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PAIN MANAGEMENT IN THE EMERGENCY DEPARTMENT - A LITERATURE REVIEW

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ABSTRACT

Introduction: Pain is the most common presenting symptom in emergency departments and requires timely, accurate assessment and effective management to prevent complications and improve patient outcomes. This review focuses on the mechanisms, classification, and management strategies for acute pain in the ED, including common clinical presentations and evidence-based therapeutic approaches.
Materials and methods: A literature search was conducted in the PubMed database to find recent systematic reviews and meta-analyses on pain management in emergency medicine. Keywords included: pain, analgesics, emergency department, injury.
Results: A review of the literature indicates that pain management in emergency medicine is primarily guided by the type, cause, and severity of pain. A multimodal approach offers significant therapeutic benefits. Despite local differences in drug preferences and clinical guidelines, accurate pain assessment and the prompt, appropriate adjustment of analgesics to symptom intensity remain a fundamental principle of pain management. Equally important is the use of adjuvant therapies and non-pharmacological interventions, including psychological support, individualized care and effective communication with the patient.
Conclusion: Effective pain management in emergency settings requires a structured, patient-centered, and interdisciplinary approach. Incorporating both pharmacologic and supportive strategies not only enhances acute symptom relief but also contributes to better long-term outcomes and healthcare resource utilization.

KEYWORDS

Pain Management, Emergency Department, Analgesics, Injury

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Introduction: The Nature and Mechanisms of Pain

Pain remains one of the most frequent and pressing complaints among patients seeking care in emergency departments worldwide [1]. It constitutes a fundamental biological response that has evolved over millions of years as a protective mechanism to alert the organism to potential or actual harm. Despite its evolutionary utility, pain is often experienced as highly distressing and disruptive, which contributes to patients' urgent pursuit of medical assistance. According to the definition by the International Association for the Study of Pain [2], pain is 'an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage'. It arises when noxious mechanical, thermal, chemical, or electrical stimuli exceed the individual's pain threshold, thereby activating specialized peripheral sensory receptors known as nociceptors. This process frequently results in tissue injury, the release of pain mediators, and the initiation of afferent transmission of nociceptive impulses toward the central nervous system [3].

Pain can be classified according to its origin, underlying neurophysiological mechanisms, and pathophysiological context. One major category is physiological pain, which serves an adaptive, protective function. It occurs in response to the activation of nociceptors within healthy tissues by potentially harmful stimuli, such as excessive pressure or temperature extremes. This type of pain is typically acute, well-localized, and self-limiting, subsiding after the removal of the stimulus or following tissue healing. Its primary role is to prompt withdrawal from danger and prevent further injury [4].

In contrast, pathophysiological pain arises from tissue damage or inflammatory processes that sensitize or persistently activate nociceptors. It is commonly observed in various disease states and post-injury conditions. The underlying mechanisms involve peripheral and central sensitization, leading to exaggerated or prolonged pain perception even in the absence of ongoing tissue damage.

A distinct third category is neuropathic pain, classified as non-nociceptive, as it does not result from direct activation of nociceptors, unlike physiological or inflammatory pain. Instead, it results from damage or

dysfunction within the peripheral or central nervous system. The pathophysiology involves altered signal transmission and processing within nociceptive pathways, including aberrant excitability, loss of inhibitory control, and maladaptive plasticity. The etiology of neuropathic pain is diverse and includes conditions such as nerve compression (e.g., in intervertebral disc herniation), viral infections (e.g., herpes zoster), ischemic injury, metabolic disturbances (e.g., diabetic neuropathy), autoimmune diseases, and trauma to neural structures [5,6,7]. Clinically, it is often chronic, refractory to standard analgesics, and characterized by abnormal sensations such as burning, shooting, stabbing, or electric-shock-like pain.

Differentiating between physiological, inflammatory, and neuropathic pain is essential for accurate diagnosis and effective treatment, as it allows for the implementation of targeted therapeutic strategies and helps avoid inappropriate or insufficient interventions.

