

## Mini review

## Pain in infants and children—Physiological background and clinical aspects

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## ABSTRACT

Pain is a vital sign in infants and children and is essential for survival. Pain is subjective and it is only the individual who can describe the pain or the anticipation of pain. In infants, observation of behaviors that suggests pain, physiological and biological markers are used in the clinical assessment.

It is well established that infants from the gestational age of about 20 weeks have a functional pain system, even if immature, which can perceive and respond to tissue injury. Prolonged or repetitive nociceptive input and stress is harmful to the nervous system especially in the neonatal period of life. The nervous system shows a high degree of plasticity and untreated pain can lead to long-term undesired changes. Preventing or treating pain is therefore a primary goal in infants and children.

Over the last decades, the practice of pediatric pain management has advanced rapidly. Pain management includes analgesics as well as non-pharmacological approaches. A multimodal strategy is often advocated. Among the non-pharmacological methods medical acupuncture has emerged as an alternative in its own right in for example baby colic.

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## 1. Introduction

It is well established that infants from the gestational age of about 20 weeks have a functional nociceptive (pain) system, even if immature, which can perceive and respond to tissue injury [1]. The nociceptive pain system matures rapidly during the first years of life but does not reach full maturity until adolescence. The descending inhibitory system is not developed by birth and matures slower than the ascending pathways [10]. The nociceptive input in a child is more intense and goes on for a longer period after a trauma compared to in adults. This implies a higher risk for nerve cell death or alterations in the nervous system due to the known plasticity occurring during intense or prolonged stimulation in the pain pathways [5,7]. It is therefore of major importance to reduce pain stimulation and treat pain in children when needed.

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Another challenge, in the newborn child and infants, is the susceptibility to various analgesics and sedatives, as several of these have been demonstrated to be neurotoxic to the developing brain [31]. In other words both pain itself as well as commonly used analgesics may result in destruction of nerve cells. The problem is probably best solved by minimizing pain, using as little analgesics as possible and minimal acceptance of observed or reported pain [30].

## 2. Assessment of pain

Pain assessment is the individuals' experiences of pain in a global perspective including biological, personal and social contexts. Pain measurement on the other hand is the application of some quantitative or qualitative aspect of pain and is the basis for evaluation from a management and scientific aspect [12–14].

In the pre-verbal child self-reporting scales are not applicable. Instead behavioral, physiological and biological parameters are used to measure that is generally believed to reflect pain or stress.

**Table 1**  
Children's Hospital Eastern Ontario Pain Scale (CHEOPS).

Item	Behavior	Score
Cry	No cry	1
	Moaning	2
	Scream	3
Facial	Composed	1
	Grimace	2
	Smiling	0
Child verbal	None	1
	Pain complaints	2
	Positive	0
Torso	Neutral	1
	Tense	2
	Restrained	2
	Shifting	2
	Shivering	2
Touching wound or painful area	Not touching	1
	Reach	2
	Touch	2
	Grab	2
Legs	Neutral	1
	Squirming	2
	Drawn up/tensed	2
	Restrained	2

There are assessments scales both for premature as well as newborns in use today. The CHEOPS is one of the first developed scales and is validated for short, sharp pain like procedural and postoperative pain (Table 1, [24,23]).

In younger aged verbal children (3–7 years old) different scales such as Poker Chip Tool, colored analogue scale (CAS), faces affective scale (FAS) Fig. 1a, Wong Baker faces scale, Smiley faces scale, faces pain scale (FPS) and commonly faces pain scale-revised (FPS-R) [28,29]. When using self-reporting scales in this age group it is important to introduce the scale in advance and make sure the patient understand the used scale.

