Trauma Monthly 2025; 30(2): 1403-1410

10.30491/tm.2025.498740.1801

Trauma Monthly

Narrative Review

An Overview Study on Pain Management in Trauma and Critical Care Patients

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Received 2025-01-08; **Accepted** 2025-02-25; **Online Published** 2025-04-29

Abstract

Introduction: Almost all injured patients endure significant pain. Addressing this pain is essential for their recovery and overall well-being. There are numerous effective pain management options for patients. The primary goal of this study is to comprehensively outline pain management options for trauma and critical care patients, emphasizing helpful pharmacological interventions.

Methods: This study involved both electronic and manual searches to identify all relevant records. The electronic search focused on published studies in English, identified through PubMed, Web of Science, Embase, and Google Scholar. We used a combination of key terms such as acute pain, critical care patients, trauma, emergency, wound, and injury.

Results: Thorough assessment of age-specific pain management strategies to tailor care effectively. Identify the most suitable analgesics to alleviate moderate to severe pain, optimizing patient comfort. Awareness of the serious adverse effects of pain medications, carefully balancing these risks against their therapeutic benefits. Routine monitoring and reassessment of patients to continuously refine and improve their pain management regimens.

Conclusion: By emphasizing these key considerations, we can significantly improve the quality of care for trauma patients, fostering their healing and well-being. To achieve genuinely patient-centered trauma care, it is essential to understand the obstacles to effective pain management and engage in open discussions with patients to identify solutions to overcome these barriers.

Keywords: Pain management, Trauma, critical care patients.

Introduction

The World Health Organization (WHO) highlights a critical issue: injuries are the leading cause of death for men and women aged 15 to 44 years. In fact, by 2020, injuries were set to be the third leading cause of death and disability for all age groups [1]. A major contributor to this alarming statistic is road traffic crashes (RTCs), which result in around 50 million injuries globally each year. It must address this urgent problem to save lives and reduce suffering worldwide [2].

The management of trauma patients with polysubstance abuse presents substantial challenges that cannot be overlooked. These individuals frequently suffer from uncontrolled pain, which forces healthcare providers to increase opioid doses. This escalation creates a dangerous cycle of dependency and tolerance. Furthermore, effective pain management in this group is complicated by unique factors like altered pain thresholds, the possibility of harmful drug interactions, and the looming risk of withdrawal symptoms. Addressing these challenges with tailored strategies is crucial to improving patient outcomes and breaking the cycle of dependency [3].

Pain complaints are one of the most prevalent issues among trauma patients in emergency room settings,

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highlighting the urgent need for effective pain management strategies [4]. Managing pain in elderly patients and children poses unique challenges; elderly individuals often face multiple chronic medical conditions, while children may experience heightened levels of anxiety [5]. Unfortunately, many traumas patient's express dissatisfaction with their pain management, underscoring a critical area for improvement. Moreover, the care of trauma patients is one of the most resource-intensive processes in emergency rooms, particularly those operating under resource constraints. Addressing these challenges is essential to enhance patient care and outcomes in emergency settings [4-6].

Trauma and critical care patients encompass a diverse range of populations, including healthy young athletes, vulnerable children, and frail elderly individuals. To deliver optimal pain management for these patients, practitioners must stay informed and proficient in using modern evidence-based knowledge and practices. Furthermore, the care process is complicated by factors such as multiple injuries, substance abuse, delayed treatment, and psychological or emotional issues that trauma patients may face [7].

There are numerous effective pain management options for patients, such as systemic analgesics, regional anesthesia techniques, and innovative multimodal analgesia strategies that can significantly enhance their comfort and quality of life. Although systemic analgesics like opioids are commonly used, they can result in increased tolerance and dependence, especially in patients with a history of substance abuse. Non-opioid analgesics, including acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs), are valuable tools for managing pain, but often they do not offer enough relief on their own. In contrast, regional anesthesia techniques such as epidural analgesia and peripheral nerve blocks (PNBs) deliver precise pain control with fewer systemic side effects, making them a superior choice for patients seeking effective pain management. Research demonstrates that these methods significantly lower overall opioid usage and serve as highly effective solutions for managing postoperative pain [8].

