

REVIEW PAPER

Current approaches to pain assessment and management in the paediatric emergency department

Tomasz Kłosiewicz^{1*}, Monika Rozmarynowska^{1*}, Piotr Suchecki², Bartosz Łasowski², Paulina Sytek², Wiktoria Michalkiewicz²

* These authors contributed equally to this work.

¹Department of Medical Rescue, Poznań University of Medical Sciences, Poznań, Poland

²The Student Scientific Society of Poznań University of Medical Sciences, Poznań, Poland

ABSTRACT

A common problem encountered in hospital emergency departments is inadequate assessment and management of pain in paediatric patients. Research shows that this is a worldwide issue, with younger patients being at greater risk of not receiving appropriate treatment. Poorly managed pain not only worsens patients' quality of life but also increases mortality and can have negative effects on child development. The aim of this study was to gather and analyse available scientific knowledge on pharmacological and non-pharmacological methods of pain management in children, considering their potential applications in hospital emergency departments. The results of this review might be used to implement optimum strategies for acute pain management, thereby contributing to improved comfort, diagnostic and treatment conditions, and thus quality of care.

KEY WORDS:

emergency department, quality of care, pain management.

INTRODUCTION

It is widely accepted that both premature infants, newborns, young infants, and older children, at every stage of development, experience pain and deserve appropriate treatment, regardless of their age and level of development. However, pain management in paediatric populations remains a complex and often inadequately addressed issue, particularly in emergency department (ED) settings [1, 2]. Poorly managed pain can result in increased morbidity and mortality, negatively impacting the quality of life, prolonging recovery, and leading to long-term developmental consequences, especially in newborns and young infants. These include alterations in brain plasticity, heightened stress response, and behavioural changes later in life [3]

Despite significant advances in medical knowledge and technology, pain in children is still underassessed

and undertreated. Paediatric patients often receive lower doses of analgesics than adult patients for similar diagnoses, and younger children are less likely to receive appropriate analgesia [4]. Several studies have highlighted a prevalent reluctance among healthcare providers to administer opioids to paediatric patients due to concerns over potential side effects, such as respiratory depression and opioid dependence. This hesitancy often leads to suboptimal pain management. This disparity in care stems from various factors, including healthcare provider biases, fears surrounding side effects, and communication challenges when evaluating pain in younger children.

The purpose of this narrative review is to consolidate available knowledge on both pharmacological and non-pharmacological methods for paediatric pain management, with a focus on their application in hospital ED. We also aim to highlight gaps in current practices and

ADDRESS FOR CORRESPONDENCE:

Dr. Tomasz Kłosiewicz, Department of Medical Rescue, Poznań University of Medical Sciences, Poznań, Poland, e-mail: tklosiewicz@ump.edu.pl

identify evidence-based strategies to enhance paediatric pain assessment and treatment.

PAIN ASSESSMENT IN CHILDREN

Effective pain management requires ongoing evaluation of its presence, intensity, and the child's response to the treatment provided. In paediatric populations, this is especially challenging due to developmental and language limitations that affect a child's ability to understand and self-report pain. Assessing paediatric pain often relies on caregivers and healthcare providers interpreting behavioural and physiological cues, while factors such as age, gender, and race can influence pain perception [5]. There are 3 primary methods of assessing pain in children:

- self-report: the child's own verbal or non-verbal expression of pain,
- behavioural indicators: observable behaviours that may signal pain,
- physiological indicators: bodily responses that may indicate pain, such as changes in heart rate or blood pressure [5].

Self-report scales are used for children who are mature enough to understand them, not overly stressed, and have no cognitive impairments. It is essential to note that no self-report scale is universally applicable across all paediatric age groups. One of the most widely used self-report tools is the numeric rating scale (NRS), which measures pain on a scale from 0 (no pain) to 10 (worst possible pain). The numeric rating scale is closely related to the visual analogue scale (VAS), a graphic version of pain intensity assessment, and the faces pain scale-revised (FPS-R), which uses facial expressions to help children communicate their pain. A modified paediatric version of the VAS can be used with children as young as 3 years old. Studies have shown that school-aged children (6–16 years old) tend to prefer the FPS-R over the NRS [6, 7]. Among the available facial pain scales, 4 are considered reliable: the faces pain scale, FPS-R, Wong-Baker faces pain rating scale, and the ouchers pain scale [8, 9]. Each of these scales offers visual cues to help children express their pain levels. However, according to Bailey *et al.*, only the VAS and the colour analogue scale show acceptable agreement in children experiencing moderate to severe acute abdominal pain [10].

