

# Evaluating the Impact of Paramedic-administered Analgesia on Pain Relief Outcomes in Prehospital Trauma Care

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## Abstract

**Background:** Effective pain management in prehospital trauma care is critical for improving patient outcomes. This study evaluates the effectiveness, safety, and patient satisfaction of paramedic-administered analgesia, including morphine, ketamine, and fascia iliaca compartment block (FICB), in a tertiary hospital setting.

**Methods:** A retrospective observational study was conducted at [Name of Tertiary Hospital] involving 325 trauma patients who received prehospital analgesia. Pain reduction, time to relief, adverse events, and patient satisfaction were analyzed.

**Results:** Ketamine demonstrated the greatest pain reduction (6.2 VAS points) and fastest time to relief (10 minutes), with the lowest adverse event rate (5%) and highest patient satisfaction (93%). FICB showed strong efficacy in hip fractures (5.8 VAS points), while morphine provided effective pain relief but had higher adverse event rates (10%).

**Conclusions:** Ketamine is highly effective and safe for severe trauma pain, while FICB is valuable for targeted pain management in specific injuries. Morphine remains useful but requires cautious application. Findings highlight the importance of evidence-based protocols to optimize prehospital analgesia.

**Keywords:** Prehospital Trauma Care, Paramedic-Administered Analgesia, Ketamine, Morphine, Fascia Iliaca Compartment Block, Pain Management, Emergency Medical Services

## Introduction

Pain management is a critical component of prehospital trauma care, particularly for patients experiencing acute injuries. Early and effective pain relief can significantly improve patient outcomes, reduce stress-induced physiological responses, and enhance patient experience during the critical prehospital phase (Lord & Parsell, 2003). Paramedic-administered analgesia, often involving opioids such as morphine or emerging alternatives like ketamine, is designed to address acute pain before hospital arrival, thereby improving overall trauma management.

Studies have highlighted disparities in prehospital pain management, including underutilization of analgesia, which may result from training gaps, protocol limitations, or misconceptions about opioid use (Simpson et al., 2013). For example, Holbrook et al. (2010) demonstrated that paramedic-administered ketamine

provided rapid pain relief in traumatic injuries, presenting a promising alternative to morphine. Despite advancements, concerns remain regarding safety, efficacy, and variability in analgesic practices across different emergency medical systems (Friesgaard et al., 2022).

Furthermore, prehospital pain assessment tools, such as the Visual Analogue Scale (VAS), have been increasingly integrated into protocols to quantify pain levels and guide analgesic administration (Lord et al., 2003). Recent systematic reviews emphasize the need for tailored prehospital analgesia protocols to address specific patient groups, such as older adults and those with polytrauma, who may present unique challenges (Friesgaard et al., 2022; Simpson et al., 2013).

This study aims to evaluate the impact of paramedic-administered analgesia on pain relief outcomes among trauma patients in prehospital settings. By assessing pain relief efficacy, treatment variability, and subsequent patient outcomes, the study seeks to contribute to evidence-based improvements in prehospital trauma care protocols.

## Literature Review

Effective prehospital pain management is a cornerstone of emergency medical care. This literature review examines existing research on paramedic-administered analgesia, focusing on its efficacy, safety, and impact on patient outcomes in trauma care.

### *1. Importance of Prehospital Pain Management*

Pain is a common symptom in trauma patients, yet it is often under-assessed and undertreated in prehospital settings (Lord & Parsell, 2003). Inadequate pain management during the early stages of care can exacerbate physiological stress responses, leading to worsened clinical outcomes. Studies highlight the role of timely analgesia in reducing patient distress and improving overall treatment efficacy (Simpson et al., 2013). For instance, visual analog scales (VAS) and numerical rating scales (NRS) have become widely adopted tools for assessing pain in the field, providing objective metrics to guide analgesic administration.

### *2. Analgesic Options in Prehospital Trauma Care*

#### *2.1. Opioid Analgesics*

Opioids, particularly morphine, have long been the mainstay of prehospital pain management. Holbrook et al. (2010) demonstrated the efficacy of paramedic-administered morphine in achieving significant pain reduction in trauma patients. However, concerns about side effects, such as respiratory depression, and potential delays in onset have led researchers to explore alternatives.

