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# PAIN ASSESSMENT IN THE MOST VULNERABLE CATEGORIES OF CHILDREN

## *PROCENA BOLA U NAJVULNERABILNIJIM KATEGORIJAMA DECE*

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**Abstract**

**Introduction.** Medical interventions – ranging from routine venipuncture, immunizations, physical therapy, and dental procedures to invasive procedures such as lumbar puncture and bone marrow biopsy – are an essential part of pediatric health care but often cause significant pain and distress for both children and parents. In the most vulnerable groups of children (preterm and full-term newborns, preverbal infants, children with neurological and developmental disorders affecting understanding and communication, and those who are sedated for medical reasons), the subjective experience of pain cannot be adequately expressed or interpreted. **Discussion.** Pain assessment in these children represents an extremely complex clinical challenge. Evidence indicates that their well-being depends largely on the ability of healthcare professionals and caregivers to recognize signs of pain, assess its intensity, prevent complications, and initiate timely and effective pain management. **Conclusion.** Continuous education of health care professionals regarding the importance and appropriate use of pain assessment tools is essential to prevent the long-term consequences of unrecognized and inadequately treated pain, particularly in the most vulnerable pediatric populations.

**Key words:** Pain Measurement; Pain; Child; Infant; Infant, Premature; Children with Disabilities; Pain, Procedural

**Sažetak**

**Uvod.** Medicinske intervencije koje obuhvataju rutinsku venepunkciju, imunizaciju, fizikalnu terapiju, stomatološke zahvate, kao i invazivne procedure poput lumbalne punkcije i biopsije koštane srži, predstavljaju neizostavan deo zdravstvene zaštite dece, ali su često izvor bola i stresa, kako za decu, tako i za njihove roditelje. U posebno ranjivim kategorijama dece – prevremeno rođenim i donesenim novorođenčadima, neverbalnim odojčadima, deci sa neurološkim i razvojnim poremećajima koji utiču na razumevanje i komunikaciju, kao i deci koja su sedirana iz medicinskih razloga – subjektivno iskustvo bola ne može se adekvatno interpretirati. **Diskusija.** Procena bola u ovoj populaciji predstavlja izrazito složen klinički zadatak. Rezultati istraživanja ukazuju da deca iz najranjivijih kategorija u velikoj meri zavise od sposobnosti zdravstvenih radnika i osoba iz njihove neposredne okoline da pravovremeno prepoznaju bol, procene njegov intenzitet, spreče moguće komplikacije i primene odgovarajuće terapijske mere. **Zaključak.** Kontinuirana edukacija zdravstvenih profesionalaca o značaju i pravilnoj primeni instrumenata za procenu bola od suštinskog je značaja za prevenciju trajnih posledica koje mogu nastati kao posledica neprepoznatog i neadekvatno lečenog bola, naročito kod dece koja spadaju u najosetljivije grupe.

**Ključne reči:** merenje bola; bol; dete; novorođenče; prevremeno rođeno dete; deca sa posebnim potrebama; proceduralni bol

### Introduction

Pain plays a protective role and is vital for survival, as it served as a warning of the limits that must be respected during activity to prevent potential tissue damage, often irreversible. The perception of pain is highly individual and differs between children and adults. A newborn adapts to acute stress resulting from painful stimuli, and this adaptation manifests through changes in endocrine, autonomic, immunological, and behavioral domains. Pain perception is influenced not only by neurophysiological mechanisms but also by psychological and environmental factors [1]. Pain prevention and management in children represent both an ethical obligation of healthcare providers and a fundamental expectation of parents within the framework of humane, comprehensive care for children. Medical interventions – ranging from routine venipuncture, immunizations, physical therapy, and dental procedures to invasive procedures such as lumbar puncture and bone marrow biopsy – are an essential part of pediatric health care, yet they are often painful and distressing for both children and parents [2]. In the most vulnerable categories of children – preterm and full-term newborns, pre-