For children younger than 8 years old the EVENDOL score may be used as appropriate. It comprises 5 items:

- vocal/verbal expression (cries and/or screams and/or moans and/or complains of pain),
- facial expression (furrowed forehead and/or frown, furrowed or bulging brow, and/or tense mouth),
- movements (restlessness, agitation, and/or rigidity and/or muscular tenseness),
- postures (unusual and/or antalgic posture and/or protection of the painful area and/or immobility),

- interaction with environment (can be comforted and/or interested in playing and/or interacts with people).

The EVENDOL score has been validated also for pre-hospital use. Importantly, fever did not have an impact on the EVENDOL score [11].

Children with polyhandicap and children who are not yet verbal present unique challenges in pain assessment. They often cannot articulate their pain, requiring caregivers and clinicians to interpret nonverbal cues. In polyhandicap children, expressions of pain may differ from typically developing children. For example, they might display agitation, changes in tone, or withdrawal rather than crying or verbal complaints. Many polyhandicapped children experience chronic pain due to underlying conditions such as spasticity, gastrointestinal discomfort, or orthopaedic deformities, complicating the differentiation of acute pain episodes. The face, legs, activity, cry, consolability scale is a behavioural pain assessment tool commonly used to evaluate pain in non-verbal or preverbal populations, such as infants, young children, or individuals with cognitive impairments. It is particularly useful for assessing pain in patients who cannot self-report, offering a systematic and objective approach to pain evaluation. Establishing a baseline of normal behaviour, crucial for detecting deviations indicative of pain assessments, should consider situational factors, such as recent medical interventions, positioning, or potential sources of discomfort [12] (Table 1).

NON-PHARMACOLOGICAL METHODS

The primary non-pharmacological approach to pain management in paediatric patients is distraction, which involves redirecting the child's focus away from pain toward more enjoyable activities [13]. Distraction techniques are typically divided into 2 categories: active techniques, such as using toys, computer games, or virtual reality (VR), and passive techniques, like listening to music or watching movies. Distraction is widely accepted as an effective method for managing pain, as supported by numerous scientific studies [13] and pain management guidelines [14]. However, identifying the most effective distraction method for children remains challenging. The choice of distraction should be based on local resources, financial capacity, and staff expertise, because not all methods are feasible in an ED setting. Utilising a combination of non-pharmacological techniques can also enhance effectiveness [13].

One of the oldest and most recognised forms of distraction is music, which has been shown to effectively reduce anxiety and pain in children undergoing medical and dental procedures [15]. With advancements in technology, VR has emerged as a popular and promising method for diverting attention. Studies involving VR have reported highly positive results, particularly in alleviating pain and anxiety associated with procedures involving

TABLE 1. Aligns pain intensity categories with specific steps of the analgesic ladder, corresponding to the appropriate level of analgesic intervention

Scale	Description	Steps of analgetic ladder		
		Step 1 (mild pain), non-opioids	Step 2 (moderate pain), weak opioids with non-opioids	Step 3 (severe pain), strong opioids with non-opioids
FPS-R	Scores are based on a visual depiction of faces, with values ranging from 0 (no pain) to 10 (max pain)	0–3	4–6	7–10
VAS	A 10-cm line on which 0 represents no pain, and 10 represents the worst imaginable pain	0–3	4–6	7–10
NRS	A verbal or written numeric scale ranging from 0 (no pain) to 10 (worst pain)	0–3	4–6	7–10
FLACC	Observational tool for non-verbal populations; scores 0–10 based on facial expressions, leg movement, activity, cry, and consolability	0–3	4–6	7–10
WBFRS	Uses illustrated faces corresponding to scores from 0 (no pain) to 10 (most pain)	0–2 faces	3–4 faces	5–6 faces

LACC – face, legs, activity, cry, consolability, FPS-R – faces pain scale-revised, NRS – numeric rating scale, WBFRS – Wong-Baker faces pain rating scale, VAS – visual analogue scale

needles [16]. As an active form of distraction, VR appears to be more effective than some passive methods [17].

