Clinical and Laboratory Assessment of Behavioral, Physiological and Hormonal Neonatal Responses to Procedural Pain in NICU

Thesis

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ABSTRACT

Background: Infants in NICU are exposed to repeated, invasive procedures resulting in acute or chronic pain that may predispose to significant clinical, physiologic and psychologic sequelae.

Aim: To assess pain response in newborns after endotracheal intubation and umbilical vein catheterization using multidimensional measurements.

Study Design & method: 75 preterm and term newborns were involved in our non-randomized controlled prospective study. They were classified into 3 groups: group A (N=30) included newborns exposed to intubation, group B (N=15) included newborns underwent insertion of umbilical vein catheterization and the control newborns (N=30) of matched age & sex. Our assessment included measurements of physiological indicators (HR, RR, MAP, SaO2 and palmar sweating), behavioral indicators (facial expression: brow bulge, nasolabial furrows, mouth opening and grimace, body movements and crying). and hormonal indicators (plasma renin activity).

Result: Regarding group A There was significant increase of HR, MAP, SaO2 and PRA and significant decline of RR after intubation. concerning group B there was no statistical significant difference of HR, RR, MAP and SaO2 after catheterization. however, there was significant increase of PRA after umbilical vein catheterization. There was significant increase of physiological, behavioral & hormonal indicators in both groups A & B when compared to control group. We found a statistical significant correlation between post-intubation PRA and MAP. PRA was found to be the single indicator of pain in group A. On the other hand, we did not find any reliable indicator of pain group B.

Conclusion: neonates show variable physiological, behavioral and hormonal responses to different procedures in NICU according to the severity of pain. We need tailored tools for assessment of pain according to both underlying illness and severity of disease.

Keywords: neonatal pain assessment; physiological, behavioral and hormonal indicators of neonatal pain

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LIST OF ABBREVIATIONS

ACE	Angiotensin Converting Enzyme
ACTH	Adrenocorticotropic Hormone
ADH	Antidiuretic Hormone
AGA	Appropriate for Gestational Age
AMP	Adenosine Monophosphate
BP	Blood Pressure
Bpm	Beat per Minute
CBC	Complete Blood Count
CNS	Central Nervous System
CRF	Corticotrophin Releasing Factor
CRP	C-Reactive Protein
CS	Caesarian Section
DBP	Diastolic Blood Pressure
DM	Diabetes Mellitus
GA	Gestational Age
GH	Growth Hormone
HR	Heart Rate
JG	Juxtaglomerular Cells

LIST OF ABBREVIATIONS (Cont...)

LBW	Low Birth Weight
MAS	Meconiem Aspiration Syndrome
MmHg	Millimeter Mercury
NICU	Neonatal Intensive Care Unit
NVD	Normal Vaginal Delivery
PaO2	Arterial Oxygen Pressure
PDA	Patent Ductus Arteriosus
PRA	Plasma Renin Activity
RAAS	Renin-Angiotensin-Aldosterone System
RDS	Respiratory Distress Syndrome
RR	Respiratory Rate
SaO2	Oxygen Saturation
SBP	Systolic Blood Pressure
TTN	Transient Tachpnea of Neoborn
VLBW	Very Low Birth Weight

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INTRODUCTION

It was long believed that newborns did not experience painful stimuli as unpleasant, and therefore they had no recollection of such painful stimuli. **Akcam &O¨ rmeci, 2004** have shown that newborns have all the necessary anatomical, physiological, and chemical systems to perceive pain. The neurobiological system needed for this perception has already been formed between the 24th and 28th weeks of pregnancy **(*Lee et al, 2005*)**, which means that it is already functional at the lowest viable duration of pregnancy (***Deshmukh & Udani, 2002*)**

Newborns are even more sensitive to pain than adults. Their suppressive mechanisms are immature, which lowers the threshold of pain perception. **(*Gaspardo et al, 2005*)** The cause is the lack of inhibition of the pain stimulus in the spinal cord (***Deshmukh & Udani, 2002)***

Pain has consequences for cardiovascular function and can lead to changes in both metabolism and intracranial pressure **(*Eriksson et al, 1999*)**. Long-term consequences can also result, namely permanent, structural, and functional changes, which include anxiety syndromes and excessive sensitivity to pain (***Akcam &O¨ rmeci, 2004*)**