Physicians often hesitate to raise the dosage of pain medications or analgesics for fear of potential adverse outcomes. There are worries about patients suffering from adverse physiological reactions, including the risk of addiction, fluctuations in hemodynamic stability, and respiratory depression. Moreover, the lack of standardized protocols for the administration of analgesics in the management of acute pain exacerbates these concerns. Addressing these issues is crucial for improving patient care and effective pain management. The primary goal of this study is to comprehensively outline pain management options for trauma and critical care patients, emphasizing helpful pharmacological interventions. The study also advocates for tailored strategies that, through careful evaluation of the injury's nature and severity, achieve superior analgesia while reducing the risk of adverse outcomes.

Methods

This study involved both electronic and manual searches to identify all relevant records. The electronic search focused on published studies in English, identified through PubMed, Web of Science, Embase, and Google Scholar. We used a combination of key terms such as acute pain, critical care patients, trauma, emergency, wound, and injury. All types of studies were included in this review, such as randomized controlled trials (RCTs), descriptive and cohort or case-control. We eliminated case reports, case series, clinical audits, and any publications not in English to ensure a focused and comprehensive analysis.

Two authors conducted a thorough and independent screening of all studies identified in their initial database search. They meticulously evaluated the titles, abstracts, and MeSH terms to ensure that only the most relevant studies met the established inclusion criteria. Studies were included if their titles contained one or more terms related to pain management, trauma, and injury. If there was any uncertainty about whether a study met the inclusion criteria, the study team reviewed the entire paper.

Results

Assessment of pain in trauma patients

Evaluating pain is challenging, as relying on a one-dimensional measurement tool can fail to capture the intricate and varied aspects of pain. To genuinely comprehend and tackle pain, it is essential to embrace a broader perspective that acknowledges its intricate and varied nature. To effectively evaluate treatment outcomes and identify the potential need for additional

medication, it is crucial to maintain a consistent measurement system. This ensures we can accurately refer to the initial pain assessment without changing the scale, allowing for a precise and reliable comparison over time (9). The size of a wound or the amount of blood loss often fails to indicate the true extent of tissue damage, the level of pain experienced, or the required pain relief. This disconnect complicates accurate pain assessment, which is crucial for effective treatment. Fortunately, various standardized unidimensional pain scales have been developed specifically for acute pain assessment, providing a reliable means to evaluate and manage pain effectively (10). The scientific community recognizes the importance of utilizing one-dimensional measurement scales to connect pain intensity with the appropriate treatment options effectively. This approach ensures tailored care for patients, optimizing outcomes and enhancing their overall well-being. In pediatric pain management, it is recommended to use the Wong-Baker (11), FLACC (12), and NRS algometric scales (13) based on the child's age, as supported by the literature. If the score is greater than 4, analgesics should be administered according to the protocols established by the team (14). Understanding the factors mentioned is vital during patient admission history and pain assessment using the Visual Analogue Scale (VAS) and Verbal Rating Scale (VRS) (15). A thorough examination and a deep understanding of pain's intricate and multifactorial nature are key to effectively guiding the prescription of analgesic medications and creating a comprehensive pain management plan. This careful approach enhances patient care and improves overall treatment outcomes (Table 1).

Table 1: The primary pain assessment scales for evaluating trauma in various age groups.

Age level	0-4 years	>4 years
Scale	FLACC, Wong–Baker Faces and	NRS and VAS
Ranking	0-10, 6 scores	NRS: 0: no pain 1 to 3 mild 4 to 6 moderate 7 to 10 severe, VAS: A 100 mm horizontal line, labeled with "No Pain" on the left and "Extreme Pain" on the right.
Interpretation	FLACC: 0 - Relaxed and comfortable. 1 to 3 - Mild discomfort. 4 to 6 - Moderate discomfort. 7 to 10 - Severe discomfort.	To clarify the scoring system: a lower score indicates "No Pain," while a higher score reflects "Extreme Pain."

Mild to Moderate Pain in trauma patients

Selecting the appropriate analgesic is crucial and should be guided by the primary assessment score alongside the WHO Pain Ladder. This ensures effective pain management tailored to the patient's needs [16]. Incorporating nonopioid agents like steroids, nonsteroidal anti-inflammatory drugs, ice, and physical therapy is essential for minimizing opioid dosage requirements. These practical methods alleviate pain and play a crucial role in preventing long-term complications [17].

