REVIEW ARTICLE

Pediatric pain: SMARTER , SAFER, KINDER: a narrative review

Yara AlGoraini[1*], Sergey Motov[2]

ABSTRACT

Background: Although pain is one of the most frequent reasons for pediatric emergency department (ED) visits, it continues to be underappreciated, underassessed, and undertreated. Despite the availability of validated pain scales and evidence-based pharmacological and non-pharmacological strategies, many children leave the ED without adequate relief. The consequences of poorly managed pain extend beyond immediate encounters with psychological and physiological sequelae that may persist into adulthood.

Methods: A structured narrative review was conducted using PubMed, MEDLINE, and the Cochrane Library from January 2013 to July 2025. The search terms included "pediatric pain," "analgesia," "ED," "multimodal analgesia," "non-pharmacologic," "opioid safety," and "family-centered care." The inclusion criteria included randomized controlled trials, systematic reviews, meta-analyses, and high-quality observational studies focusing on acute pediatric pain in the ED. Studies confined to chronic or perioperative pain without ED relevance were excluded.

Results: This review presents recent advances in pediatric pain management and introduces the practical mnemonic Systematic, Multimodal, Awareness, Reassessment, Targeted treatment, Empowering, Resource utilization (SMARTER), Safety, Avoid dangerous analgesics, Fail-safe pain management, EHR integration, Risk mitigation (SAFER), Kid-centered, Integrated non-pharmacologic support, Nurturing environment, Dignity preservation, Engagement, Reduction of procedural distress (KINDER) as a structured framework for clinicians. This mnemonic highlights systematic assessment, multimodal approaches, patient safety safeguards, and child- and family-centered care as essential principles for improving pediatric pain management practices. By integrating these domains, clinicians can address not only the technical aspects of analgesia but also the dignity and developmental needs of children with pain.

Conclusions: The mnemonic SMARTER, SAFER, KINDER integrates systematic assessment, multimodal and safe pharmacology, and compassionate family-centered care. The adoption of this framework can bridge the gap between evidence and practice, ensuring systematic, vigilant, and humane pediatric pain management.

Keywords: Pediatric pain, management, narrative review, emergency department.

Introduction

Although pain is the most common reason for children presenting to the emergency department (ED), studies have consistently shown that it remains underappreciated, underassessed, and undertreated [1-4]. Compared with adults, children are less likely to receive timely analgesia and more likely to experience delays or undertreatment of moderate to severe pain [5]. The consequences of inadequate treatment are significant, contributing not only to immediate distress but also to long-term outcomes such as altered pain thresholds, chronic pain syndromes, anxiety, and healthcare avoidance [6-8]. Untreated procedural pain in infancy can lead to central sensitization and adverse developmental effects [7,8]. Moreover, disparities in pain management persist, as minority children are less likely to receive opioid prescriptions than their peers despite presenting with similar clinical conditions [5,7]. Thus, addressing pediatric pain is both clinically and ethically imperative.

Recent advancements include the broader adoption of validated pain scales, increased use of intranasal (IN) medications, and the integration of child life specialists [9-14]. However, wide variability remains in practice, with persistent knowledge gaps and

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systemic barriers (Table 1). To address this issue, we propose a mnemonic framework, Systematic, Multimodal, Awareness, Reassessment, Targeted treatment, Empowering, Resource utilization (SMARTER), Safety, Avoid dangerous analgesics, Fail-safe pain management, EHR integration, Risk mitigation (SAFER), Kid-centered, Integrated non-pharmacologic support, Nurturing environment, Dignity preservation, Engagement, Reduction of procedural distress (KINDER), which organizes evidence-based principles into memorable settings.