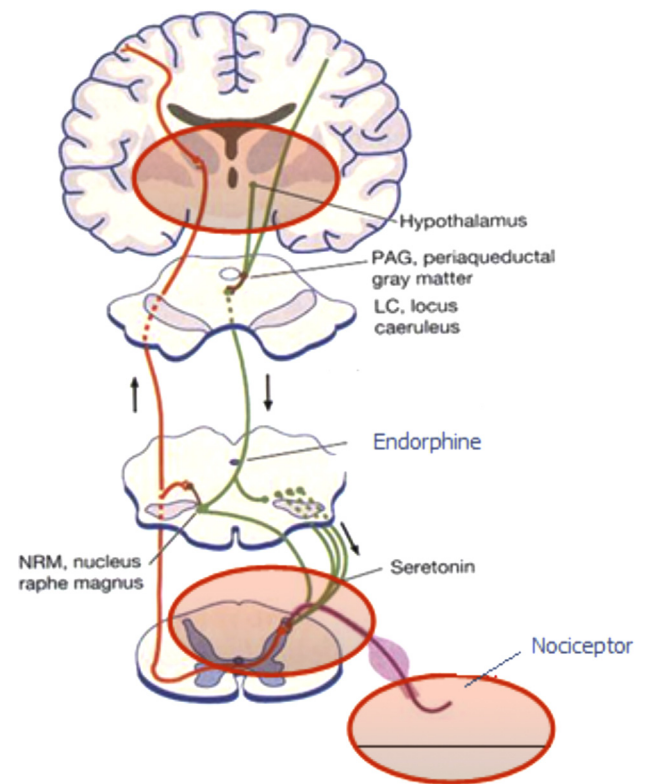
In children over 7 years of age the VAS or the numeric rating scale (NRS) is most often used. The VAS is a 10 cm long line with a sliding marker put where the person indicates the pain intensity. 0 is no pain and 10 is worst possible (imaginable pain) (Fig. 1b).

### 3. Treatment strategies

A good knowledge of the basic pharmacology of analgesic drugs, including indications, contraindications, dosage and routes of administration, is necessary for the optimum use of these drugs in children [2,6]. A multimodal analgesic approach in combination with non-pharmacological complimentary methods (distraction, guided imagery, relaxation, acupuncture, cryo therapy) can often generate an acceptable pain level without major side effects.

The use of drugs such as paracetamol (acetaminophen), non-steroidal anti-inflammatory drugs, alfa-2 adreno agonists, local anesthetics and opioids has become the cornerstone of pediatric analgesia [11,26]. They all play a part in a multimodal analgesic strategy for nociceptive pain (such as trauma and post-operative pain). Neuropathic pain, which is not as common as nociceptive pain in children, is usually treated with other types of analgesics such as gabapentine (anti-epileptic), NMDA blockers and TCAs (tricyclic anti-depressants). Nociceptive pain often responds to analgesic treatment where neuropathic pain which is rather unaffected by analgesics.

Usually drugs should be administered on a regular basis and in a more severe pain situation a drug combination like opioids, local anesthetics and alfa-2 adreno agonist could be used as a continuous infusion [20,21].



**Fig. 1.** Schematic drawing of the nociceptive system with both afferent and efferent pathways, modified from thesis of S. Lundeberg. The nociceptive system (pain system) in children is characterized by an increased number of nociceptors and an immature endogenous descending pain inhibiting system. From a clinical point of view, nociceptive pain is the most common cause of pain in pediatric patients [8]. Post-operative pain is an example of nociceptive pain and is directly related to the surgical procedures. Pain develops as a result of tissue damage and the ensuing inflammatory process. Within minutes after the surgical damage, secondary hyperalgesia develops and pain is amplified via segmental reflexes within the spinal cord.

Patient controlled analgesia (PCA) is a method which gained a lot of interest when introduced [19]. The advantages of PCA include a high degree of patient contentment owing the benefits of self control [22]. The technique allows for ample variability in individual requirements and circumvents delays in analgesic administration. PCA normally refers to a technique of intravenous administration in which the patient controls infusion equipment which delivers a bolus of analgesic drug on demand. A lock out time is used to limit the risk of over dosage and a background infusion can be added. During night hours a strict PCA bolus dose regime has some disadvantage because it might interfere with an optimal sleep pattern. PCA is often used as the golden standard of drug delivery in scientific research, when comparing drugs or methods, because it is the patient who decides on the dose needed. PCA as a method can be used from the age of 5–7 years. From a clinical point of view PCA is more seldom used today during the first postoperative night.

Drug administration should be without discomfort and create as little pain as possible to the child [25]. Topical anesthetics (EMLA®, Rapydan®) have clearly advanced the treatment of pediatric procedural pain, with many dosage forms available, including gels, sprays, creams, ointments, and patches. Intramuscular injections were abandoned due to the high degree of pain they generated.

Most of the analgesic drugs used in children are not tested or approved of in this age group. Furthermore the administration of the analgesic itself can be painful as intramuscular injections or induce pain by using concentrated solutions. A low pH of an injectable solution may also generate pain when administered. It

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