

Contextualized pain management in newborns

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From the womb to the adult

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Abstract

Neonatal pain treatment requires personalization, and pain assessment should be contextualized to be effective. Here we summarize the available tools in neonatal analgesia, paying a special attention to highlight the personalization of antalgic behavior, both in assessment and in treatment of neonatal pain.

Keywords

Sensorial saturation, pain, newborn, analgesia, heel prick, nociceptors.

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Personalization of pain treatment

The aim of this paper is to give an overview on pain treatment, highlighting a particular procedure called sensorial saturation that requires a personalization of management and a general targeted approach to neonatal pain.

Central role of pain in the newborn

Pain is one of the most disruptive experiences in neonates who require intensive care, and it occurs during a time when it is developmentally unexpected [1]. Physiologically immature infants born at very low gestational age are exposed to multiple stressful and painful procedures in the Neonatal Intensive Care Unit (NICU), during a period of rapid brain development and potential vulnerability [2, 3]. Multiple lines of evidence suggest that repeated and prolonged pain exposure alters their subsequent pain processing, long-term development, and behavior [4, 5].

The American Academy of Pediatrics (AAP) and the Canadian Pediatric Society (CPS) recommended to reduce the number of painful procedures, to prevent or treat acute and postoperative pain, and to avoid prolonged or repetitive pain/stress during neonatal care [6].

Procedural pain assessment in Neonatal Intensive Care Unit

Pain is hardly detectable in infants because newborns are preverbal beings so they are not able to communicate their feelings. Painful procedures performed in Neonatal Units are a common source of pain for the newborns. Procedural pain during heel pricks, intramuscular injections or tracheal suctioning is assessed through scales, which take into account multiple parameters. For instance heel pricks are usually performed to obtain blood samples for analyses and even healthy newborns undergo blood samples for screening purposes during the in-hospital stay. When babies are admitted to the NICUs, they undergo about 10-14 painful, occasionally very painful, procedures per day [7-12]. To date more than 40 acute pain scales exist [13], but it is still debated which is the “gold standard” for neonatal pain assessment, both in research and in clinical practice [14].

Most of the available paediatric pain scales are multidimensional, taking into consideration both behavioural (change in facial expression, move-

ments, type and duration of cry) and physiological (increase in heart and respiratory rate and blood pressure, decrease in oxygen saturation) indicators [15]. Current acute pain scales have several limitations that can reduce their usefulness in clinical practice and in experimental settings, such as recording more than ten behavioural or physiological parameters in real time [16]. Moreover, some studies report that a nurse who is performing a painful stimulus and detecting pain at the same time will give different scores than an observer, and both will give different results than an observer looking at a recorded video clip of that scene [17, 18]. Last, no pain scale is currently designed to address extreme pain such as bowel perforation, surgery or bone fractures, as it is impossible to validate such a scale.

This is why a personalized approach to neonatal pain has pivotal importance (**Fig. 1**). This means to contextualize pain assessment to a specific site and to a specific stimulus, unlike current scales do. Stimuli that might provoke pain when applied to an innervated area will not provoke it when applied in a point without nociceptors (**Fig. 2**). Considering the behavioural context makes a single pain indicator (crying onset or tachycardia) sufficient to assess that that stimulus provoked a reaction, and, if the stimulus was adequate to elicit pain, the reaction can be defined as a pain reaction. For instance crying is not specific but, if it appears soon after a painful stimulus, it can be considered as an actual sign of pain; on the other hand, if crying appears after a stimulus on an insensitive area such as the umbilical cord, or after softly massaging intact skin, it can be hardly considered painful. Stimuli that can be painful when applied in innervated areas are mechanical events, heat, cold and some chemical agents [19, 20]. When nociceptors are activated we should use noticeable signs such as crying or increased heart rate, which have been used for the validation of pain scales [21-26], though neither crying nor heart rate are specific to pain [27]. Nevertheless, the sudden appearance of these signs after a potentially painful stimulus is applied to an innervated area can help to overcome this limit [28-30] and to give reliable information about pain.