Another commonly used technique is the presence of hospital clowns. Laughter physiologically stimulates the release of beta-endorphins, chemicals similar to opioids. A meta-analysis by Fusetti *et al.* demonstrated that children undergoing vein cannulation in the presence of clowns experienced less pain and anxiety compared to those undergoing standard procedures [18].

Desensitisation is another technique, which involves gradually familiarising the child with the procedure before it takes place. For example, a false but realistic magnetic resonance imaging machine could be used to help children become comfortable with the procedure without reducing the availability of the actual machine [19].

Parental involvement is also crucial in managing paediatric pain. Studies show that parental anxiety is a predictor of a child's anxiety. However, when parents react positively using appropriate language, distraction techniques, or anxiety-coping strategies, it can reduce their child's perception of pain. Thus, parents should be seen as part of the medical team [20].

A cognitive approach can also be effective. This involves providing children with age-appropriate information about the upcoming procedure. Medical games, where children can play with medical tools or act out clinical scenarios with dolls, are a helpful way to prepare them [21]. It is essential that children are informed about what to expect during the procedure and what sensations they may experience. They should be encouraged to ask questions and, when appropriate, make certain choices. Adolescents, in particular, should be given the option to maintain as much privacy as possible, including the choice of whether or not their parents are present during the procedure.

The appearance and environment of the ED can also impact stress levels. Research has shown that a colourful, child-friendly environment equipped with toys, books, and interactive devices can significantly reduce the stress associated with hospital visits for both children and adults [22].

Another non-pharmacological factor that can influence pain perception is the attire of medical staff. A study conducted during the COVID-19 pandemic found that hospital personnel wearing surgical masks in triage reported less frequent pain occurrences and fewer cases of pain intensity greater than 4/10, compared to personnel wearing full-face masks [23].

The language used by medical staff when addressing children is also important. Avoiding medical jargon, threats, bribery, and dishonesty helps maintain trust and ensures a more comfortable experience for the child [24].

While the idea of involving therapy animals to distract paediatric patients has been explored, a meta-analysis of 9 studies did not find sufficient evidence to support the routine use of this practice in ED [25].

Sucrose administration is a widely recognised non-pharmacologic intervention for alleviating procedural pain in infants. The analgesic effect of sucrose is primarily attributed to its sweet taste, which activates endogenous opioid pathways, leading to pain modulation. This mechanism is particularly effective in neonates and young infants, who exhibit a pronounced analgesic response to sweet-tasting solutions. A comprehensive review of controlled trials involving over 7000 infants concluded that oral sucrose significantly reduces pain responses during minor procedures such as heel lance, venipuncture, and intramuscular injections. No serious adverse events associated with sucrose use are noted. Administration is typically performed orally, either by placing the sucrose solution directly onto the infant's tongue or *via* a pacifi-

TABLE 2. The initial dosage of analgesic medication in children in the emergency department

Medication	Route of administration	Dose		
		Infants < 10 kg [mg/kg]	Children < 50 kg [mg/kg]	Children > 50 kg [g]
Paracetamol	Intravenous, oral	10	15	1
Metamizol	Intravenous, oral	8–15	10–15	1
Ibuprofen	Intravenous, oral	10		
Morphine	Intravenous	0.25–0.1		
Fentanyl	Intravenous	1–2		
Tramadol	Intravenous	1–1.5		
Nalbuphine	Intravenous	0.1–0.2		
Ketamine	Intravenous	0.3		
Lidocaine	Intravenous	1.5		

er dipped in the solution. The minimally effective dose of 24% sucrose required to treat pain associated with a single heel lance in neonates is 0.1 ml. The timing of administration is crucial; delivering sucrose approximately 2 minutes before the painful procedure optimises its analgesic effect [26, 27].

PHARMACOTHERAPY

For clarity, appropriate dosages of the medicines discussed in the review are summarised in Table 2.

IBUPROFEN

Ibuprofen is the most extensively studied non-steroidal anti-inflammatory drug (NSAID) for the treatment of acute pain in paediatric populations [28]. It is available in oral, rectal, intravenous, and topical forms. In children with uncomplicated fractures, ibuprofen has been found to be as effective as morphine, with significantly fewer adverse effects [29]. For acute traumatic extremity pain, ibuprofen is also more effective than codeine or paracetamol, and as effective as combinations of paracetamol-codeine or oxycodone [30–32]. Research has shown that using a combination of ibuprofen and paracetamol allows for a reduction in the doses of both drugs, potentially minimising side effects [33]. While a few studies suggest ibuprofen may have an opioid-sparing effect, the evidence remains limited [28].