Materials and Methods

A structured narrative review was conducted using PubMed, MEDLINE, and the Cochrane Library from January 2013 to July 2025. The search terms included "pediatric pain," "analgesia," "ED," "multimodal analgesia," "non-pharmacologic," "opioid safety," and "family-centered care." The inclusion criteria included randomized controlled trials, systematic reviews, meta-analyses, and high-quality observational studies focusing on acute pediatric pain in the ED. Studies confined to chronic or perioperative pain without ED relevance were excluded. Additional references were identified by reviewing the bibliographies of key review articles. Data were thematically synthesized and organized into the SMARTER, SAFER, and KINDER frameworks. To enhance transparency, we developed a flow diagram adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 model to illustrate the literature identification, screening, eligibility, and inclusion processes for this narrative review (Figure 1).

Table 1. *Barriers to optimal pediatric pain management in the ED.*

Category	Examples
Underappreciation	Misconception that children feel less pain and misattribution to behavioral pathology
Underassessment	Inappropriate pain scales, racial/ethnic bias, and fast-paced ED environment
Undertreatment	Opiophobia, lack of pharmacologic knowledge, implicit bias, and suboptimal protocols

The SMARTER approach: systematic and evidence-driven

Systematic assessment is the cornerstone of effective pediatric pain care (Table 2). Pain assessment should be mandatory at triage and repeatedly documented during ED care. Validated scales such as Faces, Legs, Activity, Cry, Consolability, Wong-Baker FACES, and Numeric Rating Scales are widely recommended but inconsistently applied [1-4,15]. Their routine use increases the provision of analgesia and reduces the time to treatment [8]. Beyond purely quantitative scoring, a biopsychosocial approach recognizes parental anxiety, cultural norms, and the child's emotional state as key influences on the child's pain experience [9].

The management of pediatric pain should be multimodal, including a combination of pharmacological and non-pharmacological treatment approaches (Table 3).

Acetaminophen and ibuprofen administration is safe and effective against mild-to-moderate pain, with ibuprofen often demonstrating superior efficacy [16,17]. For moderate-to-severe pain, IN fentanyl provides rapid analgesia while preventing the need for intravenous (IV) access [18,19]. Ketorolac, whether IV, IN, or sublingual (SL), has been shown to be non-inferior to opioids in migraine and musculoskeletal pain [3,20,21]. Tramadol and codeine are no longer recommended owing to their unpredictable metabolism and safety risks [2,22]. Regional blocks, nitrous oxide, and topical anesthetics should be considered as part of a multimodal strategy (Table 4).

Awareness of systemic barriers is critical to the successful management of pediatric pain, which focuses on individualized, equitable, and timely pain assessment and management; developmentally tailored pain plans; assessment of family dynamics and prior pain