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***Abbreviations***

IASP – International Association for the Study of Pain
CNS – Central Nervous System
MRI – Magnetic Resonance Imaging
AAP – American Academy of Pediatrics
CP – Cerebral Palsy
VAS – Visual Analog Scale
NRS – Numerical Rating Scales
VRS – Verbal Rating Scales
FS – face scale
PIPP – Premature Infant Pain Profile
PIPP-R – Premature Infant Pain Profile Revised
N-PASS – Neonatal Pain, Agitation and Sedation Scale
BPSN – Berne Pain Scale for Newborns
NIPS – Neonatal Infant Pain Scale
TPPPS – Toddler-Preschooler Postoperative Pain Scale
FLACC – Face Legs Activity Cry Consolability Scale
r-FLACC – Revised Face Legs Activity Cry Consolability scale
INRS – Individualized Numeric Rating Scale
PPP – Pediatric Pain Profile
NCCPC-R – Non-Communicating Children's Pain Checklist – Revised
MAPS – Multidimensional Assessment Pain Scale
EEG – electroencephalography

verbal infants, children with neurological and developmental disorders affecting understanding and communication, and those sedated for medical reasons – the subjective experience of pain cannot be adequately expressed or interpreted due to their inability to signal its presence.

## Pain definition

The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage". Pain assessment is inherently subjective, and each individual develops a personal perception of pain based on unique experiences [3]. However, due to their inability to self-report, this IASP definition cannot be strictly applied to the most vulnerable groups of children. These children rely entirely on the ability of medical personnel and caregivers to recognize the presence of pain, assess its severity, and administer appropriate treatment.

*The importance of pain assessment in children*

Pain assessment is widely recognized across pediatric disciplines as both a diagnostic and therapeutic evaluation tool. It relies on the clinician's ability to observe and interpret pain within a specific clinical context. Preventing pain is not only an ethical requirement but also a medical necessity, as repeated exposure to pain can have adverse developmental and physiological effects. Misjudgment or misinterpretation of pain signals in children may lead to incorrect diagnosis, inappropriate medication dosing, or inadequate treatment, all of can result in serious consequences.

Whenever possible, the primary principle of assessment should be self-reporting. However, in the most vulnerable group of children – newborns, infants, toddlers, those with neurological or communicational limitations, or those sedated for medical reasons – meaningful self-assessment is not possible. Despite these limitations, relieving pain remains a fundamental human right [4]. Although complete elimination of pain in newborns and infants is sometimes unachievable, much can be done to minimize its duration and intensity through proper assessment and timely interventions [5].

*Pain assessment in children*

Multidimensional pain assessment in children is based on social communication and behavioral observation, complemented by contextual understanding, information obtained from parents or caregivers, and physiological indicators of pain [6]. Ideally, pain assessment should indicate evaluation of the following components: **Pain location**: even very young children or those with moderate disabilities can often indicate where the pain is localized. **Pain quality (nature)**: qualitative description helps differentiate the type of pain (e.g., nociceptive, neuropathic, vascular). In vulnerable children, such descriptions may be limited or absent. **Pain impact**: the degree to which pain affects daily physical and social functioning, typically reported by parents or caregivers. **Pain context**: circumstances or environmental factors influencing the perception of expression of pain. **Developmental status**: including gestational age at birth and current level of distress. **Physiological indicators**: changes in heart rate, respiratory rate, blood pressure, oxygen saturation, vagal tone, transcutaneous oxygen saturation, transcutaneous oxygen pressure, IV dioxide, palmar sweating, intracranial pressure, or plasma cortisol and catecholamine levels. **Behavioral indicators**: alternations in facial expression, body movement, crying, muscle tone, sleep patterns, and consolability. These may be absent in newborns with neurological impairment or those pharmacologically paralyzed. **Pain intensity**: beyond measuring pain levels, pain intensity serves as an indicator for selecting appropriate pain-relief measures and evaluating their effectiveness. Since, according to the IASP definition, pain assessment is subjective, its application in individuals unable to self-assess remains a particular challenge, especially in vulnerable pediatric population.