Paracetamol and NSAIDs are the first-line treatments for effectively managing mild to moderate pain. Depending on the patient's circumstances, these medications can be administered orally or intravenously (IV) for optimal results. NSAIDs such as ibuprofen,

diclofenac, and naproxen are widely recommended [18-20]. A double-blind study has demonstrated that paracetamol offers comparable pain relief to diclofenac for acute, mild musculoskeletal injuries. While paracetamol is a potent analgesic, it is essential to recognize that it lacks the anti-inflammatory benefits that NSAIDs provide, making each option a valuable choice based on individual patient needs [20].

NSAIDs effectively target cyclooxygenase enzymes (COX-1 and COX-2), inhibiting the production of prostaglandins. Research shows that they can be just as effective as opioids for alleviating acute traumatic pain in both adults and children, making them a strong and safer alternative for pain management [21-22].

N2O is an effective, inhaled analgesic that works quickly and offers short-term pain relief, making it an ideal choice for emergency situations. For years, it has been a trusted option in both prehospital care and EDs, where its rapid onset and brief duration of action are perfectly tailored to address acute trauma pain. Utilizing N2O ensures that patients receive prompt and effective care when they need it most [23].

Metamizole, often referred to as dipyrone, is a potent non-opioid analgesic widely utilized in emergency departments (EDs) for its efficacy in pain relief [24].

Weak opioids, including codeine and tramadol, play a vital role in effectively managing moderate trauma pain [18-19]. Tramadol not only binds to L-opioid receptors but also inhibits the reuptake of serotonin and norepinephrine, enhancing pain relief and promoting overall comfort [25]. Tramadol is an ideal choice for pain relief, especially for patients who are not on serotonergic drugs or do not have seizure disorders [26]. Its unique analgesic properties set it apart from traditional options, offering effective pain management with fewer side effects. Unlike typical opioids, tramadol is less likely to cause common opioid-related issues, making it a safer and more appealing analgesic alternative for those in need of relief [27].

Severe Pain in trauma patients

Opioids are a powerful solution for managing severe trauma pain, delivering adequate analgesia through multiple routes of administration. These methods include intravenous (IV), intranasal (IN), intra-osseous (IO), subcutaneous (SC), and oral (PO), ensuring that patients receive the necessary relief most suitably. Morphine is frequently the go-to choice in emergency settings for managing intense pain across Europe. However, it is important to recognize that other opioids, including fentanyl and oxycodone, also play a significant role in pain management. Given the pharmacokinetic and pharmacodynamic shifts that occur with aging, it is crucial to initiate opioid treatment at reduced doses—typically around 25–50% of what would be administered to younger individuals. This approach ensures safety and efficacy while addressing the complex needs of older patients [18-19, 28].

Opioids are potent tools for pain management, effectively modulating pain signals in the brain and spinal cord. They mimic the action of natural opioid peptides and activate the brain's reward system, particularly in the ventral tegmental area and frontal cortex, which can lead to misuse. Despite this risk, opioids are highly effective for pain relief due to their strong affinity for mu receptors in the central nervous system. In the spinal cord, opioids target specific receptors in the dorsal horn, where they bind to G proteins at the presynaptic level [29]. This interaction reduces the release of key pain neurotransmitters, such as substance P, and decreases neuronal excitability at the postsynaptic level by inhibiting cyclic adenosine monophosphate (cAMP) [30]. Understanding these mechanisms highlights both the effectiveness of opioids in pain relief and the importance of cautious use.

When selecting opioid therapies, clinicians must prioritize individual patient factors to ensure optimal treatment outcomes. For example, avoiding morphine in patients with renal impairment is crucial for patient safety. Additionally, considering the desired duration of action can significantly enhance pain management: fentanyl is highly effective for premedication in shorter procedures, such as chest tube insertions. At the same time, morphine or hydromorphone should be the go-to option for addressing breakthrough pain. This tailored approach improves patient comfort and promotes better overall recovery [9].

The dosing and tapering regimens for trauma patients are crucial and must be tailored to their specific needs. Factors such as the type of injury, organ dysfunction, surgical schedules, and individual clinical and demographic characteristics significantly determine the most effective approach. Customizing these regimens is essential for optimizing recovery and ensuring the best possible outcomes for each patient [9].