Due to the lack of comprehensive studies on NSAIDs in infants, ibuprofen is recommended primarily in children over 3 months old.

PARACETAMOL (ACETAMINOPHEN)

Paracetamol is the most commonly used non-opioid analgesic in children [34]. While its exact mechanism of action remains incompletely understood, it is thought to inhibit prostaglandin synthesis in the central nervous system, affect the endocannabinoid system, modulate

the 5-HT₃ serotonin receptor subtype, and inhibit nitric oxide (NO) synthesis through the L-arginine/NO pathway, which is activated by substance P and NMDA receptors [35]. Paracetamol has both analgesic and antipyretic properties, though it lacks an anti-inflammatory component. It is considered the safest pain-relief agent for all age groups, with few limitations, the most notable being hepatotoxicity at high doses. Paracetamol is used either on its own or as part of multimodal analgesia and is available in oral, rectal, and intravenous forms.

METAMIZOLE

Metamizole is an analgesic and antipyretic drug with a spasmolytic effect. It works by inhibiting prostaglandin synthesis through the suppression of cyclooxygenase (COX-1 and COX-2) activity, altering nociception induced by substance P, and affecting the cannabinoid system. Its antispasmodic effects are due to the inhibition of adenosine reuptake in the central nervous system [34]. Metamizole is an effective choice for acute pain with a spasmodic component. However, its use has been restricted in the U.S. and some European countries due to concerns over agranulocytosis. Recent studies report that the incidence of agranulocytosis following metamizole use is between 0.46 and 1.63 cases *per* million [36].

Metamizole is available in oral and intravenous forms. Findings from 4 observational studies, involving 1254 patients, suggest that intravenous metamizole is more effective than intravenous paracetamol; however, randomised trials indicate that both drugs have comparable effects [37]. Additionally, both oral metamizole and ibuprofen are equally effective in reducing fever in children without significant differences [38].

KETAMINE

Ketamine has become increasingly important in ED due to its unique pharmacological properties. It is an NMDA receptor antagonist, contributing to its anaes-

thetic, analgesic, and dissociative effects, while also interacting with opioid receptors, AMPA receptors, and voltage-gated calcium channels. Ketamine is one of the most commonly used sedative and anxiolytic agents [39].

At lower doses, ketamine provides analgesia, while higher doses induce dissociative anaesthesia. It is frequently used for procedural sedation and analgesia in emergency settings, especially for painful procedures or in uncooperative paediatric patients. A key advantage of ketamine is the variety of administration routes: intranasal, intramuscular, intravenous, and nebuliser. Intranasal administration is particularly beneficial for children due to its painless delivery, and intramuscular administration can be performed effectively in uncooperative patients. Intranasal ketamine has been shown to be both safe and effective. Common adverse effects include vomiting, agitation, hypoxia, and apnoea, occurring at rates of 56, 18, 15, and 7 cases *per* 1000, respectively. Serious adverse events are rare, with an incidence below 0.03%. In a study involving over 13,000 children, serious adverse events were reported in only 33 cases, with 4 requiring intubation [39].

OPIOIDS

Opioids are a class of medications that interact with μ , κ , and δ receptors located on the cell membranes of neurons in both the central and peripheral nervous systems. When these receptors are activated, they stimulate pathways that inhibit pain transmission within the nervous system. Although opioids are highly effective for pain relief, they can cause serious side effects, such as excessive sedation and respiratory depression. However, these adverse effects are relatively rare when opioids are properly dosed. The pharmacokinetics and pharmacodynamics of opioids in children differ from those in adults, primarily due to variations in factors such as serum protein levels, distribution volumes, body composition, liver function, and kidney function. Consequently, paediatric patients require different dosing *per* kilogram of body weight compared to adults [40]. Opioids are recommended as first-line treatment for severe pain in cases of trauma and burns. In Polish ED, the most commonly available opioid medications are morphine and fentanyl.

MORPHINE

Morphine is a potent opioid classified as a step III drug on the World Health Organisation's analgesic ladder. In Poland, morphine is available in several forms, including tablets, injectable solutions, oral drops, and oral solutions.