Materials and methods

This review was based on articles sourced from the PubMed and Google Scholar databases, with particular emphasis on the most recent systematic reviews and meta-analyses related to pain management in the emergency department. Original articles, review articles, and guidelines were used for this review. The literature review was conducted using the following keywords: pain management, analgesics, multimodal analgesia, emergency department, injury, headache, chest pain, abdominal pain, pain assessment, pathophysiology of pain, non-steroidal anti-inflammatory drugs, opioids, coanalgesics.

Results

Clinical Assessment and Pharmacological Management of Pain in Emergency Settings

With pain being one of the most prevalent symptoms and often the primary reason for seeking urgent medical attention [8], it is essential that healthcare professionals perform a comprehensive and systematic clinical evaluation to determine the underlying cause, subjective intensity, and location of the pain. A detailed assessment is critical not only for accurate diagnosis, but also for guiding the subsequent course of hospitalization, selection of appropriate analgesic therapy, and monitoring treatment outcomes, as these parameters determine both the urgency of intervention and the need for further diagnostic procedures.

A standardized method of pain assessment constitutes a critical component of effective pain management protocols. Among the various validated instruments available, the Numerical Rating Scale (NRS) and the Verbal Rating Scale (VRS) are most frequently utilized in clinical practice due to their simplicity, reliability, and practicality [9,10,11,12]. The NRS is a unidimensional scale ranging from 0 to 10, where 0 represents "no pain" and 10 indicates "the worst pain imaginable." In contrast, the VRS employs a 4–6-point descriptive scale, with labels ranging from "no pain" to "very severe" or "worst possible pain." Both tools are time-efficient, easy to administer, and particularly well-suited for use in emergency care and across diverse patient populations. Importantly, these scales enable consistent monitoring of pain over time, allowing for reliable comparisons between baseline assessments and follow-up evaluations after implemented treatment, even within the context of time constraints and systemic challenges commonly encountered in the emergency department setting.

Pharmacological management of pain is a cornerstone of acute care, and the selection of appropriate analgesic agents must be individualized based on the type and severity of pain, patient comorbidities, and the risk of adverse effects. The World Health Organization (WHO) first introduced a structured approach to pain management in 1986, known as the analgesic ladder [13]. This model proposed a three-step escalation strategy, starting with non-opioid analgesics (e.g., paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs)) for mild pain, progressing to mild opioids (e.g., codeine, tramadol) for moderate pain, and ultimately to strong opioids (e.g., morphine, fentanyl) for severe pain. At each step, the concurrent use of adjuvant therapies, such as antidepressants (e.g., duloxetine, venlafaxine, amitriptyline), anticonvulsants (e.g., pregabalin, gabapentin), spasmolytics/muscle relaxants (e.g., drotaverine, hyoscine, diazepam, tizanidine, baclofen, methocarbamol) or corticosteroids (e.g., dexamethasone, prednisolone), was encouraged to enhance analgesic effects and address specific pain mechanisms [14,15,16,17].

In recent years, however, the traditional ladder model has been re-evaluated and modified in light of advances in pain science and concerns over opioid misuse and dependence. A more dynamic, patient-centered approach has emerged, leading to the conceptual shift from an “analgesic ladder” to an “analgesic pyramid” [18,19]. This revised model emphasizes flexibility, individualized therapy, and the importance of drug titration, multimodal analgesia, and early intervention with appropriate agents rather than rigid progression through medication tiers [20]. The pyramid structure also underscores the role of non-pharmacological therapies and

interdisciplinary pain management, integrating psychological support, physical therapy, and interventional techniques where applicable. The evolution from a rigid stepwise ladder to a more adaptable pyramid framework reflects the growing recognition of the complex and multidimensional nature of pain, as well as the need for personalized and responsible analgesic use.