When babies receive long-term stressful treatments, e.g. intubated babies or post-surgery, it is important to treat them avoiding unnecessary pain. This is why a personalized treatment should be started using the available pain scales for chronic

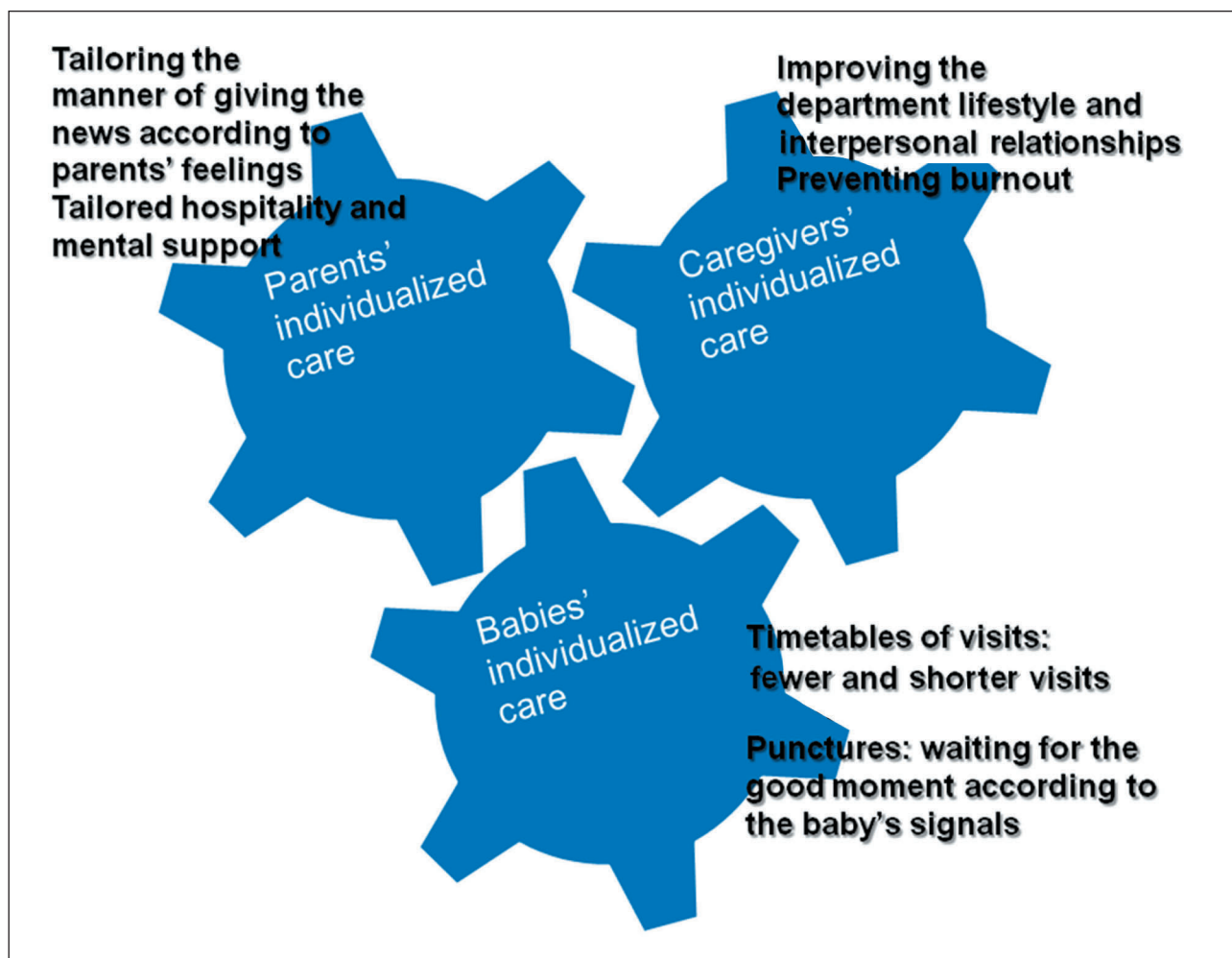


Figure 1. Taking care of the three protagonists of babies' pain.

pain assessment. Unlike acute pain scales, they are few and allow a periodical (4-6 hours) assessment of the baby's state in the previous hours. This paves the way to start or modulate a personalized pain treatment, based on good analgesic drugs, such as opioid or non-steroidal analgesic drugs.

Non-pharmacological analgesic approaches

In the last few years, several non-pharmacological strategies have been studied to overcome procedural pain in newborns. Nevertheless, only one-third of invasive procedures performed daily in the first two weeks after birth are carried out using analgesia [31]. Non-pharmacologic approaches are often performed as the first step in neonatal pain management, particularly because of their favorable side-effect profile, their ability to reduce acute pain from invasive or non-invasive procedures, and their beneficial long-term effects as compared with the systemic analgesics [32]. Non-pharmacologic

analgesic tools range from sweet oral solution at different concentrations [33] to multisensory approaches [34].

