedded in developmental care are recommended as a front line defence against stress and discomfort.

**Keywords:** Developmental Care; Pain; Stress; NICU; Interventions

### Introduction

Neonates hospitalized in the neonatal intensive care unit (NICU) are exposed repeatedly to painful stimuli associated with medical procedures. Pain in neonates is often unrecognized and undertreated. Prior to 1980 it was believed that neonates could not perceive pain, this has now been proved wrong. The brain of a full term neonate is able to interact with the environment in an organized manner but pain responses are observed in preterm neonates too, although the way they are expressed may vary. Pre-terms are more sensitive to pain than full term neonates because they display a lower threshold and more pronounced reflex responses to touch. Neonatal period is a period of rapid brain development, programming of the hypothalamic-pituitary-adrenal (HPA) axis and potential vulnerability [1]. Brain

development includes establishment and differentiation of subplate neurons, alignment, and orientation and layering of cortical neurons, elaboration of dendrites and axons, formation of synapses, selective pruning of neuronal processes and synapses, and proliferation and differentiation of glial cells [2]. Repetitive procedural pain has been linked to adverse long-term neurodevelopment outcomes. Stress and pain have major role as modifiers of brain development. Research indicates that procedural pain initiate changes in cerebral blood flow [3]. In addition, according to studies, stress and pain management improves short and long term outcomes [4,5]. Multiple pain assessment scales exists to assess neonatal stress. The Swedish ALPS-Neo pain and stress assessment scale for newborn infants is a new tool to assess neonatal pain in the NICU [6].

**Objectives**

In level 3 neonatal intensive care unit of maternity hospital “Elena Venizelou”, we aimed to relieve neonatal pain and manage neonatal stress during medical procedures by practicing developmental care interventions. Since November 2016, our unit participates in FINE (family and infant neurodevelopmental education) programme. FINE is a curriculum for healthcare professionals aiming to improve family centered developmental care in neonatal units [7,8].

**Methods**

In a four month period, between November 2017 to February 2018, pain and stress was assessed in 40 neonates during routine blood sampling, in a prospective randomized crossover trial. Any neonate receiving concurrent alternative analgesic medication was excluded from the study. All the infants were managed as per the unit developmental care protocol. The routine NICU protocol among infants includes the following interventions: a) incubator cover to protect the neonate from too many light impulses; b) placing neonates in nests and adjusting boundaries, much like they had into the womb; c) massage therapy that involves hands-on and skin-to-skin manipulation of the soft tissue; d) non-nutritive sucking via pacifier or milk feedings to reduce pain responses associated with invasive procedures.

Blood sampling techniques used in this study were venipuncture and heel lance. Blood sampling was performed twice, the first time without developmental care interventions and the second time it was performed using developmental care pain relief methods. We collected the demographic, clinical and laboratory data on all 40 infants. Neonatal details included date of birth, gestational age, mode of delivery, resuscitation methods and Apgar score, gender, birth weight, age at pain assessment, blood culture reports, physical examination details and antibiotics used. Maternal details included age.

Pain assessment in the non-verbal neonate can be very difficult. Documentation of pain is important as there can be variation in pain perception in neonates between various caregivers. The pain scale used to assess stress and pain during the study period was the Swedish ALPS-Neo pain and stress assessment scale for newborn infants [6].

	0	1	2
Facial Expression	Peaceful	Distressed expression May grimace slightly	Distressed expression, may cry Chin drop
Breathing Pattern	Calm effortless breathing	Slightly strained breathing Breathing pauses	Tense or flacid
Tone of Extremities	Normal tone	Varied tone	Tightly clenched Fingers/toes spread Flaccid
Hand/Foot Activity	Relaxed	Slightly clenched May try to grasp Hand on face	Tightly clenched Fingers/toes spread Flaccid

**Table:** ALPS-Neo Pain and Stress Assessment Scale (Astrid Lindgren and Lund Childrens Hospitals Pain and Stress Assessment Scale for Preterm and Sick Newborn Infants. Lundqvist P, Kelberg A., et al. 2014).  
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During blood sampling, neonates clearly display well defined pain responses, so five behaviours were observed according to the pain scale: facial expression, breathing pattern, tone of extremities, hand and foot activity and the level of activity. An infant in a balanced state shows organized behavior, which corresponds to the scale’s score of 0. If the neonate is distressed, the total sum is high. When the neonate shows signs from two different cells, the higher value applies [8]. This study was designed to investigate the score differences when neonates undergoing brief but painful medical procedures receive pain relief interventions and when they don’t.