Ketamine, a potent derivative of phencyclidine, serves as a fast-acting antagonist of the N-methyl-D-aspartate

(NMDA) receptor, making it an invaluable tool in the initial treatment of trauma patients [31]. A typical intravenous (IV) dosage of 0.3 to 0.5 mg/kg is administered as a bolus for effective acute pain management in clinical settings. This can be complemented by an infusion, generally maintaining a rate of 0.1 to 0.2 mg/kg per hour, tailored to the duration of analgesia the patient requires. Utilizing ketamine not only enhances patient comfort but also improves overall treatment outcomes [32].

Ketamine stands out as a valuable option for prehospital care due to its broad therapeutic index, consistent cardiovascular stability, and the fact that it does not cause respiratory depression. Its dissociative properties make it particularly effective in managing trauma pain. Nevertheless, it is crucial to address safety concerns related to possible psychological effects and long-term psychotomimetic symptoms, ensuring that its benefits can be maximized while minimizing risks [33].

Methoxyflurane is an innovative, low-dose, non-opioid anesthetic that is delivered via a convenient hand-held inhaler. While its use in general anesthesia has been halted due to renal safety concerns, studies show that administering it in sub-anesthetic concentrations over brief periods poses no risk of kidney damage. This makes methoxyflurane a safe option for patients seeking effective pain relief without the risks associated with traditional opioids [34].

A multimodal pain approach is essential for effectively managing trauma pain, combining two or more medications that harness different mechanisms of action. This comprehensive method integrates strategies, including systemic analgesics, regional analgesic techniques, and non-pharmacological interventions, to target peripheral and central nervous system pain pathways. By applying the concept of multimodal analgesia throughout the treatment continuum, healthcare providers can tailor specific solutions to each phase of care, ensuring more effective pain relief for patients [35-37].

Fentanyl, a potent derivative of phenylpiperidine resembling pethidine, poses significant risks for patients with asthma and cardiac or atherosclerotic conditions. Its potential to induce histamine-related hypotension makes it a serious concern that warrants careful consideration [38].

Pethidine is a synthetic opioid analgesic recognized for its mu (μ) receptor agonist properties and anticholinergic effects. However, it is crucial to avoid using Pethidine for chronic pain relief in patients with renal or hepatic impairment. The risk of metabolite accumulation and norpethidine toxicity can lead to serious side effects, including irritability, nervousness, tremors, myoclonic jerks, muscle twitches, and potentially life-threatening convulsions. It is essential to choose safer alternatives for these vulnerable populations [39].

Adjuvant analgesics are crucial in managing pain, even though they are primarily designed for other medical conditions. Their unique analgesic properties make them valuable tools in treating various painful conditions. These medications include antidepressants, anti-seizure drugs, muscle relaxants, sedatives, anti-anxiety medications, dexmedetomidine, corticosteroids, and botulinum toxin. To maximize their effectiveness and safety, it is essential to have a comprehensive understanding of their recommended dosages, potential side effects, and possible drug interactions. By leveraging adjuvant analgesics wisely, we can significantly improve patient outcomes in pain management [40].

Administrations routs

For optimal pain management, it is highly effective to administer rapidly acting intravenous agents in small doses at frequent intervals until adequate pain relief is achieved. This method enables practitioners to gauge the patient's baseline needs accurately, paving the way for the timely introduction of long-acting medications or patient-controlled analgesia. Embracing this strategy can significantly enhance patient comfort and care. Experiencing hypotension after administering analgesics frequently indicates hypovolemia, making it essential to investigate potential hidden hemorrhage while continuing with resuscitation efforts. Although achieving total pain relief may not be feasible, adopting multimodal pain management strategies can significantly enhance patient comfort. It can deliver adequate analgesia by combining two or more medications that target pain through different mechanisms. These medications may be administered via the same or various routes, ensuring a tailored approach to pain management that meets the patient's needs [9, 41].

In trauma care, many patients must remain nil per os (NPO), making the intravenous route the most effective method for administering medications. This method

ensures swift and reliable treatment when patients cannot take anything by mouth. It is also essential to consider alternative administration routes, such as Patient-Controlled Analgesia (PCA), subcutaneous, intramuscular, rectal, transdermal, buccal, sublingual, spinal intrathecal, epidural, and inhalation. By utilizing these methods, we can provide optimal pain management and care for trauma patients [10].

