

## **Assessment of the intensity of procedural pain in newborns treated in the intensive care unit measured by the Neonatal Infant Pain Scale (NIPS)**

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**A**- Conception and study design; **B** - Collection of data; **C** - Data analysis; **D** - Writing the paper; **E**- Review article; **F** - Approval of the final version of the article; **G** - Other (please specify)

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### **ABSTRACT**

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**Introduction:** Newborns born prematurely and treated in intensive care units are at greater risk of experiencing pain than patients treated in other units.

**Purpose:** To evaluate the severity of pain perceived by children during the performance of medical procedures related to the treatment and care process.

**Materials and methods:** The study was conducted at one of the Intensive Care Units in Opole. The study group consisted of 100 newborns, 60% of the subjects were prematurely born newborns, and 40% - were full-term. The degree of procedural pain associated with blood collection, peripheral puncture insertion, upper respiratory tract suction, gastric tube insertion and ophthalmic examination was assessed by an observation method using the standard Neonatal Infant Pain Scale Form (NIPS).

**Results.** Out of the analysed medical procedures, 100% of children experienced acute, severe pain

over the course of suction and ophthalmological examination. The highest perception of pain was experienced by 88.3% of premature newborns and 71.8% of full-term newborns. Over the course of medical procedures, 84% of male and 79.6% female newborns experienced acute pain. It was shown that the degree of pain perception was determined by the type of performed medical procedure ( $p=0.001$ ) and the gestational age of the newborn ( $p=0.037$ ). On the other hand, there was no correlation between the sex of the newborn child and the degree of pain perception ( $p=0.758$ ).

**Conclusions.** Based on the foregoing study result, bearing in mind the need to minimise the effects of pain stimulation, it seems important to use standardised tools to assess the severity of pain in newborns treated in Intensive Care Units on a larger scale.

**Keywords:** newborn, pain measurement, sensation, signs, symptoms, procedural pain

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## INTRODUCTION

In the 1960s, many scientists underestimated pain at the youngest age, believing that the child, when it was born, did not have sufficiently developed structures to receive pain stimuli [1]. Nevertheless, studies have demonstrated that the first skin sensory receptors appear in the vicinity of the mouth as early as in a seven-week-old foetus, while the pathways of pain conduction develop during the 29th week of pregnancy [1,2]. In the case of premature infants, newborns and younger children, lack of verbal communication skills do not equal lack of pain perception [3]. The density of pain innervation in the skin is the same in newborns as in adults. On the other hand, premature newborns have an underdeveloped pain-inhibiting system which may cause their hyperactivity to pain [4]. Subjecting premature newborns to pain stimulation does not decrease the reaction to pain impulses, it may even lead to gradual sensitisation, i.e. hyperactivity, and may also cause consolidation of pathological pain patterns [2,5]. Newborns treated in the Intensive Care Unit (ICU) are exposed to pain more frequently and more intensively compared to patients treated in other units, e.g. paediatric units [4]. Studies show that the number of painful procedures to which they are subject during the day ranges from 12 to 16, and in the most extreme situations - to as many as 62 [6,7]. This includes invasive procedures, such as intubation, venepuncture, heel puncture, central line, but also activities performed during routine care, e.g. insertion of a gastric tube into the stomach, change of patches, physical examination, catheterisation of the urinary bladder [4]. Due to difficulties in communication, pain assessment in the youngest age group is a huge challenge for medical personnel and parents, and therefore it is important to carefully observe them [1,3].

Long-term exposure of a child's body to pain stimuli can present significant importance for its future. It is believed that regular children exposure to pain stimulation may cause emotional or behavioural disorders and lead to cognitive function impairment [8,9,10,11].

When assessing the severity of pain in children, it is necessary to use scales according to the guidelines of *The Association of Paediatric Anaesthetists* (APA) of 2012 and the Polish guidelines of 2011 [12,13].

For the assessment of acute and postoperative pain in full-term and premature infants, the authors of APA recommend the following scales:

- **Premature Infant Pain Profile (PIPP)** - used to assess the procedural pain

premature newborns and postoperative pain in full-term newborns;

- **Neonatal Infant Pain Scale (NIPS)** - used for the assessment of procedural pain in premature newborns, and full-term newborns;
- **Neonatal Facial Coding Scale (NFCS)**;
- **Crying Requires oxygen Increased vital signs Expression Sleep (CRIES)** - intended for children under 6 months of age, evaluating postoperative pain, used in premature newborns and full-term newborns;
- **Face Legs Activity Cry Consolability (FLACC)**;
- **Comfort and Neonatal Pain Agitation and Sedation (N-PASS)** - used in intensive care and for assessment of postoperative pain in newborns [6,8].