Overview of Common Analgesics

Paracetamol is a widely used, often first-line agent in the management of mild to moderate pain due to its proven efficacy, safety profile, and broad availability. It can be employed either alone or in combination with other analgesics, to enhance pain control. Compared to NSAIDs and opioids, paracetamol has fewer side effects and poses minimal risk of gastrointestinal, renal, or respiratory complications. Oral, intravenous and rectal formulations are available, allowing flexibility depending on the clinical context. [21,22,23]

Non-steroidal anti-inflammatory drugs, including ibuprofen, diclofenac, ketoprofen, and naproxen, are commonly used to treat mild to moderate pain, particularly when inflammation is a contributing factor. They have a recognised ceiling effect, beyond which no additional analgesia is observed. Although generally well tolerated, NSAID use is limited in patients with gastrointestinal, renal, or cardiovascular comorbidities. Oral, parenteral, and topical formulations are available, allowing for individualized administration based on clinical urgency and patient-specific factors. [24,25]

Metamizole is not classified as a typical NSAID, as it possesses comparatively weaker anti-inflammatory properties and lacks the characteristic gastrointestinal, renal, and cardiovascular risks associated with traditional NSAIDs. It has demonstrated analgesic efficacy in acute conditions such as renal colic [26], pancreatitis-related pain, and primary headache (e.g., episodic tension-type headache). Its use varies widely across countries - restricted or rarely used in some, and commonly prescribed in others - largely due to its association with rare but potentially life-threatening adverse effects, most notably agranulocytosis [27]. This risk may be influenced by genetic and ethnic factors, with higher susceptibility reported among populations of British and Scandinavian descent, although further research is needed [28].

Tramadol is a centrally acting weak opioid agonist with additional activity as a serotonin and norepinephrine reuptake inhibitor, making it effective for moderate pain. It is often used in mild-to-moderate trauma cases or as a step-down analgesic after stronger opioids. Its relatively favorable side-effect profile compared to stronger opioids makes it suitable for older adults or patients with comorbidities; however, care must be taken in those at risk for seizures or serotonin syndrome, particularly when used with SSRIs or MAO inhibitors. [29]

Lidocaine, traditionally used as a local anesthetic and antiarrhythmic agent, is increasingly employed in systemic form as an adjunct analgesic for acute and neuropathic pain, especially in trauma. Intravenous lidocaine infusion at sub-anesthetic doses has shown efficacy in reducing pain intensity and opioid consumption in fracture, burn, and rib injury patients. It is also effective in renal colic, with a fast onset and great pain relief [30]. Lidocaine mechanism involves sodium channel blockade, resulting in reduced nociceptive transmission and dampening of ectopic discharges from injured nerves. It is generally safe when used within therapeutic ranges but should be avoided in patients with cardiac conduction disorders, liver dysfunction, or seizure risk.

Morphine remains the gold standard for managing moderate to severe acute pain, including that caused by major trauma such as long bone fractures, crush injuries, or polytrauma. Morphine acts primarily through mu-opioid receptor agonism, providing potent analgesia but with dose-dependent side effects, including respiratory depression, hypotension, nausea, and constipation. Monitoring is essential, particularly in patients with compromised renal function, as morphine-6-glucuronide, an active metabolite, may accumulate and cause toxicity. [31,32]

Fentanyl is a synthetic opioid approximately 100 times more potent than morphine, with a rapid onset and short duration of action, making it ideal for use in acute trauma settings, especially during procedures such as fracture reduction, burn dressing changes, or intubation. Administered intravenously, fentanyl provides potent analgesia with minimal cardiovascular effects, an advantage in hemodynamically unstable trauma patients. Due to its high lipid solubility, it also has rapid CNS penetration. However, the narrow therapeutic window necessitates careful monitoring for respiratory depression and chest wall rigidity, particularly with high doses or rapid administration. [33]