The rectal route is a valuable option for patients who are unconscious, unable to swallow, or NPO for any reason, including those experiencing nausea or vomiting. However, it is important to note that using suppositories in patients with neutropenia can heighten the risk of septicemia, so caution is advised [42].

The spinal cord is rich in both opioid and non-opioid receptors, which are essential for effectively modulating pain signals: some receptors diminish the sensation of pain, while others may intensify it. Understanding the intraspinal approach, which includes both epidural and intrathecal injections, is vital for effective pain management. Intrathecal medication involves delivering drugs directly into the subarachnoid space, while epidural injections place medication into the epidural space. Harnessing the intraspinal route has proven to be an invaluable strategy for alleviating pain in trauma situations. Additionally, the inhaled gas Entonox stands out as one of the most effective and widely used options for pain relief. Embrace these methods to optimize pain management and enhance patient comfort [10].

Upon arrival at the emergency department, after employing non-pharmacological interventions such as appropriate positioning and splinting of fractures, it is essential to incorporate an effective treatment regimen. This should consist of intravenous opioids and ketamine, complemented by controlled doses of inhaled analgesics. Consider adding a peripheral nerve block to optimize pain management for cases involving peripheral or localized injuries. This versatile multimodal approach should be tailored in subsequent phases to meet specific outcomes, mainly to ensure the provision of effective long-term pain relief. Utilizing medications such as weak opioids and NSAIDs can significantly enhance treatment efficacy and improve patient comfort [9].

Upon arrival, we prioritize effective pain management by first implementing non-pharmacological treatments. Following this, intravenous opiates and ketamine are administered to ensure rapid relief. We then introduce inhaled analgesia using a mixture of methoxyflurane as a safer alternative to N2O. In the post-emergency department phases, we skillfully taper the doses of opioids and ketamine, transitioning to weaker oral opioids like oxycodone, hydrocodone, and tramadol as needed. This is complemented by paracetamol and NSAIDs to optimize recovery while minimizing discomfort, ensuring our patients receive the highest standard of care throughout their treatment journey [43].

For trauma patients, regional analgesia via an epidural or brachial catheter is highly recommended. This approach not only minimizes the reliance on systemic narcotics, enhancing safety but also significantly aids in facilitating early mobilization, which is crucial for recovery. Epidural analgesia offers exceptional benefits, including high patient satisfaction and improved pulmonary function after major thoracoabdominal and orthopedic surgeries in elective cases. Given these advantages, it is highly likely that trauma patients would also experience significant improvements with this approach. Regional techniques can be ineffective when patients present with multiple injuries, fractures, or open wounds. While epidural placement in anesthetized patients carries a relative contraindication due to the risk of undetected spinal cord injury (SCI), the advantages often outweigh the risks in trauma cases. During surgery, general anesthesia enables optimal positioning and enhances patient cooperation, making epidural placement a viable and beneficial option [44-45].

Conclusion

The goal of pain management in trauma is to lower mortality and morbidity rates significantly. By effectively addressing pain, we can shorten hospital stays, promote early mobilization, and reduce healthcare costs. This strategy significantly boosts patient satisfaction and elevates their overall quality of life, positioning it as a vital component of effective trauma care. Traumatic injuries can range significantly in severity, from simple limb fractures to complex and potentially fatal injuries involving multiple bones and soft tissues. Understanding the vast range of these injuries is essential, as is the urgent need for timely and efficient medical care. Ensuring the provision of adequate analgesia is an essential element of effective trauma management. This requires a comprehensive

approach that includes:

1. Thorough assessment of age-specific pain management strategies to tailor care effectively.
2. Identify the most suitable analgesics to alleviate moderate to severe pain, optimizing patient comfort.
3. Awareness of the serious adverse effects of pain medications, carefully balancing these risks against their therapeutic benefits.
4. Routine monitoring and reassessment of patients to continuously refine and improve their pain management regimens.

By emphasizing these key considerations, we can significantly improve the quality of care for trauma patients, fostering their healing and well-being. To achieve genuinely patient-centered trauma care, it is essential to understand the obstacles to effective pain management and engage in open discussions with patients to identify solutions to overcome these barriers.

Acknowledgments

None.

Conflict of Interest Disclosures

There is no conflict of interest.

Funding Sources

None.

Authors' Contributions

The authors equally worked in this study.

Ethical Statement

None.

Declaration of Generative AI and AI-assisted technologies

None.

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