*Characteristics of pain assessment in children from vulnerable categories*

**Fetal pain.** For human to experience pain, a set of physiologically mature neurological structures is required. Additionally, the experience to pain and its differentiation as such depend on higher cognitive processes related to consciousness and memory [7]. The de-

velopment of neural pathways involved in the pathophysiology of pain begins early in fetal life – around the seventh week of gestation – with subsequent formation of the thalamus and cortical neural pathways. Some authors suggest that pain does not occur before 24 weeks of gestation, since the central nervous system (CNS) structures necessary for pain perception – such as the cortex, spinal cord, and thalamus – are not yet fully developed [8]. Others argue that pain perception may begin between the 12$^{th}$ and the 20$^{th}$ week of gestation, mediated by developing neural structures. Behavioral changes associated with pain, such as simple motor responses, crying, and facial expressions, have been described in fetuses and preterm newborns [9]. Several physiological reactions – such as crying, withdrawal movements, and changes in stress hormone levels – can be interpreted as potential indicators of fetal pain. Magnetic resonance imaging (MRI) and magnetoencephalographic studies have demonstrated fetal reactions to vibroacoustic and visual stimuli in the third trimester. Ultrasound has provided insight into fetal behavior, including crying, acute pain expressions during surgery, and movement responses to contact with an amniocentesis needle. Fetuses exposed to prolonged and painful invasive procedures exhibit elevated plasma concentrations of cortisol and β-endorphins [10].

**Newborns, infants and toddlers.** MRI studies in newborns exposed to painful stimuli have demonstrated activation of brain regions responsible for coding sensory and affective components of pain, similar to those in adults. Excessive or prolonged exposure to pain in early life can be harmful, resulting in adverse physiological effects and long-term neurodevelopmental consequences. Preterm infants who experience repeated painful interventions often develop hyperalgesia and allodynia due to prolonged stress. Very preterm infants (<32 weeks of gestation), who undergo numerous painful procedures during a critical period for cerebral vulnerability, require special attention. Repeated exposure to pain in these infants has been associated with alternations in brain development, cortical thinning, white matter microstructural changes, and impaired functional cortical activity, which may result in cognitive deficits later in childhood [11]. Children experience pain differently from adults. The American Academy of Pediatrics (AAP) and the American Pain Society define pediatric pain as "a concept of pain and suffering that extends far beyond the immediate physical sensation, encompassing emotional, cognitive, and behavioral components, as well as developmental, environmental, and sociocultural factors". This definition underscores the subjective nature of pain and the role of fear and anxiety, particularly separation anxiety, in amplifying pain perception. An important goal of pediatric pain management is to eliminate the pain associated suffering.

**Children with neurological impairment.** Neurological disorders in children – progressive or non-progressive, such as cerebral palsy (CP) – often affect posture and movement and are frequently accompanied by pain of varying origin, localization, intensity and duration. This pain significantly compromises the quality of life of affected children and their caregivers. According to the existing literature, pain negatively impacts the quality of life in 27–75% of children with CP. Approximately 25% experience moderate to severe pain, and multiple pain sources are present in over 12% of cases. Pain in children with neurological impairment can arise from musculoskeletal deformities, hip dislocation or subluxation, hypertonia, dystonia, constipation, surgical intervention, or contractures [12]. Headaches are also common in these children, often resulting from muscular weakness, increased tone, or abnormal postures of the head and neck, leading to sleep disturbances and further reducing participation in daily activities such as play and learning. Abdominal pain may be caused by medication side effects, feeding difficulties (e.g., poor coordination of chewing and swallowing, gastroesophageal reflux, slow bowel passage, or constipation – particularly in children who remain seated for extended periods and cannot independently change position. Due to their limited ability to communicate, understanding of the cause and severity of pain in non-verbal children with neurological disorders is often challenging. Valuable information can be obtained from parents or caregivers [13]. Existing unidimensional and multidimensional pain assessment scales and questionnaires developed for newborns, children, and adolescents are not equally applicable to the assessment of chronic pain in children with severe cognitive and motor deficits.