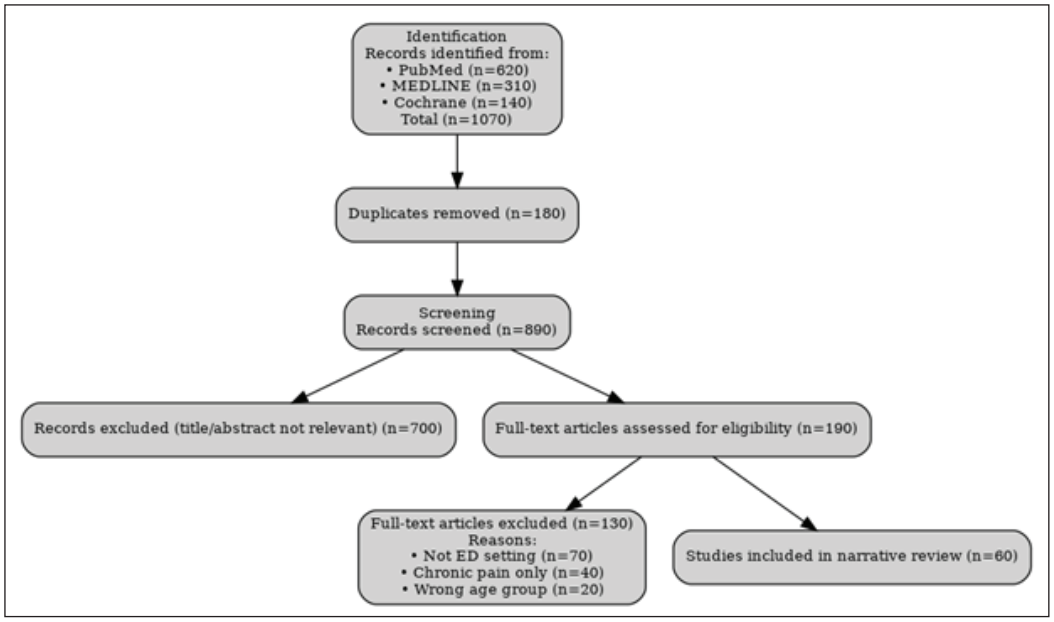

Figure 1. *A flow diagram illustrating our literature identification, screening, eligibility, and inclusion process.*

Table 2. *SMARTER.*

Domain	Focus	Clinical examples
Systematic multimodal assessment	Use age-appropriate tools, triage-based screening	FLACC (infants), FACES (young children), NRS (older children), and parental input
Multimodal analgesia	Layered pharmacologic strategies	Ibuprofen, acetaminophen(paracetamol), IN ketamine/ fentanyl; topical anesthetics, nitrous oxide, ultrasound-guided regional anesthesia (UGRA), and inhaled methoxyflurane
Awareness	Developmentally tailored pain plans	Family dynamic and prior experiences Avoid assumptions based on size or demeanor Listen to the caregiver
Reassessment and titration	Continuous monitoring and dose adjustment	Reassess pain and sedation every 30-60 minutes
Targeted and triage-initiated treatment	Timely and effective analgesic interventions matching pain type and severity	Age-and pain severity-based interventions Topical, oral, IN, nebulized routes and combinations
Empowering the patient/parent/ caregiver	Engaging parents as advocates and partners in pain management	Shared decision-making, education, comfort
Resource utilization	Effective use of EMR, clinical pharmacist, and child life specialist.	ED order sets; AI-facilitated clinical decision support tool

AI: artificial intelligence; ED: emergency department; EMR: electronic medical record; FLACC: Faces, Legs, Activity, Cry, Consolability; NRS: Numeric Rating Scale.

Table 3. *Pediatric pain treatment modalities.*

Non-pharmacological modalities	Pharmacological modalities
Heat/cold application	Acetaminophen
Distraction techniques (cartoons, bubbles, music)	Ibuprofen
Cognitive behavioral therapy (CBT)	Ketorolac (IV, IN, SL) *
Virtual reality (VR)	Fentanyl (IN, IV)
Child life specialist support	Ketamine (IN, IV, short infusion)
Guided imagery, storytelling	Nitrous oxide
Breathing exercises	Regional anesthesia (nerve blocks)
Swaddling/oral sucrose (infants)	Avoid: Codeine, Tramadol

experiences; and avoidance of assumptions based on size or demeanor. Racial disparities in opioid administration have been reported in pediatric EDs, potentially influenced by differences in clinical response to prior analgesics and the timing of escalation to opioid therapy [23], underscoring the need for recognition, education, and vigilance.

Reassessment with a focus on timeliness and documentation of pain intensity and functional improvement is equally important. Pain trajectories frequently change, and without proper re-evaluation, many children remain undertreated [11].

Triage-initiated analgesia programs, where nurses provide analgesics at first contact, significantly reduce the time to analgesia, increase the proportion of children receiving timely pain treatment, and improve parental satisfaction [19,22].

Empowering parents to participate as comforters and advocates contributes to effective family-centered pediatric pain care in the ED, strengthens the therapeutic alliance between the child, parent, and clinician, and improves pain-related outcomes [24,25].

Resource utilization, such as electronic medical record (EMR)-integrated pain management order sets, artificial intelligence (AI)-driven clinical decision trees, and the availability of clinical pharmacists, child life specialists, and consultants, is central to enhancing children's experience and improving clinicians' adherence [26].

