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Facial Expression and Physiological Changes in Newborns Following Procedural Pain

Elizabeta Zisovska*

University Clinic for Gynecology and Obstetrics, Vodnjanska 17, 1000, Skopje, Republic of Macedonia
Email: elizabeta.zisovska@ugd.edu.mk

Abstract

All healthy human beings feel pain and they express it in different ways. Some researchers elaborate that the newborns don't feel pain, because they have immature brain, and the transmission of the stimuli is not complete or strong. But, evidence was presented that they do feel pain reacting with behavioral and physiological changes. The objective of this study was to assess the importance of facial expression, with the regard to procedural pain during heel prick and to assess the time for recovery after the procedure. The score for facial expression was compared to the objective parameters as pulse rate and oxygen saturation on room air. In the study were included healthy, term newborns, and the pain was assessed following strong recommended instructions. As baseline facial score was considered state of relaxed fed newborn. Although expected, the score for facial expression was the highest during heel prick (2,9/3), but it was even higher for physiological parameters (3,8/6), and longer time was needed for recovery (more than 15 minutes), for the physiological parameters (1,8/6). Surprising result was the score for both facial expression and physiological parameters during preparing for heel prick, thus meaning that even in that period the newborn experiences pain. These results are based on small group of newborns, but nevertheless, it is strongly recommended to consider neonatal pain, assess it and apply evidence based management of procedural pain, due to the results of long term adverse effects on neurobehavioral development of the infant.

Key words: assessment; heel prick; newborn; pain.

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* Corresponding author.

1. Introduction

By definition, *pain* means "…an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage" according to the International Association for the Study of Pain (IASP) [1].

According to this definition, it comes that neonatal pain cannot be assessed and registered, because newborns cannot verbally express it. Therefore, pain in newborns is often unrecognized and undertreated [2]. Looking this definition and treatment of newborns, it could be perceived that it is the root of the common misconception and myths concerning neonatal pain. Some researchers argue that the newborns do not feel pain for many physiological reasons, mainly because their too immature nervous system. This false premise lies in the misbelief that newborns do not have the neurological substrate for the perception of pain because of lack of myelination, incomplete pain pathways from the periphery to the cortex, or immaturity of the cerebral cortex. Some of the researchers assume that even if newborns do feel pain, they cannot remember it, or even if they feel or remember pain, it doesn't cause them harm [3]. Such beliefs were supported with the fear of giving local or systemic analgesia or anesthesia, considering them more dangerous than the harm caused by the pain [4, 5].

The main authors who have argued opposite of this premise, were Anand and Hickey [6] who have published many papers and have proved that the newborn babies can feel and express pain. An assessment of pain in babies relies mostly on observing facial expression and behaviors [7]. Their revolutionary work strongly supported the need for development of pain assessment tool (PAT). But still, pain assessment is not an exact science. To lessen the guesswork, pain assessment tools, which are generally checklists of possible pain indicators, take into account behavioral, physiological, and contextual measures [8]. It is very difficult to study the neuronal anatomy and chemistry, and it makes difficult to explain the mechanism and expression of the neonatal pain [9,10].

The evidence coming out from the American Academy of Pediatrics has shown that at birth, a neonate has developed the neural pathways for nociception and for experiencing pain, but the pain responses of a newborn baby is not simply a copy or immature version of that of an adult [11]. Neuroanatomical components and neuroendocrine systems are sufficiently developed to allow transmission of painful stimuli in the neonate [12].

Compared with older age groups, newborns may experience a greater sensitivity to pain and are more susceptible to the long-term effects of painful stimulation. The nerves of young babies respond more readily to noxious stimuli, because the neonatal threshold for sensitisation is decreased. Sensitisation refers to the phenomenon that a noxious event increases the sensitivity of the nociceptor system to another such event – or to a much milder or even entirely non-noxious event. The experience of severe pain to a mildly painful stimulus is called hyperalgesia, and pain in response to a stimulus which would normally not be painful is called allodynia [13]. This happens in adults and babies, but in babies this occurs more quickly and the sensitised area is larger than in adults, for the same initial stimuli [14].

The pathways that descend from the brain to the spinal cord are not well developed in the newborn, so the

ability to reduce or inhibit nociception via central brain mechanisms is limited. A lack of behavioral responses (including crying and movement) does not necessarily indicate a lack of pain [5].

And at the end, considering many other reasons which probably still need to be discovered, a noxious event which appears minor to adults, can have unexpectedly widespread effects in the baby's nervous system; it is sensed more intensely and potentially more diffusely than it would be in the adult, thus causing more deleterious effects on the neonatal health and wellbeing [15].