The aim of the study was to assess the severity of pain experienced by newborns during the performance of medical procedures used in the intensive care unit and to identify the factors determining the severity of pain.

## MATERIALS AND METHODS

Qualitative study was conducted after obtaining the permission of the bioethical commission of the Public Higher Medical Professional School in Opole, in the period from November 2016 to January 2017 in one of the Intensive Care Units in Opole.

The observation method and a standardised technique with the NIPS scale form were used, which involves the assessment of five parameters, i.e: facial expression, crying, position of the upper limbs, position of the lower limbs, and state of consciousness. Each parameter, with the exception of crying, is subject to a one-stage scoring, whereas crying is assessed in a scale from 0 to 2 points (Table 1).

For the needs of the study, it was assumed according to Panek and Kwinta [6] that the result:

- 0-2 points indicates no perceived pain
- 3-4 is means mild to moderate pain
- more than 4 points demonstrate acute, strong pain.

The study group, which included 100 individuals, consisted of premature newborns, i.e. between 28 and 37 weeks of gestation, as well as full-term newborns. The following medical procedures were performed in both groups:

- blood collection
- insertion of a peripheral venous catheter
- insertion of a gastric tube
- suction of secretion from the upper respiratory tract
- ophthalmic examination.

**Table 1.** NIPS scale (Panek, Kwinta, 2014) [6]

	0	1	2
<b>Facial expressions</b>	Relaxed	Grimace	
<b>Crying</b>	No crying	Whimpering	Crying
<b>Breath pattern</b>	Calm	Accelerated	
<b>Hand position</b>	Free	Flexed	
		Straight	
<b>Feet position</b>	Free	Flexed	
		Straight	
<b>State of agitation</b>	Sleeps	Agitated	
	Active		

Children with pharmacological coma and children with diagnosed lethal abnormalities were excluded from the study.

The study was carried out by the authors of independently, on their own, in the morning between 9 am and 12 pm, during the performance of medical procedures by nurses. Behavioural changes that occurred in the newborn child during the procedure were noted in the observation sheet.

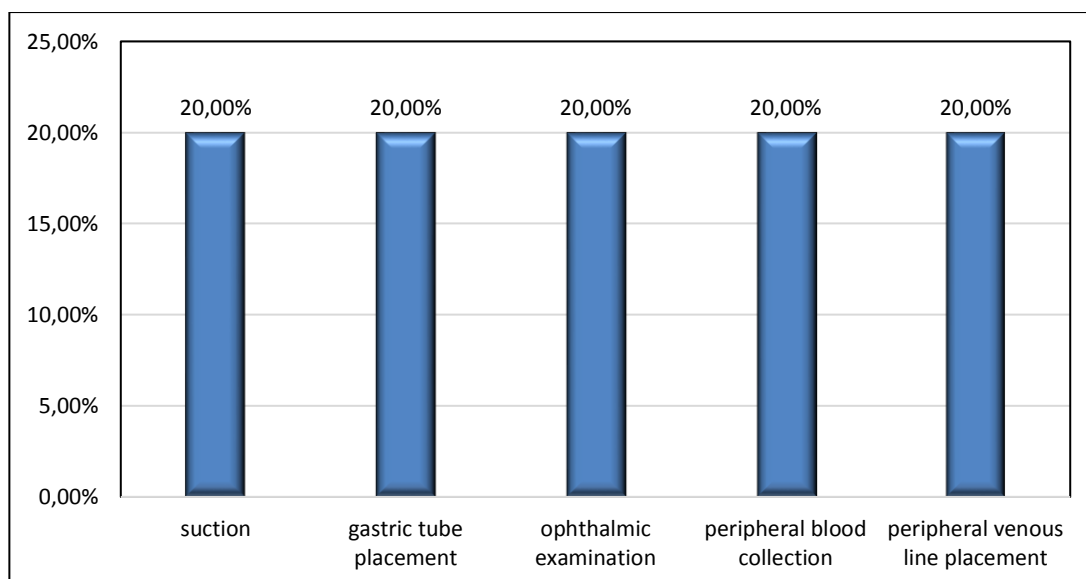
The obtained data were processed using a spreadsheet in Microsoft Office Excel 2013[14]. Statistical analysis was performed using the Statistica 12 program (StatSoft, Inc., USA). The results are presented in tables, charts and descriptions. A percentage has been deducted in case of percentage variables. The results were compared using a chi-square test and a Fisher's exact test. The statistical significance level was assumed as  $p = 0.05$ .