The SAFER approach: minimizing risks and maximizing protection

Children are especially vulnerable to medication errors due to weight-based dosing, variable pharmacokinetics, and narrow therapeutic windows (Table 5). Safe dosing and routes must be emphasized, supported by standardized concentrations, weight-based charts, and double-check systems [23,27-29]. IV paracetamol requires strict dosing to avoid hepatotoxicity, while ketamine should be titrated carefully to minimize adverse effects [23,27].

Therefore, the use of certain agents must be avoided. Both the Food and Drug Administration and European Medicines Agency have issued warnings against the use of codeine and tramadol in children under 12 years of age and caution in adolescents owing to unpredictable Cytochrome P450 2D6 (CYP2D6) metabolism leading to toxicity or treatment failure [22,28]. Safer alternatives are widely available, rendering their continued use unnecessary.

The implementation of fail-safe processes can mitigate the risk of preventable harm. Independent double-checks, barcode verification, and "no interruption" medication safety zones are effective safeguards [29,30]. Electronic health record (EHR) integration offers additional layers with built-in dosing calculators, alerts for overdosing or interactions, and embedded pain scales prompting reassessments [26,30]. Beyond technological advances, education remains an essential component; families should be counseled on the safe storage and disposal of prescribed analgesics and recognition of adverse events [26], while providers require ongoing training to reduce knowledge gaps and implicit bias and maintain vigilance in safe analgesic administration [15,18,20] (Table 6).

Table 4. *Commonly used analgesics in pediatric emergency care.*

Drug	Route(s)	Dose	Comments/Notes
Acetaminophen (Paracetamol)	PO, PR, IV	10-15 mg/kg every 4-6 hours (max 75 mg/kg/day or 4 g/day)	IV: give over 15 minutes; monitor cumulative dose for hepatotoxicity
Ibuprofen	PO	10 mg/kg every 6-8 hours (max 40 mg/kg/day)	Avoid if dehydrated, renal impairment, or GI bleed risk
Ketorolac	IV, IM, IN, SL	0.5 mg/kg every 6 hours (max 15 mg/dose; max 60 mg/day)	Useful for migraine, MSK pain; avoid in renal impairment
Fentanyl	IN IV	1-2 µg/kg every 30-60 minutes as needed 0.5-1 µg/kg every 10-20 minutes with titration to effect	IN onset ~5-10 minutes; monitor for respiratory depression
Methoxyflurane (Penthrox®)	Inhaled via a hand-held inhaler	3 mL single-use vial; maximum 6 mL/day (not to exceed 15 mL/week)	• Suitable for children >5 years who can self-administer under supervision • Rapid onset (~4-5 minutes), short duration of effect (~25-30 minutes per vial) • Useful for trauma, fracture reduction, dressing changes • Avoid in significant renal impairment, hepatic disease, or when exposed repeatedly • Contraindicated with concurrent nephrotoxic drugs (e.g., high-dose tetracyclines)
Morphine	IV PO	0.05-0.1 mg/kg IV every 2-4 hours (max 5 mg/dose) 0.2 mg/kg	Use for severe pain; titrate every 20-30 minutes and Reduce dose /avoid in patients with severe renal insufficiency
Hydromorphone	IV	0.015 mg/kg IV every 3-4 hours (max 2 mg/dose)	Use for severe pain, titrate every 15-20 minutes Reduce the dose in severe renal insufficiency
Ketamine (sub-dissociative dose)	IV IN Inhaled	0.1-0.3 mg/kg IV over 10-15 minutes; 1 mg/kg IN 0.75/mg/kg	Provide pre-ketamine administration coaching Monitor for psycho-perceptual adverse effects (feeling of unreality) and provide reassurance
Nitrous oxide	Inhaled (50-70%) in combination with Oxygen	Self-administered under supervision	Fast onset/offset; avoid in pneumothorax, bowel obstruction
Topical lidocaine (e.g., EMLA)	Topical	Apply 1-2 g/10 cm^2, cover for 45-60 minutes	For IV cannulation or minor procedures
Regional anesthesia (nerve block)	Local infiltration, ultrasound-guided nerve blocks	Depends on local anesthetic (e.g., Bupivacaine 0.25%, 2 mg/kg max)	Always calculate max safe dose; monitor for LAST (local anesthetic systemic toxicity)
Safety note: • Avoid codeine and tramadol (unpredictable metabolism, Food and Drug Administration/European Medicines Agency contraindications in children <12 years). • Always dose mg/kg and check maximum daily limits. • Reassess pain/sedation every 30-60 minutes when opioids or ketamine are used.			