**Results**

Forty infants were included in the study (37,5% female, 62,5% male) Median (range) gestational age at birth and birth weight for the whole group were 33,6 ± 3,9 (34,1: 26 - 42) weeks and 2100 ± 820; (2032: 635 - 3600 gr) respectively. Median corrected gestational age during the study period was 34,6 ± 3,52; 34,5: 27,6 - 42,3 weeks and median body weight was 2044,7 ± 736,9; 2060: 790-3510 gr. 85% (34) of all neonates were born by caesarian section. 87,5% (35) of the study population had reached full enteral feeding and the same percentage required intravenous antibiotics. 20% (5) of all neonates had central line and 75% (30) had peripheral venous catheter. Table 1 summarizes the characteristics for the study population.

Study population	No	%
Male	25	62, 5%
Female	15	37, 5%
Caesarian section	34	85%
Median gestational age	33,6 ± 3,9; (34,1: 26-42)	
Median birth weight	2100 ± 820; (2032: 635 - 3600gr)	
Full enteral feeding	35	87,5%
Central line	5	20%
Median corrected gestational age	34,6 ± 3,52; 34,5: 27,6 - 42,3 weeks	
Median body weight	2044,7 ± 736,9; 2060: 790 - 3510 gr	
Peripheral venous catheter	30	75%
Intravenous antibiotics	35	87,5%

**Table 1:** Baseline characteristics of the study population.

Mean pain score in male and female neonates was found to be similar. Mean (SD) pain scores for the intervention stage and for the control stage (without interventions) were (1,65 ± 0,6; 2: 1 - 3) and (4,55 ± 0,5; 5: 3 - 5) respectively with significant difference in mean scores (p = 0,011) (Table 2).

Stage	No
During Interventions	1,65 ± 0,6; 2: 1 - 3
Without Interventions	4,55 ± 0,5; 5: 3 - 5

**Table 2:** Mean pain scores.

During interventions all incubators (100%) were covered, all neonates (100%) were placed in nests. 50% of study population received therapeutic massage simultaneously with milk feeding (85%) or non-nutritive sucking (15%) (Table 3).

Intervention	%
Incubator cover	100%
Nesting	100%
Therapeutic massage	50%
Non-nutritive sucking via pacifier	15%
Milk feedings	85%

**Table 3:** Developmental care interventions.

### Discussion and Conclusion

In this study, highest pain scores were observed when neonates experienced iatrogenic pain without pain relief interventions. Scores of neonates receiving developmental care interventions were significantly lower.

Non-nutritive sucking” refers to the placement of a pacifier in an infant’s mouth to promote sucking behaviour without breast or formula milk to provide nutrition. “Non-nutritive sucking” on a pacifier resulted in a significant reduction in the pulse rate and seems to be highly effective [12].

Mother’s milk has an analgesic effect that minimizes pain in neonates [13]. Massage movements are thought to have an effect on minimizing pain by calming and decreasing crying.

Non-pharmacological pain relief methods and supportive “environmental care” should be first-line choice for minor procedural pain management and as an adjunct for moderate or severe pain. Neonates respond well to sensory stimulation such as massage and non-nutritive sucking. In addition, developmental care interventions are convenient, inexpensive, simple, easy to use, safe, without adverse effects in comparison to pharmacological pain relief methods. Because of the physiologic and metabolic immaturity of the neonate, doses of medications that are effective for the reduction of pain may be close to the doses that cause toxicity.

The American Academy of Pediatrics and the Canadian Pediatric Society recommended in 2006 that each health care system should establish a neonatal pain control program [9].

Full-term neonates exposed to repeated heel lance procedures in the first 36 hours of life demonstrated increased pain responses to venipuncture [10].

Pain in neonates is often unrecognized. Studies have shown that repeated painful procedures carried out on premature neonates hospitalized in intensive care unit may have long-term consequences on their neurodevelopment [11]. The goal in neonatal pain management is to decrease pain and to help the infant cope with pain.

Because of short-term and long-term effects of untreated pain it’s an ethical obligation for all health professionals to protect neonates exposed to repeated noxious stimuli and provide a systematic approach to procedural pain management, including assessment and treatment.

### Declaration of Conflicting Interests

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