Pain exposure in a neonatal intensive care unit (NICU) is considered a major source of distress for children and their families. The most frequently described painful procedures include endotracheal and naso-pharyngeal suctioning and heel lances. The removal of adhesive tape and the application of an intravenous cannula are also frequently performed painful procedures. The number of such procedures to which a neonate is exposed varies from 2 to 14 per day ***(Cignaccoa et al, 2009).***

Optimal pain management requires competent pain assessment, which can be especially difficult to perform in neonates. The pain-assessment tool used should be multidimensional, including measurements for both physiologic and behavioral indicators of pain, because neonates cannot self-report. Physiologic indicators of pain include changes in heart rate, respiratory rate, blood pressure, oxygen saturation, vagal tone and palmar sweating. Behavioral indicators include changes in facial expressions, body movements, and crying, but such parameters may be absent in some neonates who are neurologically impaired or pharmacologically paralyzed ***(American academy of pediatrics, 2006).***

Significant hormonal and biochemical responses have been measured in preterm and term infants undergoing procedures such as circumcision, chest physiotherapy, heel

lances, and suctioning. In painful situations, these responses stimulate the release of “stress hormones” (catecholamines, corticosteroids, glucagons, epinephrine, norepinephrine and beta-endorphins), meanwhile insulin production is suppressed. Growth hormone and prolactin are secreted more frequently when the infant has had less anesthesia or pain management to control the nociception. The renin–aldosterone pathway was found to increase with a painful procedure and to decrease again over time. Plasma rennin activity can be used as an indicator for assessment of pain in neonates in NICU. It is characterized by being simple and reliable measure of pain response ***(Goldman & Koren, 2002)***

AIM OF THE WORK

Our aim was to assess pain response in the newborns after two painful procedures (endotracheal intubation and umbilical vein catheterization) using multidimensional measurements (physiological, behavioral and hormonal). It was not a scoring system of pain but to answer the question: do we need tailored tools for pain assessment with different painful procedures?

PAIN PHYSIOLOGY

Pain is a highly individualized subjective experience affecting people of any age. It is a universal experience ***(Ricci & Kyle, 2009)***. Pain is whatever the patient says it is, and occurs whenever he says it does ***(Browne et al., 2008)***. It is considered the fifth vital sign ***(Ruth et al., 2007)***. Anxiety is part of pain, the relationship between fear and anxiety levels and the ability to cope with pain may have a significant effect ***(Price, 2008)***. It is one of the main parental concerns for infants in intensive care or undergoing procedures ***(Lissauer et al., 2006)***. Pain response includes behavioral changes such as facial expression, motor activity, cry consolability and overall tone and physiological changes such as increase or decrease pulse, respiration, blood pressure and oxygen saturation ***(Ricci & Kyle, 2009)***.

Pain is protective mechanism for the body. It causes the individual to remove the painful stimuli so prevent tissue damage ***(Guyton, 2005).***

Painful procedures are expected to cause acute pain with tissue damaging or none tissue damaging ***(American Academy of Pediatrics, 2006)***. Most of painful intervention includes blood sampling such as vein puncture and heel stick ***(Cignacco et al., 2006)***.

Pain Receptors:

They are wide spread in the superficial layer of the skin and also in certain internal tissues such as the periosteum, the arterial walls, the joint surfaces and the falx ***(Guyton, 2005).***

Nerve fibers that innervate bone and skin and form the peripheral nervous system begin migration from the neural crest at about 7 weeks gestation. This migration process is complete by 20 weeks gestation. By 28-30 weeks, the density of nociceptive nerve endings is equal to that of adults ***(Esma and Rana, 2007).***

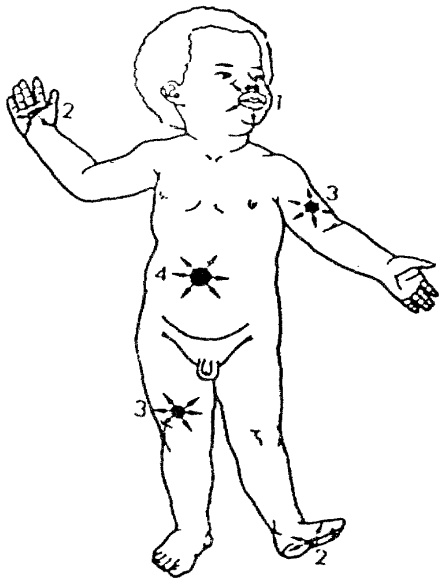

Fig. 1: Embryology of Nociceptors

1)***7 weeks*** 3)***15 weeks***

2)***11 weeks*** 4) ***20 weeks***

(Anand & Hickey, 1987)