EMLA, eutectic mixture of local anesthetics; MSK, musculoskeletal pain.

Table 5. *SAFER.*

Domain	Focus	Clinical examples
Safety in dosing and choice of routes and drugs	Accurate mg/kg dosing; avoidance of contraindicated meds	IV paracetamol, titration of opioids, sub-dissociative dose ketamine (short infusion)
Avoid dangerous analgesics and combinations	Elimination of dangerous analgesics and their combinations	Tramadol and codeine combination of opioids with benzodiazepines, muscle relaxants, gabapentinoids
Fail-safe pain management processes	Create/incorporate processes that detect, prevent, and respond to pain treatment-related complications	Reassess pain regularly Reassess sedation, respiratory rate, and consciousness Use of order sets with embedded dosing safeguards
EHR integration	Built-in alerts and dosing calculators	Overdose warnings Drug-Drug interactions warnings
Risk mitigation education	Parental education and counseling on side effects and storage	Staff education on red flags for the toxicity of commonly used analgesics Parental counseling on side effects and storage Parental education on the need for strict adherence to the RX dosing and frequencies

The KINDER approach: compassionate, developmentally sensitive, and child-centered

The KINDER framework emphasizes the human dimension of pain (Table 7).

Child-centered communication is critical for effective and efficient pain management, with a focus on developmentally appropriate language, avoidance of words that amplify fear, and positioning comfort rather than restraint [31].

The integration of non-pharmacological methods, such as distraction, storytelling, breathing techniques, virtual reality (VR), oral sucrose, swaddling, and facilitated tucking, is highly effective in creating positive experiences for infants and young children experiencing pain [32].

A nurturing environment and emotional well-being are paramount to decreasing fear, stress, and anxiety among children. Reducing unnecessary separation

Table 6. *Safety pearls in pediatric analgesia.*

Pearl	Explanation
Always dose per mg/kg	Reduces overdose risk
Avoid codeine and tramadol	Unpredictable CYP2D6 metabolism
Double-check high-risk meds	Opioids, ketamine
Use standardized concentrations	Prevents dilution errors
Reassess pain and sedation q30-60 minutes	Prevents under/over treatment
Counsel parents on safe storage	Prevents accidental ingestion
Avoid combining opioids with benzodiazepines/gabapentinoids/muscle relaxant	High risk of respiratory depression
Use EHR dosing calculators and alerts	Adds systemic safeguards

Table 7. *KINDER- compassionate and family-centered.*

Domain	Focus	Clinical examples
Kid-centered communication	Age-appropriate approach, language, and autonomy	"This is medicine to help your body feel better," offer choices
Integrated non-pharmacologic support	Distraction, positioning, behavioral methods	Bubbles, VR, cold spray, and guided imagery.
Nurturing environment and emotional well-being	Child-Parent-Physician Partnership Emotionally safe and welcoming approach	Familiar items, child life specialists, comfort position
Dignity preservation	Respect, communication, participation,	Comfort-first approach: Use of EMLA, bundled procedures, and reducing unnecessary IVs
Engagement with family	Parents as active allies for comforting, explaining, and advocating	Parental presence and active participation in the encounter; education before discharge
Reduction of procedural distress	Gentle handling, prep, and recovery	Comfort holds, storytelling, countdowns, breathing games

EMLA, eutectic mixture of local anesthetics.

from caregivers, acknowledging emotional pain, and validating fear can ensure safer experiences [33].