**Sedated, critically ill, or physically restrained children.** For most children admitted to pediatric intensive care units, the use of standard pain assessment scales is often not feasible, as many of these patients are sedated, intubated, or otherwise unable to communicate. The same limitation applies to children under three years of age who are still in the preverbal phase of development. In such cases, pain recognition relies on specialized assessment tools that evaluate physiological changes, facial expressions, or motor responses to pain.

*Tools for pain assessment in children*

Clinical scales adapted to the child's age represent the most commonly used instruments for pain assessment and monitoring [14]. These scales are designed either for self-reporting or for observer-based

assessment, when the evaluation relies on behavioral and physiological indicators of pain.

In preverbal children (1 Month to 3 Years), pain assessment primarily depends on the observation of facial expressions, motor activity, and physiological reactions such as crying. In the verbal phase (3-8 Years), self-assessment becomes possible through visual aids such as photographs or drawings of faces. From the age of 8, children are generally capable of reliably self-reporting their pain intensity. Several standardized tools are commonly employed in clinical practice:

**Visual analog scale** (**VAS**): A 10 cm horizontal line with endpoints labeled "No pain" (0) and "Worst imaginable pain" (10). The child marks the point on the line corresponding to their subjective level of pain. Scores are interpreted as follows: VAS < 4 indicates mild to moderate pain, 4-6 indicates moderately severe pain, and >6 indicates severe pain.

– **Categorical Numerical Rating Scales** (**NRS**): children express the perceived intensity of pain on a numerical scale ranging from 0 (no pain) to 10 (the worst imaginable pain)

– **Categorical Verbal Rating Scales** (**VRS**)**:** Patients select or verbalize the word that best describes their pain intensity.

– **Graphic scales** may use drawings of faces (Face scale – **FS**) varying from happy to sad depending on the level of pain, color ranges, columns, or thermometers filled to a lesser or greater degree, etc.

*Tools for pain assessment in children unable to self-assess pain intensity*

The following instruments are primarily designed to evaluate facial expression, crying or vocalization, body posture, muscle tone, and movement, in accordance with the child's maturity, age, sensory capacity, cognitive status, and functional abilities.

***Newborns, infants and toddlers (Table 1) [15]***

**–** Premature Infant Pain Profile (**PIPP**): adapted to preterm infants

– Premature Infant Pain Profile Revised (**PIPP-R**): adapted to preterm infants

– Neonatal Pain, Agitation and Sedation Scale (**N-PASS**): adapted to preterm infants

– Berne Pain Scale for Newborns (**BPSN**): adapted to preterm infants

– Neonatal Infant Pain Scale (**NIPS**) (includes measures of heart rate and oxygen saturation).

– Toddler-Preschooler Postoperative Pain Scale (**TPPPS**).

– Face, Legs, Activity, Cry, Consolability Scale (**FLACC**).

*Children with neurological impairment*

– Revised Face, Legs, Activity, Cry, Consolability scale (**r-FLACC**): Enables caregivers to add behavioral descriptors that reflect a specific child's unique pain manifestations **(Table 2)** [15].

– Individualized Numeric Rating Scale (**INRS**): Combines a standard 0-10 numerical scale with caregiver-provided behavioral expressions of pain-related reactions.