Morphine acts as an agonist at μ , κ , and δ opioid receptors. It is metabolised in the liver into 2 major metabolites: morphine-3-glucuronide and morphine-6-glucuronide, both of which contribute to its therapeutic effects and side effects. Morphine increases the release of histamine, which can lead to hypotension following its administration. Both morphine and its metabolites are primarily excreted by the kidneys.

Morphine is approved for use in children experiencing severe pain that cannot be adequately controlled with non-opioid analgesics. The maximum initial recommended dose for pain control is 0.1 mg/kg [34].

FENTANYL

Fentanyl is another potent opioid, also classified as a step III drug on the analgesic ladder. It is available in a variety of forms in Poland, including buccal tablets, sublingual tablets, nasal aerosols, injectable solutions, and transdermal patches. Fentanyl primarily acts as an agonist at μ opioid receptors and is approximately 100 times more potent than morphine when administered in equivalent doses. Unlike morphine, fentanyl does not cause significant histamine release, thus reducing the risk of hypotension. It has a rapid onset of action and a short duration, making it ideal for use in situations where short-term pain relief is needed, such as during brief procedures in paediatric ED [41]. The recommended dose of fentanyl for paediatric patients varies depending on the route of administration, with intranasal fentanyl often used for quick, short-term analgesia during minor medical procedures. The recommended initial dose for intravenous fentanyl is 1–2 μ g/kg [34].

NALBUPHINE

Nalbuphine is a synthetic opioid analgesic classified as a mixed agonist-antagonist. It functions as an agonist at κ opioid receptors and an antagonist at μ opioid receptors in the medulla and cerebral cortex. This dual mechanism provides effective analgesia with a reduced risk of certain adverse effects commonly associated with pure MOR agonists.

As a κ agonist, nalbuphine induces analgesia and sedation. Its μ antagonism contributes to a ceiling effect on respiratory depression, meaning that increases in dosage beyond a certain point do not proportionally enhance respiratory depression. This characteristic distinguishes nalbuphine from pure μ agonists, which lack such a ceiling effect. Therefore, the safety profile of nalbuphine is favourable. Adverse reactions are rare when compared to other opioids and include sedation, nausea, vomiting, and pruritus. Nalbuphine provides effective analgesia for moderate to severe pain. For paediatric patients is administered *via* intramuscular, intravenous, or subcutaneous routes. The typical dosage is 0.1–0.2 mg/kg [34, 42]. Nalbuphine is not recommended for children below 18 months of age.

TRAMADOL

Tramadol is weak opioid agent. Its unique mechanism of action, combining opioid receptor agonism with monoamine reuptake inhibition, distinguishes it from traditional opioids.

Typical opioid side effects are rare with the use of tramadol, making this analgesic a useful analgesic option. Patients may experience nausea, dizziness, constipation, headache, and somnolence. Tramadol can lower the seizure threshold, particularly at higher doses or when combined with other medications that also reduce seizure threshold. Due to its serotonergic activity, tramadol carries a risk of serotonin syndrome. Therefore, tramadol is not indicated in patients taking serotonergic drugs or in those with underlying seizure disorders. The typical dosage for tramadol is 1–1.5 mg/kg > 1 year of age [34, 43].

LIDOCAINE

Lidocaine, an amino amide local anaesthetic, has been extensively used in clinical practice due to its ability to block the initiation and propagation of nerve impulses by inhibiting voltage-gated sodium channels in nerve fibres. This inhibition effectively prevents the transmission of pain signals, making lidocaine a reliable and versatile option for pain management. In addition to its local anaesthetic properties, lidocaine can modulate sympathetic smooth muscle tone by reducing transmission through afferent sensory pathways, further contributing to its analgesic effects.

Lidocaine has been studied in various fields of emergency medicine, demonstrating efficacy in treating a wide range of pain conditions, including visceral and central pain, renal colic, pain in terminally ill patients, and headaches. Its ability to reduce the need for opioid analgesics has been particularly significant. Studies show that the use of lidocaine can decrease opioid consumption and associated side effects, making it a safer option for pain management, especially in patients at risk of opioid-related complications [44].

Intravenous lidocaine has gained attention for its use in acute pain management in emergency settings. Dosing and infusion duration vary across studies, but a common approach is a dose of 1.5 mg/kg, often administered over a short infusion period. This dosage has been found to be effective in reducing pain without causing significant adverse events [45].