Ketamine is increasingly recognized for its analgesic properties at sub-anesthetic doses. Among other mechanisms, it exerts its effects via NMDA receptor antagonism, which helps block central sensitization and "wind-up" phenomena in acute and chronic pain. In trauma, low-dose ketamine is particularly useful for

patients with opioid intolerance, hypotension, or chronic opioid use, and it provides effective analgesia without significant respiratory depression. It can also be co-administered with opioids to achieve opioid-sparing effects. Side effects such as dysphoria, hallucinations, and emergence reactions are rare at analgesic doses, but may be mitigated by concurrent administration of benzodiazepines if needed. [34,35,36]

Common Presentations of Pain in the Emergency Department: Etiology, Diagnosis, and Treatment

a) **Headache**

Headache is a common and often diagnostically challenging complaint in emergency departments. It may result from a broad spectrum of causes, ranging from benign primary headache disorders, such as migraine, tension-type headache, and cluster headache, which constitute the vast majority of cases, to rare but potentially life-threatening secondary conditions, including subarachnoid hemorrhage, meningitis, intracranial mass lesions, temporal arteritis, and cerebral venous sinus thrombosis [37,38,39].

The initial diagnostic approach involves a meticulous clinical history and neurological examination, with particular attention to warning features such as sudden onset ("thunderclap" headache), older age, immunosuppression, fever, altered mental status, focal neurological deficits, papilledema, or history of cancer [40]. When secondary headache is suspected, appropriate laboratory and imaging investigations must follow. Laboratory testing typically includes complete blood count to detect leukocytosis (suggestive of infection), C-reactive protein and erythrocyte sedimentation rate to screen for inflammatory conditions, and serum electrolytes, which may reveal metabolic disturbances contributing to headache (e.g., hyponatremia) [41]. In suspected meningitis or encephalitis, blood cultures and serologic or molecular testing for infectious agents are indicated, along with lumbar puncture if there are no contraindications [42].

Neuroimaging plays a pivotal role in identifying structural and vascular causes of headache. The Canadian CT Head Rule can assist in determining the need for urgent computed tomography of the head [43]. In patients presenting with acute or severe headache, non-contrast CT of the head is the first-line imaging modality, particularly sensitive for detecting acute hemorrhage. In cases where vascular pathology such as aneurysm, dissection, or venous thrombosis is suspected, CT angiography may be indicated [39,44].

Treatment of a headache depends on the underlying cause. Migraines may respond to NSAIDs, triptans, or antiemetics, while tension-type headaches are often relieved with simple analgesics [45,46]. In contrast, secondary headaches require urgent treatment of the underlying pathology, such as antibiotics for meningitis or surgical intervention for hemorrhage [39,42].

b) **Chest Pain**

Chest pain is a high-priority symptom in emergency medicine due to its potential association with life-threatening conditions. While most severe cases are related to cardiovascular emergencies (e.g., acute coronary syndrome, aortic dissection, cardiac tamponade, peri- or endocarditis, pulmonary embolism) [47], chest pain can also result from a wide range of non-cardiac etiologies, including musculoskeletal disorders (e.g., costochondritis, intercostal strain, or rib contusions) [48], pulmonary conditions (e.g., pneumonia, pleuritis, pneumothorax, lung cancer) [49], gastroesophageal reflux, esophageal spasm or rupture [50], postherpetic neuralgia and other neuropathic conditions [51], and psychogenic causes such as anxiety or panic disorders [52].

A structured diagnostic approach includes an electrocardiogram, cardiac biomarkers (e.g., high-sensitivity cardiac troponin, creatine kinase MB fraction) [53,54], chest X-ray, and, when indicated, CT angiography [55] or echocardiography. Once life-threatening causes have been excluded or appropriately addressed, the symptomatic management of pain becomes a key aspect of emergency care. Pharmacological treatment is tailored to the underlying etiology but generally aims to reduce discomfort, improve respiratory effort, and facilitate further diagnostic evaluation.