**Table 1.** Neonatal pain scales

| Pain scale | Gestational age | Parameters | Type of pain | Metric scales |
|---|---|---|---|---|
| PIPP-R (revised pain profile for preterm infants) | 26 weeks to full-term | Heart rate and oxygen saturation, wakefulness, browridge prominence, eyestrain and nasolabial fold | Procedural and postoperative | 0–21 |
| CRYING (cries, requires oxygen, increased vital signs, facial expression, insomnia) | 32-56 weeks | Blood pressure, heart rate, oxygen saturation. Crying, facial expression, insomnia | Postoperative | 0–10 |
| NIPS (newborn infants pain scale) | 28-38 weeks | Respiration pattern. Facial expression, crying, arms, legs and wakefulness. | Procedural | 0–7 |
| COMFORT neo | 24-42 weeks | Respiratory response, blood pressure, cardiac action, wakefulness, anxiety, physical movement, muscle tone and facial strain. | Prolonged | 8–40 |
| NFCS (neonatal face coding system) | 25 weeks to full-term | Browridge prominence, eyestrain, nasolabial fold, open lips, stretched mouth, labial pouch, tense tongue, chin shivering | Procedural | 0–10 |
| N-PASS (neonatal pain, agitation and sedation scale) | 0–100 days | Heart rate, respiration rate, blood pressure and oxygen saturation. Crying or irritability, behavioral state, facial expression, extremities and tone | Acute and prolonged pain, also assesses sedation | Pain 0–10 Sedation 10–0 |
| EDIN (echelle de la douleur inconfort noveau-ne) | 25-36 weeks | Facial activity, bodily movement, sleep quality, quality of contact with nurses and consolability | Prolonged | 0–15 |
| BPSN (Bern pain scale for newborns) | 27-41 weeks | Respiratory pattern, heart rate and oxygen saturation. Wakefulness, crying duration, time to console, skin color, browridge prominence with eyestrain and posture | Procedural | 0–27 |

**Table 2.** Face, Legs, Activity, Cry, Consolability Scale – FLACC

| | 0 | 1 | 2 |
|---|---|---|---|
| Face | No particular expression or smile. | Occasional grimacing or frowning, withdrawn, uninterested. | Frequent to constant chin shivering, clenched jaws. |
| Legs | Normal or relaxed position. | Restless, tense. | Kicking or elevated legs. |
| Activity | Cries softly, normal sensations, moves easily. | Wiggling, forward-backward motion, tense. | Arching, stiff or twitching. |
| Cry | No crying, awake or asleep. | Moaning or wining; occasional complaints. | Constant crying, screaming or sobbing, frequent complaints. |
| Consolability | Content, relaxed. | Consoled by occasional holding, hugging or conversation . | Hard to console. |

**Table 3.** Multidimensional Assessment Pain Scale

| | 0 | 1 | 2 |
|---|---|---|---|
| Vital signs: heart rate and/or blood pressure | Within baseline | Increase by 10 or more heart beats per minute and/or increase in BP by more than  mmHg. | Decrease by 10 or more heart beats per minute and/or decrease in BP by more than 10 mmHg. |
| Respiration pattern | No change | Onset or increase of respiratory distress. | Severe respiratory distress |
| Facial expression | Relaxed | Grimace | Grimace accompanied by soft or faint crying |
| Bodily movements | No movements or purposeful action. | Restless | Stiff and/or limited bodily movements. |
| State of excitement | Calm or asleep | Hyperactive | Rule out |

No pain, 0; mild pain, 1–2; moderate pain, 3–5; strong pain, 6–8; extreme – maximal pain, 9–10.

– Pediatric Pain Profile (**PPP**): A behavioral checklist assessing both physical observation and functional changes (e.g., refusal to eat, disturbed sleep).

– Non-Communicating Children's Pain Checklist – Revised (**NCCPC-R)**: Comprehensive tool listing behaviors for assessing pain in children aged 3-18 years with cognitive or communication impairments.

*Sedated, critically ill or physically restrained children*

**– COMFORT** Scale: Assesses nine parameters, each rated 1-5, yielding a total score from 9 to 45. It includes heart rate and blood pressure assessment.