Preserving dignity through age-appropriate explanations and involving children in the decision-making process strengthens trust and resilience [34].

Engagement with families beyond passive presence supports parental involvement in comforting the child and decision-making, reduces anxiety, and improves the treatment outcomes [24,25].

Procedural distress can be reduced with anticipatory guidance, topical anesthetics, bundling of interventions, and observation of recovery [35,36]. Every encounter is an opportunity not only to treat pain but also to build resilience.

Results

A total of 1,070 records were identified (PubMed 620, MEDLINE 310, and Cochrane 140), of which 180 duplicates were removed, leaving 890 records for screening. After title and abstract review, 700 were excluded, and 190 full-text articles were assessed. Of these, 130 were excluded for reasons including non-ED setting ($n = 70$), chronic pain only ($n = 40$), and wrong age group ($n = 20$). Ultimately, 60 studies were included in this narrative review (Figure 1). These comprised randomized controlled trials, systematic reviews, meta-analyses, and high-quality observational studies. The findings were thematically synthesized into the SMARTER, SAFER, and KINDER frameworks: validated pain scales were shown to improve timeliness of analgesia, multimodal approaches (acetaminophen, ibuprofen, IN fentanyl, ketorolac, and regional blocks) outperformed single agents, and triage-initiated analgesia and EMR-based order sets reduced delays; codeine and tramadol were consistently unsafe due to metabolism variability, while double-check protocols, barcode verification, and EHR dosing safeguards reduced errors; and child-centered approaches including distraction, VR, sucrose, caregiver presence, developmentally appropriate communication, family involvement, and preservation of dignity were found to enhance trust, reduce anxiety, and improve overall outcomes. Collectively, the evidence demonstrates that systematic assessment, multimodal therapy, safety safeguards, and compassionate care significantly improve pediatric pain management in the ED.

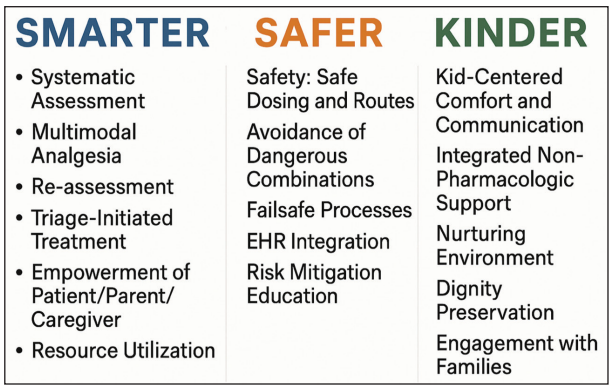

Figure 2. *The SMARTER, SAFER, KINDER framework.*

Discussion

This narrative review aimed to synthesize contemporary evidence on pediatric pain management in the ED and organize it into a practical framework. By systematically reviewing 60 studies, we identified recurring themes and developed the SMARTER, SAFER, KINDER model (Figure 2), which emphasizes systematic assessment, multimodal analgesia, safety safeguards, and compassionate, child-centered care. The novelty of this study lies in the consolidation of diverse evidence into a structured and memorable framework that can serve as a clinical decision aid for busy ED providers, thereby bridging the gap between evidence and practice. Table 6 summarizes the key safety parameters employed to guide clinicians in daily practice.