The skin-to-skin contact, defined as kangaroo care, is an effective and safe approach both for term and preterm neonates weighing more than 1,000 grams and it has beneficial effects on growth, mother-infant bonding, and long-term neurodevelopmental outcomes [35]. Facilitated tucking can provide some relief for procedural pain but it is not as effective as sucrose for skin-breaking procedures [36, 37].

The use of oral sweet solutions at concentration above 20% decreases pain, while the use of 10% glucose is effective only by the combination of several stimulations such as non-nutritive sucking or sensorial saturation. Other treatments like topic analgesic creams or systemic analgesics seem to be ineffective for heel prick pain [38].

A recent non-pharmacologic analgesic technique is the Sensorial Saturation (SS). SS can be used in both preterm and term infants and it has been



Figure 2. Manoeuvres that activate nociceptors.

studied mainly on heel pricks. It consists of the so called “3 T” intervention: taste (instillation of a few drops of 10% glucose solution or breast milk in the baby’s mouth), touch (gentle massage on the back or the head with slow, circular movements) and talk (the mother or nurse will talk continuously to the infant with a gentle tone of voice, or may use a music box to keep the auditory stimulation) [39]. SS has been adopted by several national guidelines for neonatal analgesia including guidelines by the Pain Study Group of the Italian Society of Neonatology or the Association of Pediatric Anesthetists of Great Britain and Ireland [40-43].

It should be pointed out that SS is effective only if correctly performed; to this aim a personal caregiver-baby interaction is not just desirable but mandatory, because only when the caregiver (for example, the mother or a nurse) becomes aware that “it is the good moment” the acute painful event can be performed with the assurance of an analgesic result [44]. The baby should be the “promoter” for the beginning of the procedure, showing that the level of distraction and sense saturation is complete; the main sign is the presence of staring and of rhythmic suction at a pace of one suction per second. This makes the

caregiver aware that the baby is ready to undergo the procedure.

SS is not only a manoeuvre, but also an interaction that enters in the field of NIDCAP (neonatal individualized care assessment program), namely in the range of interaction between baby, parents and medical staff [44]. Every manoeuvre performed on the baby should respect this interaction, and modern neonatology puts the baby, the family and their rhythms at the center of the care.

Pharmacological analgesia

Several drugs have been used throughout the last few years to blunt or to overcome neonatal pain. Here we highlight two of the most promising ones in this field.

Paracetamol use is common in infants and neonates, with rectal, enteral and intravenous formulations [45-47]. Paracetamol shows a ceiling effect, but it does not lead to develop tolerance, unlike opioids [46, 47]; both can be used simultaneously so that lower doses of morphine are necessary in neonates co-treated with intravenous paracetamol [48]. Paracetamol has no effect for procedure-related pain, e.g. heel-prick [49]. Paracetamol has been successfully used in neonates after vacuum extraction, improving their behavior [50], but babies who received paracetamol after vaginal birth had higher pain scores during routine heel pricks.

Remifentanyl is a potent, short-acting synthetic opioid analgesic drug [51]. It is faster than both fentanyl and morphine, achieving the maximum analgesic effect one minute after the administration [52], though there is still limited experience of its use in neonates; for instance it has been observed to decrease pain due to the placement of a percutaneous central venous line in preterm babies [53]. It should be monitored for possible hyperalgesia, tolerance or chest rigidity [53].

These two drugs are an example of how neonatal pharmacopeia evolves, but validated drugs such as morphine or topical analgesic creams should never be neglected when necessary.

Conclusion

Neonatal pain management has made great steps forward in the last few years. In order to avoid severe short- and long-term adverse effects of pain, all NICU patients deserve pain prevention and assessment. Moreover, personalized strategies for

pain management, using both non-pharmacologic and pharmacologic approaches, should be used. This implies a deep respect of the baby and a thorough knowledge of his/her rhythms and signals. An individualized treatment is mandatory in analgesic practice as well, because administering drugs is not enough. The first step in a good analgesic attempt is not provoking pain, but this should be preceded by the creation of a baby-centered environment, where the family and the baby are active protagonists. An individualized environment exposes the baby to a lower risk of brain damage, and the active presence of the family reduces stress, increases collaboration and consequently improves outcomes.

Declaration of interest

The Authors report no conflict of interest.

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