For musculoskeletal chest pain, the first-line pharmacologic agents are NSAIDs such as ibuprofen or naproxen or acetaminophen (paracetamol) as a safer alternative in patients with contraindications to NSAIDs (e.g., gastrointestinal ulcers, renal dysfunction). For patients with severe pain that limits adequate ventilation or coughing, short-acting opioids such as morphine or hydromorphone may be considered, though with caution due to their potential to depress respiratory drive. These agents are typically reserved for cases where NSAIDs and acetaminophen provide insufficient relief [56]. Anxiety-related chest pain, particularly when accompanied by hyperventilation or panic attacks, may benefit from short-term use of anxiolytics, such as low-dose benzodiazepines (e.g., lorazepam or diazepam) [57]. These agents should be used judiciously and only after organic causes have been ruled out.

Regardless of the cause, re-evaluation of pain intensity following pharmacologic intervention is essential, and clinicians must remain vigilant for any evolution in symptoms that might indicate a missed or developing critical condition.

c) **Abdominal Pain**

Abdominal pain is another prevalent reason for emergency consultation and can arise from a variety of gastrointestinal, hepatobiliary, urological, gynecological, or vascular causes. Common etiologies include appendicitis, cholecystitis, pancreatitis, renal colic, bowel obstruction, gastroenteritis, and perforated ulcers, among others [58]. A careful history, including pain location, character, radiation, associated symptoms (e.g., vomiting, fever, change in bowel habits, urinary complaints), combined with abdominal examination provides initial diagnostic clues. Laboratory tests, including complete blood count, C-reactive protein, liver enzymes, amylase, lipase, and urinalysis, are typically obtained, along with abdominal ultrasonography. [58] Depending on clinical suspicion of a potential vascular incident, CT imaging may also be useful [59,60]. Prompt recognition of potentially emergent conditions such as appendicitis, bowel perforation, mesenteric ischemia or ruptured abdominal aortic aneurysm is crucial [61].

Pharmacological treatment of abdominal pain is tailored to both the suspected etiology and the pain type (visceral, colicky, or somatic). In colicky pain associated with biliary or renal colic, spasmolytic agents play a central role. One widely used spasmolytic is drotaverine, a selective phosphodiesterase-4 inhibitor, which reduces smooth muscle tension without affecting autonomic function. Drotaverine is particularly effective in relieving cramp-like pain in conditions such as ureterolithiasis [62]. It is often administered intravenously or intramuscularly in acute care settings due to its rapid onset of action. In moderate to severe cases of abdominal pain, particularly those involving peritonitis, pancreatitis, or bowel ischemia, opioid analgesics such as tramadol or morphine may be required. Adjunctive pharmacologic therapies may include antiemetics (e.g., ondansetron, metoclopramide), which are especially helpful when nausea and vomiting accompany abdominal pain or prophylactically with opioids in some cases [63], and proton pump inhibitors or H2-receptor antagonists in cases suggestive of gastritis or peptic ulcer disease [64]. In inflammatory conditions such as diverticulitis or appendicitis, antibiotic therapy may reduce pain indirectly by addressing the underlying infectious process. Tailoring therapy to the suspected underlying cause - whether visceral spasm, inflammation, or obstruction - optimizes patient outcomes and comfort while ensuring clinical safety.

d) **Back Pain**

Back pain is a widespread and sometimes complex complaint in the emergency setting, with etiologies ranging from benign musculoskeletal strain to serious pathologies such as spinal cord compression, vertebral fracture, or infection. Red flag symptoms, including neurological deficits, urinary retention, saddle anesthesia, fever, history of trauma or cancer, necessitate urgent evaluation for conditions like cauda equina syndrome, vertebral osteomyelitis, or epidural abscess. [65] In the absence of red flags, imaging is typically deferred, and a diagnosis of non-specific low back pain is made [66]. Initial management includes analgesia with NSAIDs, muscle relaxants [67], sometimes opioids or corticosteroids [68], and advice on maintaining mobility after discharge from the hospital. In more serious cases, MRI is the imaging modality of choice. Surgical referral is indicated for neurological compromise or spinal instability.