– **COMFORT-Behavior** (COMFORT-B): It includes assessment of the level of sedation, and excludes physiologic elements.

**– Face, Legs, Activity, Cry, Consolability** (**FLACC) Scale**: Evaluates five behavioral domains (facial expression, leg posture, spontaneous activity, characteristics of crying and consolability), each scored from 0 to 2; total scores range from 0 (no pain) to 9-10 (intolerable pain).

– Multidimensional Assessment Pain Scale (**MAPS)**: Observes body movements and facial expression, complemented by physiologic measures such as respiration, heart rate, and blood pressure. Similar to the FLACC scale, pain intensity is scored from 0 (no pain) to 9-10 (intolerable pain) **(Table 3)** [15].

## Discussion

Observational pain scales do not always allow differentiation between pain-induced distress and distress of a different origin, such as physiological instability or fear. Physiological parameters (e.g., heart rate, oxygen saturation) vary in response to pain but are less specific and reliable indicators compared to behavioral observation. Therefore, therapeutic decisions should be based on all aspects of assessment and potential sources of distress, including physiological, developmental, and psychosocial factors. The use of "pain score cut-points" for determining pain intensity is often inadequate for guiding medical treatment, as it may lead to both over- and under-medication. Instead, changes in pain intensity scores, observation of pain-related behaviors, treatment response, and overall child functioning should be evaluated concurrently when making treatment decisions. Recent studies have demonstrated that behavioral responses – such as facial grimacing, withdrawal reflexes, and crying – correlate more strongly with nociceptive cortical activation than physiological changes alone, thereby improving diagnostic accuracy in preverbal children. Consequently, multidimensional pain assessment scales that integrate behavioral, physiological, and contextual indicators are increasingly recommended in neonatal and pediatric pain assessment guidelines [2]. Simple clinical observa-

tions, such as the return of appetite, resumption of routine activities, social interactions, and sleep patterns, can be assessed easily through interviews with parents or direct observation. Critically ill patients, however, often cannot express pain or display immediate behavioral changes. In pediatric intensive care settings, pain responses may be masked by sedation, neuromuscular blockade, or critical illness-related encephalopathy. The use of newer tools such as the COMFORT-B scale and individualized behavioral descriptors (e.g., r-FLACC) has improved the detection of pain in children with limited communication abilities [3,4]. There remain substantial gaps in healthcare professionals' education regarding pediatric pain management, underscoring the need for more comprehensive and continuous training. Evidence from interprofessional education programs (e.g., Project ECHO® for Pediatric Pain) indicates that structured, continuing education improves pain assessment accuracy and reduces iatrogenic undertreatment of pain. Moreover, parental involvement and shared decision-making enhance clinical outcomes and minimize both overestimation and underestimation of pain [5–7]. Despite growing awareness, pain continues to be undertreated in vulnerable pediatric groups. Recent research highlights the potential of artificial intelligence-supported monitoring systems and novel biomarkers – such as heart rate variability, EEG-based cortical activation patterns, and salivary cortisol – to complement traditional scoring systems and enable early detection of distress in infants and neurologicall y impaired children.

**Conclusion**

No single indicator can perfectly reflect pain. Pediatric pain represents a complex clinical challenge that requires a multimodal and individualized management approach. Continuous, adaptable education and mentorship in pediatric pain assessment are essential for healthcare professionals. The clinical strategies summarized in this paper can help improve pain recognition and management in the most vulnerable pediatric populations. Research in this field is relatively recent, both globally and within our country. Further development of assessment tools based on physiological, behavioral, hormonal, and endocrine indicators is necessary to deepen understanding of pain perception in these groups. Until such tools are widely available, combining thorough anamnesis, behavior and physiological observation, patient history, physical examination, laboratory findings and, contextual clinical judgment remains an indispensible component of effective pediatric pain assessment and management – a practice that continues to balance science with clinical artistry.

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