## RESULTS

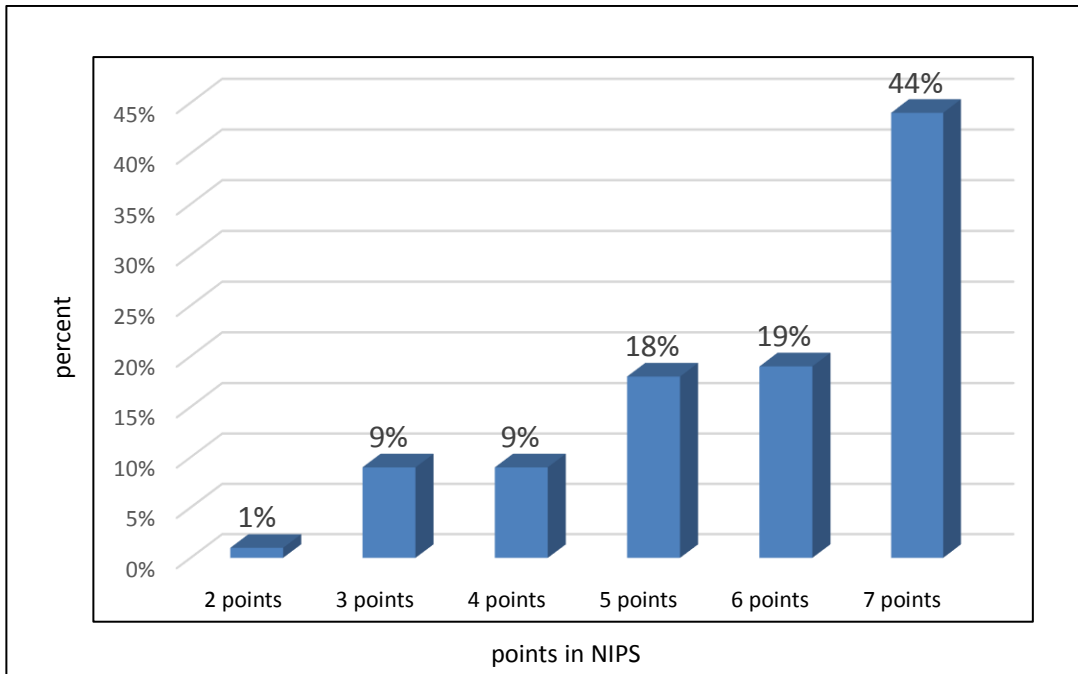
Among the examined newborns, more than half – 60% (n=60) was constituted by premature newborns, full-term constituted 40% (n=40) of the total number of subjects. Among the studied group of children, 50% were female and 50% were male.

Study subjects were divided into five groups according to the type of procedure used. Each group constituted 20% (n=20) of the total number of studied children. The procedures used to identify individual groups are presented in Figure 1.

Over the course of the foregoing procedures, 44% of newborns reported a pain intensity of 7 points in the NIPS. The intensity of 6 points was recorded in a group of 19% of newborns, and of 5 points - in a group of 18%. The pain intensity at the level of 3 and 4 points on the NIPS scale was observed in the group of 9% of newborns subject to observation. The results are shown in Figure 2.



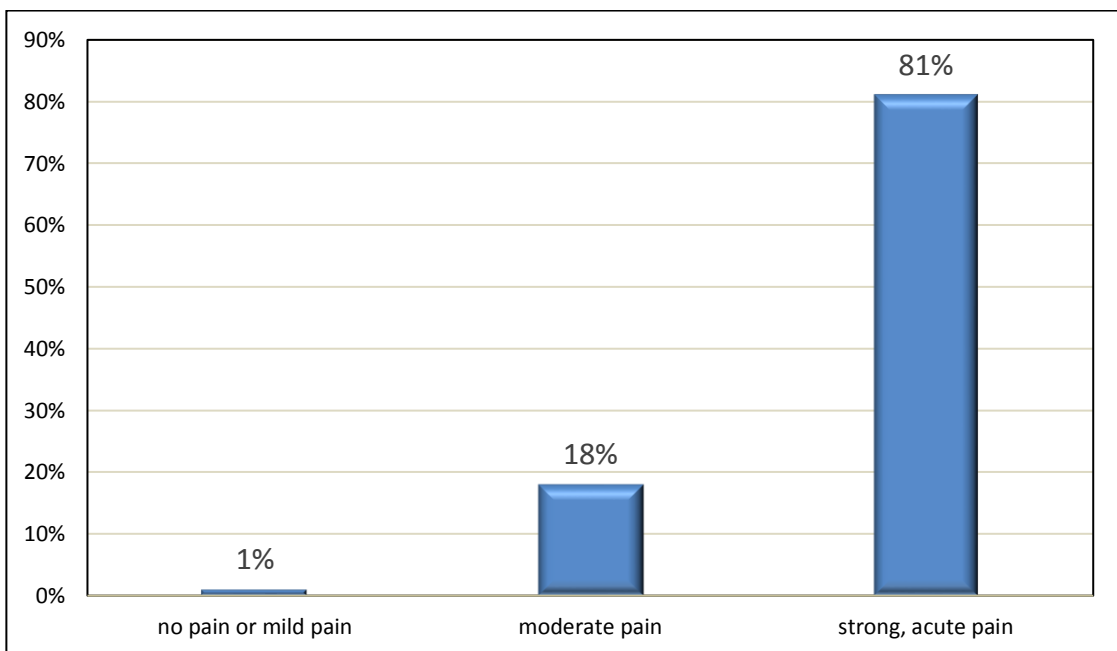
**Figure 1.** Diversification of the study group in terms of the followed procedure