A large Cochrane systematic review of perioperative pain management, which included over 2500 patients, found no reports of serious adverse events associated with lidocaine use. The review supports lidocaine's safety and efficacy as a perioperative analgesic and highlights its minimal side-effect profile compared to other pain management agents [46].

Lidocaine is well-tolerated across various populations, and its safety, combined with its opioid-sparing effects,

makes it an ideal choice for pain management in emergency settings. Its versatility, minimal risk of serious side effects, and efficacy in a range of pain conditions ensure its continued relevance in both acute and chronic pain management protocols.

NITROUS OXIDE

Nitrous oxide is an effective but often underutilised agent for paediatric sedation in emergency care. It enhances the depth of sedation, with patients typically achieving a score of 2 vs. 1 on the Michigan sedation scale, allowing access to a broader range of painful procedures. Nitrous oxide has a high sedation efficacy, ranging 80.5–97.4%, with its effectiveness being inversely related to the child's age, decreasing as the child gets older [47].

When administered as a 50/50 mixture of nitrous oxide and oxygen, around 80% of paediatric patients report feeling no pain, accompanied by significant calming effects. This concentration is considered optimal, balancing effective sedation with a low risk of adverse effects. Higher concentrations may increase the likelihood of side effects, underscoring the importance of dosage control. Nitrous oxide is particularly useful for less painful procedures because its efficacy decreases with increasing pain intensity. However, its safety profile makes it a highly attractive option in paediatric emergency care [48].

One of nitrous oxide's major advantages is its minimal risk of serious side effects. This allows for sedation to be administered by trained healthcare staff, including nurses, with no significant difference in the incidence of adverse events between doctors and non-physician staff members [49]. Additionally, its low blood-gas coefficient ensures rapid onset of sedation and a quick recovery of consciousness upon discontinuation, making it ideal for short procedures like intravenous cannulation. Parental, paediatric, and physician satisfaction with nitrous oxide sedation is high, with reported satisfaction levels of 97%, 89%, and 96%, respectively [50]. A low prevalence of adverse events was reported (6.5%), with vomiting as the most common (2.4%). The combination of nitrous oxide with other sedative agents, particularly opioids, has been shown to increase the risk of adverse effects [51].

TOPICAL ANAESTHETICS

An alternative option for anaesthesia in paediatric ED is local anaesthesia, which offers a painless method of application directly to the site of injury. Commonly used agents for local anaesthesia include lidocaine, tetracaine, and prilocaine, often combined with a vasoconstrictor like epinephrine to prolong their duration of action. These agents are frequently used in formulations that do not penetrate the skin layers, such as EMLA patches or gels (a combination of lidocaine and prilocaine) and gel or solution (a combination of lidocaine, epinephrine,

and tetracaine). These combinations are effective for procedures such as venous cannulation, circumcisions, and perianal blockades. However, local anaesthetics do not provide an anxiolytic effect, so they should be used in conjunction with either non-pharmacological methods or nitrous oxide to manage anxiety in children. It is important to allow topical anaesthetics to remain on the skin for 30–60 minutes prior to the procedure for optimal effectiveness [52].

CONCLUSIONS

Patient safety is a paramount consideration in the assessment and management of pain in paediatric ED. Ensuring safety requires well-trained medical personnel. Healthcare providers must possess advanced competencies in paediatric pain assessment, including familiarity with age-appropriate pain scales, non-verbal indicators, and contextual factors affecting pain perception in children. Regular training programs, simulation exercises, and interdisciplinary collaboration enhance the ability of staff to deliver safe, effective, and timely pain management.

Continuous observation of vital signs, including heart rate, respiratory rate, oxygen saturation, and blood pressure, should be integral to paediatric pain assessment protocols. Coupled with behavioural observations, this approach provides a comprehensive understanding of the child's condition and safeguards against complications.

Modern pain therapy should combine non-pharmacological methods, pharmacotherapy, and collaboration with parents. The medications available in EDs are generally safe, with severe side effects being rare. Technologies like VR and multimedia offer affordable, innovative solutions for pain management.

Despite advances, paediatric pain management and the prevention of distress during necessary procedures in the ED require further attention and promotion.

Even for minor procedures such as blood draws, intravenous access, and injections, we strongly recommend pain-reducing strategies, including topical anaesthetics, nitrous oxide, comfortable positioning, and age-appropriate distractions.

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