Newborns are as sensitive to pain as adults, and preterm newborns are even more sensitive to pain. Neurotransmitters in the dorsal horn of the spinal cord are associated with nociception and increased somatosensory excitability in the preterm spinal cord. On the other hand, neurotransmitters in descending inhibitory nerve fibers are only present at term. Thus, there is diminished inhibition of pain in premature infants [16,17,18].

Unless more powerful tools of functional neuroimaging to use while studying neonates are designed, the practically used modes of detecting neonatal pain could be developed as indirect tests, from activation of nociceptor nerve pathways, by biochemical changes, by changes seen during functional neuroimaging, or by physiological and behavioral assessments.

Recent years more evidence regarding neonatal pain comes, and therefore the assessment tools are improved a lot compared with the first developed [19]. All assessment tools have advantages and disadvantages, and different strength of sensitivity and specificity due to the difference in scaling up, and assessing the strength of pain. Searching the literature, it is evident that there is a lack of information, especially clinical results of neonatal experience of pain. Expressing pain during a heel prick is an example of a normal response to a noxious event. Not expressing pain in such a situation may be of more concern, indicating that something is wrong with the either peripheral or central nervous system. Sometimes, inappropriate expression of pain may occur in severely ill or very painful infants which could lead the newborn in shock.

2. Purpose of the research

Almost all assessment tools has not confirmed high reliability rate. Therefore, there were only few objectives for this study, as follows:

1) To assess the facial expression in newborns as a result of a painful procedure (heel prick) applied as a routine procedure in neonatal period;
2) To find correlation between the level of facial expression and two physiological objective indicators (heart rate and oxygen saturation measured by pulse oximetry);
3) To assess the time for recovery after the painful experience of the heel prick as a painful procedure.

3. Material and methods

The design of the study is first of its kind within the Region, thus expected to get useful information. The study

was conducted prospectively. For the purpose of the study, 200 healthy newborns successively born at the University Clinic for Gynecology and Obstetrics and admitted to the Department of Neonatology were assessed. The investigation was performed in the period beginning of March up to the end of June 2014. All newborns were treated according to the currently adopted and officially approved Clinical Guidelines respectively to their health status. Informed consent was obtained by the parents, although no harmful procedure was performed, but observation and non-invasive pulse oximetry.

Inclusion criteria:

-healthy term neonates admitted to nursery for healthy newborns or observational unit;

Exclusion criteria:

-preterm neonates

-newborns admitted to intensive or post intensive care (critically ill newborns or neurologically damaged ones, who have different expression of pain);

-absent informed consent by the parents

As painful procedure heel prick was applied for thyroid screening, a procedure that belongs to the routine care of the newborn.

For the purpose of the study, one neonatologist was trained for assessment. Almost all types of assessment tool contain facial expression of the pain, but some of them include physiological signs which are very important and on the other hand difficult to assess. In our study, measuring of heart rate and blood oxygen saturation was measured as objective signs of suffering.

After the review of the available pain assessment tools, as the most appropriate was considered BPSN- Bernese Pain Scale for Neonates, because is user friendly, can detect subtle signs of uncomfort, and has high intra-rater and inter-rater reliability.

The major limitation of the study is the unavailability and ethically inappropriate laboratory testing for the level of Cortisol, Catecholamine, Glucagon, and Insulin, proven as biochemical markers for pain and stress in otherwise healthy term newborns for research purposes. This limitation actually exists in many other researches even in developing Pain Assessment Tools, an issue that reduces the reliability of the tool.

The BPSN contains 9 items, each scored 0-3 points: 3 physiologic (heart rate, respiratory rate, and oxygen saturation and 6 behavioral (grimacing, body movements, crying, skin color, sleeping patterns, consolation items.

Initial psychometric testing of the BPSN demonstrates good construct validity with differentiation between painful and non-painful procedures, i.e. intrarater reliability r= 0.98-0.99 and inter-rater reliability correlation

coefficients r= 0.86-0.97

For the purpose of the study, in the Department were assessed facial expression and confirmation of physiological discomfort heart rate and oxygen saturation measured with pulse oximetry (Nelcor pulsoximeter neonatal). (Table 1)

Table 1: Assessed parameters for expressing neonatal pain

Parameter/score	**0**	**1**	**2**	**3**
Facial expression				
Eyebrow bulge with eye squeeze	Relaxed face	Light eyebrow bulge	Eyebrow bulge with eye squeeze	Eyebrow bulge with eye squeeze
Physiological parameters				
Changes of heart rate	Puls of 100	Puls >100	Puls >110	Tachycardia >120
Oxygen saturation on room air	>95%	90-95%	85-90%	<85%

As baseline value was considered the state of the newborn assessed 10 min after feeding (breastfeeding starts in delivery room or feed in the Unit) in 200 term newborns, considering this period as the most pleasant one, and as baseline pain score;

Treatment period comprised heel prick, as part of the routine care for thyroid screening of the newborn, a procedure that consists of two preparatory steps: warming of the foot with a warm towel (contact) and capillary blood sample from heel (taken by lance).