**Figure. 2.** Pain severity score assessment

Based on Panek and Kwinta assumptions concerning result interpretation, 81% of newborns experienced strong, acute pain during the

procedures. Moderate pain was found in 18% of the studied children. For 1% of children pain was not observed or was mild (2 points in NIPS scale). The results are shown in Figure 3.



**Figure. 3.** Severity of perceived pain

All newborns undergoing the procedure of suction and ophthalmological examination experienced strong, acute pain. For the other procedures, the results were more mixed. Among

newborns with gastric tube, as many as 73.7% experienced severe pain and 26.3% - moderate pain.

Among newborns subject to taking peripheral blood samples, 35% experienced

moderate pain, while the remaining 65% experienced strong, acute pain. Among newborns undergoing peripheral line placement, 70% of had strong pain, while 30% - moderate pain. Based on the foregoing analysis, it can be assumed that suction and ophthalmological examination were procedures associated with the highest intensity of pain. The foregoing relation is statistically significant,  $p=0.001$ . The results are shown in Table 2.

Acute, strong pain was perceived by 83.3% of premature newborns and 71.8% of full-term newborns, 84% of boys and 79.6% of girls. A statistically significant correlation was found for the foetal age of the examined newborns ( $p=0.037$ ); no such correlation was noted for sex ( $p=0.758$ ). The results are shown in Table 3.

**Table 2.** Relationship level between the type of performed procedure and the degree of pain perception

Type of perceived pain		Procedure					p
		suction	insertion of a gastric tube	ophthalmic examination	peripheral blood collection	insertion of a peripheral venous catheter	
moderate	N	0	5	0	7	6	0.001
	%	0.0%	26.3%	0.0%	35.0%	30.0%	
strong, acute	N	20	14	20	13	14	
	%	100.0%	73.7%	100.0%	65.0%	70.0%	
Total	N	20	19	20	20	20	
	%	100.0%	100.0%	100.0%	100.0%	100.0%	

**Table 3.** Relationship level between the type of perceived pain and the fetal age of the newborn child

Type of perceived pain		Gestational age		test result
		premature newborn	full-term newborn	
moderate	N	7	11	$\chi^2 = 3.305$ df=1 $p = 0.037$
	%	11.7%	28.2%	
strong, sharp	N	53	28	
	%	88.3%	71.8%	
Total	N	60	39	
	%	100.0%	100.0%	
Type of perceived pain		Sex		test result
		boy	girl	
moderate pain	N	8	10	$\chi^2 = 0,095$ df = 1 $p = 0,758$
	%	16.0%	20.4%	
strong, sharp	N	42	39	
	%	84.0%	79.6%	
Total	N	50	49	
	%	100.0%	100.0%	

## DISCUSSION

The analysis of adequate tests to assess the severity of pain associated with the following

medical procedures, i.e.: gastric tube insertion, upper airway suction, peripheral venous catheter placement, blood sample collection and ophthalmological examination, in the group of full-

term newborns and premature newborns, is significantly impeded due to their limited availability. The articles published so far, which constitute the subject literature of this paper, will be discussed and commented in detail below.