e) **Pain Due to Injury or Trauma**

Pain resulting from injury is one of the most common presentations in emergency medicine and may arise from fractures, dislocations, soft tissue trauma, burns, or penetrating wounds. While timely analgesia is essential, it must follow the initial exclusion of life-threatening conditions such as internal hemorrhage or organ injury. Pain characteristics vary based on the mechanism, location, and severity of trauma, as well as patient-specific factors like pain threshold, comorbidities, and risk of adverse reactions. Effective pain control is both a clinical necessity and an ethical obligation, facilitating diagnostic procedures, physical examination, early mobilization, and reducing the risk of chronic pain syndromes. Management should employ a structured, multimodal approach combining pharmacological agents with complementary mechanisms to enhance efficacy and reduce opioid use. With fentanyl being the most often used opioid in injured patients, a “gold standard”, due to its minimal effect on hemodynamics and central nervous system depression [69], non-pharmacological measures, such as limb elevation, cold therapy, and psychological support, serve as important adjuncts. Multimodal strategies have been shown to improve outcomes and reduce opioid-related complications. Ongoing assessment of pain and function is critical, alongside careful monitoring for drug toxicity, particularly in high-risk or polytrauma patients.

Discussion

Pain management practices in emergency departments vary significantly across regions, influenced by factors such as drug availability, prescribing habits, regulatory frameworks, and institutional protocols. Intravenous analgesia is generally preferred for its rapid onset of action, particularly in cases of severe or acute pain. However, for patients presenting with mild to moderate pain, oral analgesics have demonstrated comparable efficacy, offering a less invasive and more accessible alternative. The choice of analgesic agents also differs regionally, with certain medications being more readily available or more commonly used in specific healthcare systems. Striking an appropriate balance between the use of opioid and non-opioid medications remains a critical consideration, particularly in light of the ongoing opioid crisis [70] and the evolving understanding of pain pathways. Advances in the neurobiology of pain are increasingly informing targeted, multimodal approaches that aim to optimize analgesia while minimizing adverse effects and the risk of dependency [71].

Beyond pharmacological considerations, additional variables - such as triage protocols, staffing levels, clinician training, clinical judgment, experience, and knowledge - can significantly influence the timely and effective delivery of pain relief. Institutional factors, including formulary restrictions and electronic prescribing systems, may also impact the selection and administration of analgesics [14]. Moreover, non-pharmacological pain management strategies should be integrated into routine care, as they have been shown to contribute meaningfully to pain alleviation and overall patient comfort. Recognizing these interregional and interinstitutional differences is essential for the development of adaptable, evidence-based guidelines that promote optimal pain management across diverse emergency department settings.

Conclusions

In conclusion, effective pain assessment and management in emergency settings require a comprehensive, standardized, and patient-centered approach. This includes the consistent use of validated assessment tools, evidence-based pharmacological protocols, and regular re-evaluation of treatment efficacy. A modern multimodal strategy, integrating pharmacological, interventional, and non-pharmacological therapies, is often necessary to address the complex biological, psychological, and social dimensions of pain. In addition to selecting appropriate analgesics based on the nature and severity of pain, supportive measures such as physical interventions, environmental comfort, and psychological reassurance play a vital role. When patients feel safe, heard, and genuinely cared for - and when their pain is effectively acknowledged - they are more likely to engage with the treatment plan, comply with medical advice, and avoid misuse or overuse of medications. A patient-centered approach also reduces the risk of repeated emergency department visits for the same complaint, thereby improving both short-term symptom control and long-term clinical outcomes. Ultimately, integrating these principles into emergency care enhances pain management, promotes patient satisfaction, and supports more effective recovery.

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