

Anesthesia and analgesia in newborns

Pain is defined as an unpleasant sensory or emotional experience associated with immediate or potential tissue damage or described based on this damage (according to the *International Association for the Study of Pain*, IASP). However, this definition cannot be used for newborns (nonverbal and preverbal individuals). According to another definition (Anand and Craig, 1991), pain is an inherited quality of life, manifested already after birth, serving as a signal and prevention against tissue damage.^[1]

Even a premature neonate has anatomical, neurochemical, and hormonal systems mature enough to perceive, process, and respond to pain. Premature neonates are more sensitive to painful stimuli due to increased excitability of sensory pathways and delayed maturation of descending inhibitory pathways and the endogenous opioid system. Newborns have a 3-5 times stronger stress response than adults. According to functional MRI and NIRS, newborns respond to weaker stimuli than adults. The fetus after the 20th week of gestation has the morphological, neurochemical and functional prerequisites for pain perception.^{[2][1]}

Analgesia is the loss of the ability to feel pain without loss of consciousness. **Anesthesia** is the elimination of all perception, both sensory and pain perception (general anesthesia), or numbing of a certain part of his body (regional, local anesthesia).^[3]

Types of pain

- nociceptive – starts at pain receptors (nociceptors/nocisensors);
- neuropathic – arises during the conduction of pain on nerve fibers.^[1]

Basic components of pain

- sensory (sensory-discriminative);
- affective (emotional);
- vegetative (autonomic; sympathetic activation);
- motor (fight or flight behavior in acute pain).^[1]

Types of pain in newborns

- childbirth trauma - especially during delivery by vacuum extraction or forceps;
- acute pain during procedures – endotracheal intubation, suctioning, artificial lung ventilation, insertion of chest drains, examination of retinopathy of prematurity, insertion of central venous catheters, lumbar puncture, blood collection from the heel (heel prick), etc.;
- acute postoperative pain;
- chronic pain.^[2]

Assessment of pain in newborns

- there are a number of different scaling systems such as:
 - Premature Infant Pain Profile - Revised (PIPP-R);
 - CRIES Neonatal Pain Assessment Tool (Cry, Requires oxygen, Increased vital signs, Expression, Sleeplessness);
 - Neonatal Infant Pain Scale (NIPS);
 - Neonatal Pain, Agitation, and Sedation Scale (N-PASS);
 - COMFORT scale.
- assessment of physiological and behavioral parameters;
- usual manifestations of pain:
 - increased heart rate, change in breathing rate, blood pressure fluctuations, painful expression on the face, motor restlessness, crying, sweating of the palms;
- physiological changes during pain:
 - increased need for oxygen, ventilation-perfusion mismatch, increased stomach acidity, disruption of the sleep-wake cycle; in case of long-lasting pain, then slowed heart rate, slowed breathing rate, lethargy, impaired blood circulation, cold sores;
- metabolic and hormonal changes:
 - increase in plasma levels of renin, adrenaline and noradrenaline, cortisol, release of growth hormone, glucagon, cortisol and aldosterone; decreased insulin secretion.^[2]

Consequences of untreated pain

- increased catabolism and hypermetabolism;
- worsening of hypoxia, acidosis, hypercapnia, respiratory distress and hyperglycemia;
- increased susceptibility to infections, increased morbidity and suboptimal outcome;
- altered pain perception (inability to respond to pain or, conversely, exaggerated physiological response to pain) with permanent neuroanatomical and behavioral consequences.^[2]

Pain treatment

- **non-pharmacological interventions:** kangarooing, breastfeeding, administration of breast milk, glucose or sucrose, non-nutritive sucking, tying/swaddling, positioning - in a ball, reducing the light level and reducing the noise level, music (after the 31st week of gestation), massage, etc.
- **pharmacological treatment:**
 - sucrose per os, ev. 20–30% glucose (from the 25th week of gestation; 0.2–0.5 ml/kg 24% sucrose p.o. 2 minutes before the procedure) – e.g. before taking blood from the heel, before venipuncture or intramuscular injection;
 - topical anesthetics - EMLA cream (a eutectic mixture of 2.5% lidocaine and 2.5% prilocaine), etc. - before venipuncture, insertion of a central venous catheter or puncture of a peripheral artery;
 - subcutaneous lidocaine infiltration;
 - systemic analgesia.^[2]

Analgesics

- opioids – most commonly used, strong analgesic effect, but accompanied by respiratory depression
 - morphine – the most commonly used opioid in neonatology;
 - adverse effects: respiratory and CNS depression, arterial hypotension, urinary retention, tolerance, dependence, constipation;
 - fentanyl;
 - alfentanil, sufentanil, remifentanil – fast-acting, used for shorter procedures;
- paracetamol – for the treatment of mild and moderate pain; when given after surgery, it allows to reduce the dose of opioids;
- non-steroidal antirheumatic drugs – they are used to pharmacologically block persistent Botall's ducts (PDA); they are not suitable for the treatment of pain due to a large number of side effects (pulmonary hypertension, renal insufficiency, platelet dysfunction);
- other possible drugs, which, however, have not been sufficiently studied in newborns:
 - methadone – satisfactory analgesic effect, but unclear dosage;
 - propofol – non-barbiturate anesthetic for short-term sedation and anesthesia; adverse effects: prolonged hypotension, bradycardia, desaturation and significant variability in pharmacokinetics;
 - gabapentin – selective alpha-2-adrenergic agonist; sedation and analgesia with minimal respiratory depression;
 - ketamine – agonist of N-methyl-D-aspartate receptors; sedation, analgesia and amnesia.^[2]

Sedative (no analgesic effect)

- used in combination with analgesics for restlessness associated with pain;
- benzodiazepines – sedation, muscle relaxant and anxiolytic; when administered with opioids, they increase respiratory depression and hypotension;
 - midazolam – the most commonly used benzodiazepine in neonatology; rapid onset of action; potential neurotoxicity (abnormal hippocampal growth and neurodevelopment);
- chloral hydrate.^[2]

Ladder of pain

- avoiding painful procedures if possible;
- non-pharmacological interventions;
- topical gels;
- oral or rectal analgesics;
- slow infusion of opiates;
- local anesthetics;
- general anesthesia.^[1]

Sources

Related articles

- Labor analgesia and anesthesia • Opioids (pediatrics)

External links

- Prevention and Management of Procedural Pain in the Neonate: An Update (<https://pediatrics.aappublications.org/content/137/2/e20154271>)
- Neonatal pain guideline - GG&C NHS (<https://www.clinicalguidelines.scot.nhs.uk/ggc-paediatric-guidelines/ggc-guidelines/neonatology/neonatal-pain-guideline/>)

References

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2. GOMELLA, Tricia – EYAL, Fabien – BANY-MOHAMMED, Fayez. *Gomella's Neonatology, Eighth Edition*. 8.

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3. BLÁHA, J. , et al. ANALGEZIE U VAGINÁLNÍHO PORODU. *Česká gynekologie* [online]. 2008, y. -, vol. 82, no. 2, p. 145-149, Available from <<https://www.gynultrazvuk.cz/data/clanky/6/dokumenty/p-2018-analgezie-u-vaginalniho-porodu.pdf>>.