In the 2009 study, Amber et al. [15] used the NIPS scale to assess the severity of heel puncture pain in premature newborns. The study group consisted of 40 premature newborns born earlier than in the 30<sup>th</sup> week of gestation, staying in ICU. The behaviour of children before, during and after the procedure was recorded by means of a camera. The heel was punctured at night between 2 a.m. and 6 a.m. The results demonstrated that the reduced pain perception was associated with low birth weight, mechanical ventilation and a longer stay in the unit. The authors also stated that acute, severe pain was manifested in most cases (85%) through crying, facial grimace, and the state of child agitation [15]. The analysis of authors' own studies confirmed this relationship. The facial grimace appeared in 100% of newborns when performing each of the analysed procedures. Newborn crying accompanied 60% of procedures, crying was observed in 37%, and as many as 69% of subjects were agitated during medical procedures.

In 2007, a team of researchers supervised by Belleni et al. [16] compared the reliability of using two scales to assess the severity of pain associated with heel puncture. The PIPP and NIPS scales were verified. The study group included 20 newborns born between 33<sup>rd</sup> and 35<sup>th</sup> week of gestation, and 20 full-term newborns. The PIPP scale was applied to premature newborns, while the NIPS scale was used in the group of full-term newborns. The reliability of the scales was compared based on the analysis of the results collected by a group of three nurses. Two of them performed direct observation and the last one recorded behavioural changes over the course of the painful procedure, using a camera. The results of the study showed greater reliability using the NIPS scale, however, at the same time the authors emphasize that this scale, compared to the PIPP scale, does not contain such an extensive interpretation of the results [16].

Egyptian researchers Atef El-Sayed and Tolba also used the NIPS scale in their study [17]. By studying the reaction to pains in premature newborns, they concluded that the extent and number of painful procedures could result in a weakened behavioural response, and an excessive physiological response to the pain. The authors concluded that the proceedings limiting exposure to pain stimulation and reliable monitoring of the pain perception level in order to avoid long-term complications in the development of the nervous system are important [17]. The results of our study proved that acute pain, related to the type of

performed procedure, is more common in the group of premature babies. Having considered that, it seems important to minimise pain and behavioural support when performing pain-related procedures in the group of premature newborns.

In 2016, a group of French scientists led by Courtois [18] conducted a prospective study to assess the burden related to venepuncture in newborns treated in the ICU using the DouleurAiguë Nouveau-né (DAN) scale. The aim of the analysis was to determine the frequency of the procedure, the intensity of pain associated with it and to analyse the analgesic proceedings. Studies have shown [18] that during the first two weeks of ICU stay, newborns born earlier than in the 33<sup>rd</sup> week are subjected to an average of 4.1 venous punctures, and one fourth of them to more than 5. Only 61.7% of the procedures were successful at the first attempt, and multiple repetitions resulted in a higher degree of pain perception. Only 76% of the performed punctures were preceded by analgesic action. Courtois et al. [18] demonstrated that the acute pain that occurred during blood collection or at peripheral venipuncture was associated to the absence of parents during the procedure, the operations performed during the tests, and the number of unsuccessful attempts to place a line and collect blood samples. In the group of premature newborns born between the 30<sup>th</sup> and the 37<sup>th</sup> week, 46.2% of venous punctures were associated with perception of acute pain, according to the assumptions of the DAN scale [18]. Comparing the foregoing results with the analysis of authors' own studies, acute pain associated with venipuncture in premature newborns occurred in 90% of blood collection cases and 80% of peripheral venous line placement cases.

As mentioned above, no analyses identical to the subject of this paper were found in the available studies. Nevertheless, referring to the results presented above, it seems justified to conduct studies assessing the degree of pain sensation in the group of full-term newborns and premature newborns, as well as to analyse the methods of monitoring and counteracting it.

### **Limitations of the study**

One of the limitations of the study was too small study sample and a small number of procedures under observation. In the future, it is worth performing tests on a larger number of newborns. In addition, it is worth investigating the reaction to pain while performing nursing activities (i.e. change of position, change of diaper, change of bed linen), removing patches, intramuscular and intradermal injections, puncturing the heels, change of dressings, lumbar puncture, mechanical ventilation etc.

## CONCLUSIONS

1. It was demonstrated that the degree of pain perception is determined by the type of performed medical procedure and the foetal age of the newborn child.
2. Suction and ophthalmological examination were procedures associated with the highest intensity of pain. Therefore medical staff should perform these medical procedures with extreme caution, delicacy, and efficiency.
3. There was no correlation showed between the sex of the newborn child and the degree of pain sensation.

## POSTULATES

Based on the foregoing study results, bearing in mind the need to minimise the effects of pain stimulation, it seems important to use standardised tools to assess the severity of pain in newborns treated in Intensive Care Units on a larger scale.

## Conflicts of interest

The authors declare no conflict of interest.

## Source of founding

This work was founded by the authors own sources.

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