The most important finding is that consistent use of validated pain assessment tools and multimodal treatment strategies significantly improves timeliness and adequacy of analgesia [1-4,8,15]. This supports prior work demonstrating that underassessment is a major driver of undertreatment in pediatric Ed's

[7,12,13]. The incorporation of nurse-initiated triage analgesia and EMR-based order sets also demonstrates clear systems-level benefits [19,22,26]. A second major finding is the strong evidence base against the use of codeine and tramadol in children, highlighting the importance of safe prescribing and the value of technological safeguards such as barcode verification and embedded dosing calculators [22,28-30]. A third key finding is the impact of non-pharmacological and child-centered approaches - including distraction, caregiver presence, and developmentally appropriate communication - on improving both immediate pain experiences and long-term resilience [24,25,31-34]. These findings collectively highlight the multidimensional nature of pediatric pain and the necessity of addressing biological, psychological, and systemic factors simultaneously.

Several controversies emerged from the review. While opioid avoidance is justified by safety concerns [23], overly restrictive policies risk inadequate treatment of severe acute conditions, such as fractures and abdominal pain. Comparative studies suggest that opioids, when judiciously titrated and combined with multimodal strategies, remain essential for select cases [21,23]. Similarly, although non-pharmacological interventions have shown robust benefits in infants [32,35], the evidence in older children remains mixed [36]. These inconsistencies likely reflect methodological heterogeneity in study design and outcome measures. Nevertheless, the low risk profile of such interventions justifies their routine incorporation [32,36].

The strengths of this review include a structured and transparent methodology, integration of diverse study designs, and the development of a clinically applicable framework. Limitations include the restriction to English-language publications, potential publication bias, and the exclusion of chronic pain and perioperative contexts, which may limit generalizability. Another limitation is that narrative reviews, unlike systematic reviews or meta-analyses, cannot provide pooled effect sizes, and the conclusions remain interpretive rather than quantitative.

Clinically, the SMARTER, SAFER, KINDER framework provides a roadmap for frontline providers to improve pediatric pain outcomes while balancing efficacy, safety, and compassion. However, barriers to implementation remain, including knowledge gaps [15,18,20], implicit bias [23,36], and limited availability of child life specialists and VR-based distraction tools [24,25,32,37]. To overcome these limitations, future studies should focus on the development of standardized pain care bundles, integration of decision support into EHRs [26,30], and training programs that embed pediatric pain management into curricula across disciplines [37].

Looking ahead, emerging fields hold promise for transforming pediatric pain care. Pharmacogenomics, particularly CYP2D6 genotyping, may support individualized opioid prescribing [38]. Digital health tools such as AI-powered EHR alerts, mobile applications for reassessment, and VR-based distraction therapies are likely to play a growing role [26,37,39]. Furthermore, simulation-based education and interprofessional training can help reduce variability and foster equity in care [37]. At the institutional level, policies that standardize pediatric pain assessment and management as a fundamental right are essential for sustaining improvements [23,36].

In summary, this review highlights that pediatric pain in the ED remains undertreated despite available evidence-based strategies. The SMARTER, SAFER, KINDER framework provides a novel, structured, and actionable model to guide clinicians in daily practice. By aligning clinical care with evidence, ensuring safety, and prioritizing compassion, pediatric emergency medicine can move closer to the goal of making effective pain relief a universal standard rather than a negotiable element of care.

Conclusion

Despite decades of research, pediatric pain remains underappreciated, underassessed, and undertreated. The mnemonic SMARTER, SAFER, KINDER integrates systematic assessment, multimodal and safe pharmacology, and compassionate family-centered care. The adoption of this framework can bridge the gap between evidence and practice, ensuring systematic, vigilant, and humane pediatric pain management. No child‘s distress should be ignored, and pediatric emergency medicine should lead the way in embedding these principles in routine care. Standardizing pediatric pain management as a right and not an option should be considered a global priority.

Acknowledgement
None.

List of abbreviations

AI	Artificial intelligence
CYP2D6	Cytochrome P450 2D6
ED	Emergency department
EHR	Electronic health record
EMR	Electronic medical record
IN	Intranasal
IV	Intravenous
VR	Virtual reality

Conflict of interest
The authors declare that there is no conflict of interest regarding the publication of this article.

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