The assessment of the facial expression and physiological parameters was performed during the procedure, and the same done (facial expression, heart rate and oxygen saturation) 15 minutes after the procedure. The last assessment was performed 15 minutes after the procedure, and it was standard time given for recovery after the painful procedures.

Total of n = 800 observations (analyses) were performed. All neonates were observed and scored after feeding, during the warming of the feet, while a routine capillary blood sample was taken and 15 minutes after the blood sample was taken.

Descriptive methods in statistics were applied.

The observation and assessment of variables (either facial expression or physiological) consisted of observation of the neonate for 15-30 seconds for the facial expression. The neonate was scored for each of the facial and physiological parameters.

4. Results

The baseline characteristics of the included neonates are presented in Table 2, and it is obvious that all included newborns had stable physiological and anthropometric parameters, therefore there was no doubt that any of them had some level of pain because of difficult delivery. The baseline characteristics for pain assessment are measured in stable condition, fed and breathing room air. The score is driven out of the BPSN scale for pain assessment in newborns.

Table 2: Characteristics of the included newborns

Caracteristic of the patients	Healthy newborns
Birth weight (g)	3050±126
Gestational age (weeks)	39±0.3
Male neonates	53%
Female neonates	47%
Vaginally born	67%
Born by caesarean section section	33%
Average Apgar score in 1st minute	7,5±0,2
Average Apgar score in 5th minute	8,7±0,3
Baseline score of facial expression	0,6±0,03
Baseline score of physiological parameters	0,4±0,04

The parameters of the chosen assessment tool were assessed in included patients and assessed as baseline parameters (prior to procedure), during preparation, during application of the procedure, and 15 minutes after the procedure, calculating the recovery of the facial expression core and physiological parameters.

The neonates had their baseline pain score of 0,6/3 for facial expression, and 0,4/6 for physiological indicators. It shows that they didn't experience pain prior this procedure.

None of the assessors could expect to get pain score of zero, because during the first 6 hours of life newborns are exposed to many actions in order to manage their extra uterine adaptation: drying the skin, cleaning vernix, bringing to the mother for skin-to-skin contact, first breastfeeding, etc. Although some of them are pleasant ones, they influence the alertness and physiological processes. Sometimes, it depends on the manner how the midwives treat the babies, gentle or in a rush.

The score for both, facial expression and physiological parameters, are presented on Table 3.

Table 3: The facial and physiological changes during heel prick in healthy term newborns

Average score	Baseline score	warming of the foot with a warm towel (contact),	capillary blood sample from heel (lance)	15 min after the procedure (blood sample has been taken)
Facial expression				
Eyebrow buldge with eye sqweeze	0,6±0,03	1,6±	2,9±	1,5±
Physiological parameters				
Changes of heart rate	0,3±0,03	1,9±0,01	2,2±0,02	1,1±0,03
Oxygen saturation on room air	0,1±0,04	1,6±0,02	1,6±0,01	0,7±0,02
Physiological score	0,4±0,04	3,5±0,02	3,8±0,01	1,8±0,03

The facial expression score after the heel prick in each stage showed specific pattern of pain experience and needed longer time for recovery than expected. The procedure of heel prick routinely is applied 48 hours after the birth. The preparation for this procedure contains two steps, warming the heel with warm cloth and gentle rubbing of its side edge, and soon after, heel prick with a lancet. Pain score for facial expression during the preparation for the procedure was 1,6/3 and the score for physiological parameters 3,5/6, which means high pain score ("the baby feels pain"). It could be assumed that the preparation for heel prick is also painful procedure. This pain score is significantly higher than the baseline score ($p<0,05$). Greater difference exists between the baseline score for facial expression during the puncturing the heel, 2,9/3, and it is highly significant difference. The same exists for physiological parameters. The visual comparison of the comparison between the scores of facial expression and physiological parameters in newborns is presented on Figure 1.

