

Acute pain management in the neonate

Glyn Williams

Abstract

Acute pain management in the neonatal period remains a challenge for the clinician. Responses to pain and analgesic intervention are developmentally influenced and cannot be not directly extrapolated from the older child. Successful and safe intervention will minimize acute physiological and behavioural distress, reduce pain scores and potentially improve short- and long-term outcomes. This requires an understanding of the physiology and pharmacology in this age group alongside a multi-modal approach to treatment using both pharmacological and non-pharmacological interventions.

Keywords Acute pain; local anaesthetic; multi-modal; neonate; opioid; pain assessment; pain mechanisms; paracetamol

Royal College of Anaesthetists CPD Matrix: 1D02, 2D05, 3D00

Children of all ages are exposed to painful stimuli in a variety of healthcare settings. These include procedural pain, perioperative pain, pain associated with intercurrent illness and pain experienced in the intensive care environment. Current evidence confirms neonates are able to perceive and respond to noxious stimuli and may be at increased risk of experiencing moderate to severe pain.¹

Alongside the obvious humanitarian reasons, providing safe and effective analgesia will minimize acute physiological and behavioural distress and improve both acute and long-term outcomes. This requires specific age-appropriate evidence alongside the consistent implementation of guidelines and local practice protocols into clinical settings.

Whilst evidence to guide best analgesic practice is increasing in children, neonatal specific evidence is limited in many areas.² This perpetuates the need to extrapolate data from older age groups into neonatal practice. This needs to be done, however, with a full understanding of the pathophysiology of pain and the pharmacology of the agents used in this age group.

Pain mechanisms

Neonates will display responses to noxious stimuli in the pain pathways at all points from the periphery to the cortex. Though there is developmental regulation of the degree and nature of these responses.³

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Learning objectives

After reading this article, you should be able to:

- explain the differences in pain processing between neonates and older children
- recognize the importance of pain assessment in successful analgesic management
- summarize the common analgesic interventions used in this age group
- formulate an analgesic plan for acute pain management in a neonate

Peripheral nociceptors

At birth nociceptors respond to mechanical, thermal and chemical stimuli. Peripheral sensitization and primary hyperalgesia will occur within areas of tissue injury.

Spinal cord

Spinal reflexes show a more generalized response with lower thresholds due to changes in anatomical distribution of incoming sensory fibres. In neonates there is overlap of A- β fibres (touch) with A- δ and C-fibres (pain) in laminae I–II of the dorsal horn. With increasing age the A- β fibres regress to laminae III–IV.

An increased response to noxious stimuli is still seen, however, as demonstrated by the greater reflex withdrawal seen associated with heel lance when compared with light touch.

Descending inhibition

Endogenous inhibition of pain pathways both within the spinal cord and via descending pathways matures relatively late in the developing child. Consequently neonatal pain pathways have a relative excess of excitation.

Somatosensory cortex

Pain signals reach the somatosensory cortex in preterm and term neonates and alterations in cortical activity are seen following noxious stimuli.

The development of the central nervous system can be affected by changing levels of neural activity. There is an increasing awareness of the effect of both pain and analgesic intervention on the development of the pain pathways and future pain responses.

Infants who have undergone circumcision without analgesia in the neonatal period show an enhanced behavioural response to immunization. Similarly increased analgesic requirements have been noted in infants requiring surgery who also underwent surgery in the neonatal period. Animal studies suggest changes in sensory processing (both excitatory and inhibitory) following neonatal injury that are not replicated when the injury occurs in older age groups and analgesic intervention at the time of injury will modulate these effects.³

Neonatal intensive care is associated with adverse neurodevelopmental outcomes that are poorer in preterm infants who also underwent surgical procedures. The specific contributions of pain, analgesia and anaesthesia are hard to determine due to

many confounding factors but statistical correction for these confounders suggest a potential influence.

Analgesic planning

Successful pain management is based on the formulation of a sensible analgesic plan for each individual patient. It is best to take a practical and pragmatic approach that is dependent on the patient, the setting and the resources available. The primary aims are to recognize pain, to minimize moderate and severe pain safely, to prevent pain where it is predictable, to bring pain rapidly under control and to continue pain control for as long as it is required. The plan should be discussed with the parents and staff to confirm acceptability, consider preferences, answer questions and take into account previous experiences.

The plan should allow treatment to be titrated to effect and also include provision for the rapid control of breakthrough pain and the identification and treatment of adverse effects. In established paediatric centres with a high level of resources, a dedicated paediatric pain service is the standard of care. Where that is not available, significant improvements in pain management can be made by the establishment of clinical routines and protocols for the treatment and assessment of pain and a network of interested medical and nursing staff to provide ongoing education.

Pain assessment

Effective pain management in children is underpinned by the use of developmentally appropriate pain assessment and measurement tools alongside appropriate documentation and assessor education and training. They are used to measure pain severity and the effectiveness of analgesic intervention.

Neonates display a range of physiological and behavioural responses to pain, which form the basis of the many validated clinical assessment tools in current practice.⁴ Some examples are given in Table 1. The ideal tool should be easy and quick to use, give reproducible results, non-invasive and appropriate to the clinical setting. Other measures such as hormonal responses, functional imaging and measures of cortical activity are more appropriately used in research settings.

Multimodal analgesia

Multimodal, or balanced analgesia, involves the simultaneous use of a number of analgesic interventions to achieve optimal pain management. Analgesics acting independently and synchronously on pain mechanisms at different points on the pain pathway are likely to be more effective than a single drug. A multimodal approach also minimizes the doses of drugs used, thereby reducing adverse effects and improving outcomes. Multimodal analgesia also allows for the use of non-pharmacological pain control strategies where appropriate.

There is evidence for the effectiveness of this approach in children and effective pain management is achievable for patients of different developmental ages.⁵

Non-pharmacological interventions

The use of and evidence for the effectiveness of non-pharmacological interventions for the prevention and treatment of acute and procedural pain in the neonatal period is well established.² A range of techniques have been employed that incorporate tactile, visual, auditory and taste stimuli (Box 1).

The use of many of these interventions has been demonstrated for the reduction of pain and those physiological and behavioural disturbances associated with procedures such as heel lance, venipuncture, immunization and nasogastric tube placement. It is often advisable to use these techniques in conjunction with pharmacological strategies to improve overall analgesic effectiveness.

Pharmacological interventions

Sucrose

Sucrose solutions have been shown to reduce physiological and behavioural indicators of stress and reduce pain scores in neonates for a variety of procedures.² It is thought to work through endogenous opioid and non-opioid mechanisms and appears to be directly related to the sweet taste.

These solutions are effective in low volumes and there has been a wide range of concentrations used (9–30%). Sucrose can be administered directly on to the tongue by dropper or syringe or by dipping a pacifier in the solution. It should be administered

Examples of neonatal pain assessment tools

Tool	Assessment criteria	Gestational age	Utility
Premature infant pain profile (PIPP)	Gestational age, heart rate, oxygen saturations, behavioural state, facial expressions	28–40 weeks	Procedural and postoperative pain
COMFORT behaviour scale	Alertness, calmness, respiratory response (ventilated) or crying (not ventilated), movement, muscle tone, facial expression	Preterm and term neonates	Postoperative pain in NICU
Neonatal facial coding system (NFCS)	Facial expressions	Preterm and term neonates	Procedural pain
Neonatal infant pain scale (NIPS)	State of arousal, breathing, cry, facial expression, arm and leg movement	Preterm and term neonates	Procedural and postoperative pain

Table 1

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