The most surprising result was found for the indicator "recovery after the procedure" which showed much higher score for physiological parameters than for facial expression, and the correlation coefficient was $r=0,58$. Statistically, as this coefficient is going towards 1,0, it means that this is moderately high positive correlation between the level of pain and both, facial expression and physiological parameters, but not so much for facial expression. This finding warns that looking only for facial expression while applying painful procedures can mislead the medical professional for the level of the pain. This is important when considering management of pain in neonates and implementing the existing Clinical Guidelines for Management of procedural pain in neonates.

5. Discussion and conclusion

The results of this observational study represent the first attempts to assess the level of procedural pain in term neonates. The low total baseline score of 1/9 (facial expression and physiological parameters) was expected and

this result gave us challenge to continue the study. The results are similar to some literature data, although there are not many studies assessing the procedural pain. Also, there is confusion regarding the assessment tool used in neonatal departments, profile of newborn babies (premature, term), health status, methods of care for newborns, etc. All these confounding factors may change the reliability of assessment tools.

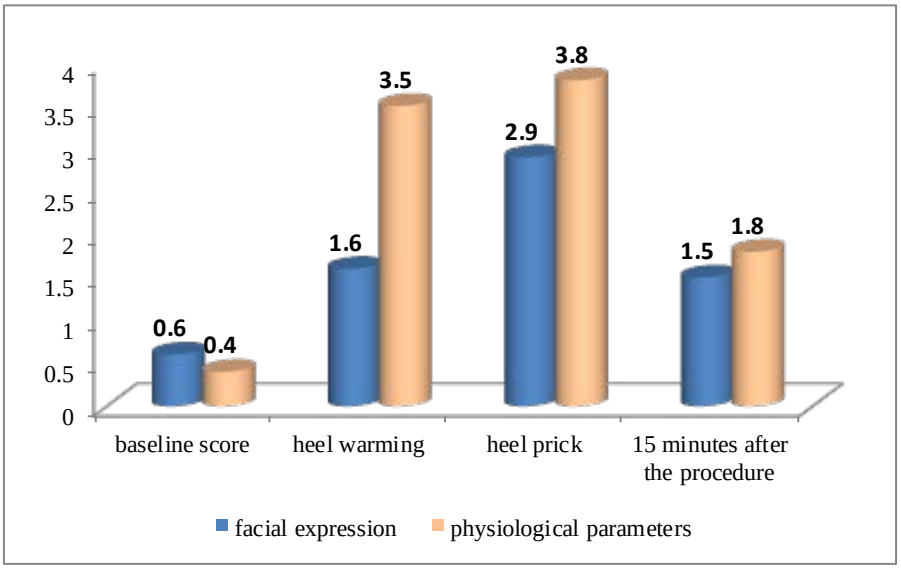

Figure 1: Comparison between the scores of facial expression and physiological parameters in newborns

Our results showed that care should be provided during preparing for procedure (heel warming) implementing the Clinical Guideline for Management of procedural pain for neonates in order to prevent the unpleasant feeling and negative impact to the overall health and wellbeing. Also, the results pointed out that proper care and observation should be provided to all newborns during performing painful procedures, especially looking for the signs of facial expression of pain.

Following these results, and the existing challenge, the steps forward is the intention to extend the study, including much more newborn babies, possessing different health indicators, and using different assessment tools, thus comparing the accuracy of each of them and choosing the most appropriate tool for neonatal population.

In any case, it was proved as very important step assessing and making the pain an objective indicator, because there are already Clinical Guidelines for management of procedural pain in newborns [20, 21]. None of the Guidelines could be applied if not assessed the pain [8,21,22]. If pain score is below the limit, only nursing comfort measures during crying should be applied. And, at the end, the newborns cannot express their feelings, and the pain as an expression of some tissue damage, especially if continuous, will act deleterious and cause harm to them, unpleasant memories, and even impact on the overall development [22, 23].

6. Recommendation

Considering all deleterious effects of the pain to the human beings, where all newborns belong to, the pain in

newborns must not be neglected and pain assessment should be performed in each procedure performed in the Unit. Due to inability to assess the level of pain in newborns following procedural pain to its full magnitude, using less and more aggressive assessment methods, the overall recommendation that has aroused from this small study is that observation of facial expression combined with monitoring of physiological parameters is of outmost importance for the health and wellbeing of the newborns. Even observation of the facial expression alone during procedural pain in countries with limited resources, can give information about the experienced pain, therefore requiring cost-effective measures for pain management in newborns. Therefore, pain assessment should be important and useful tool within the routine care of the healthy newborns.

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