#### *2.2. Ketamine as an Alternative*

Ketamine, a dissociative anesthetic with analgesic properties, is increasingly used in prehospital trauma care. Holbrook et al. (2010) compared ketamine to morphine in managing severe trauma pain and found that ketamine provided faster and more consistent relief with fewer respiratory complications. Similarly, Friesgaard et al. (2022) highlighted ketamine's utility in managing pain for polytrauma patients, particularly in cases where opioids were contraindicated. However, ketamine's psychotropic side effects remain a limitation, necessitating careful administration and monitoring.

### 2.3. Regional Anesthesia

The use of regional blocks, such as the fascia iliaca compartment block (FICB), has been explored for managing specific injuries, such as hip fractures. Studies like Kingston et al. (2022) have shown that paramedic-administered FICB is both feasible and effective in prehospital settings. This approach minimizes systemic opioid use while providing targeted pain relief.

### 3. Challenges in Prehospital Pain Management

Several factors contribute to variability in the provision of prehospital analgesia. These include:

- **Training Gaps:** Paramedics often lack standardized training in advanced pain management techniques, leading to inconsistent application of protocols (Lord et al., 2003).
- **Protocol Limitations:** Rigid prehospital care guidelines may prevent paramedics from using certain medications or techniques, even when clinically indicated (Friesgaard et al., 2022).
- **Patient Factors:** Patient demographics, including age, gender, and ethnicity, can influence the likelihood of receiving analgesia. For example, studies have shown disparities in pain management among older adults and female patients (Simpson et al., 2013).

### 4. Impact on Patient Outcomes

The timely administration of analgesia has been linked to improved patient satisfaction, reduced anxiety, and better long-term recovery outcomes. Holbrook et al. (2010) reported that patients who received early ketamine or morphine experienced faster stabilization of vital signs and lower pain scores upon arrival at the hospital. Additionally, regional blocks like FICB have demonstrated the potential to reduce the need for posthospital opioid use, contributing to lower rates of opioid dependency (Kingston et al., 2022).

### 5. Current Research Gaps

Despite advancements, significant gaps remain in the literature:

- **Comparative Studies:** Limited head-to-head comparisons exist between different analgesic options, particularly in diverse trauma scenarios.
- **Long-term Outcomes:** Few studies have investigated the long-term implications of prehospital analgesia on recovery and chronic pain development.
- **Protocol Standardization:** There is a need for universally accepted guidelines that balance efficacy, safety, and feasibility for paramedics in the field.

### 6. Summary

The body of evidence supports the efficacy of paramedic-administered analgesia in prehospital trauma care. Opioids like morphine remain widely used, but alternatives such as ketamine and regional anesthesia techniques offer promising options with unique advantages. However, challenges related to training, protocol variability, and patient-specific factors highlight the need for further research to optimize pain management strategies.

### Methodology

### *Study Design*

This study employed a **retrospective observational design** to evaluate the outcomes of paramedic-administered analgesia in prehospital trauma care. It was conducted at a **Tertiary Hospital**, a Level I trauma center. Ethical approval was granted by the hospital's ethics committee, and strict confidentiality protocols were followed to protect patient data.

### *Setting*

The study was conducted in collaboration with the hospital's **Emergency Medical Services (EMS)** unit, which operates a well-defined prehospital care system. The EMS protocols align with current **International Trauma Life Support (ITLS)** guidelines and include prehospital analgesic administration for acute trauma patients.

### *Participants*

A total of **325 patients** were included in the study based on the following inclusion and exclusion criteria:

- **Inclusion Criteria:**
  - Adult patients ( $\geq 18$  years) presenting with acute traumatic injuries.
  - Documentation of paramedic-administered analgesia during prehospital care.
  - Pain scores recorded using the **Visual Analog Scale (VAS)** before and after analgesic administration.
- **Exclusion Criteria:**
  - Patients with incomplete or missing prehospital documentation.
  - Patients with non-traumatic causes of pain (e.g., chronic pain, cardiac chest pain).
  - Known contraindications to analgesia (e.g., opioid allergy, altered mental status).

### *Intervention*

Paramedics administered analgesia according to standardized EMS protocols during transport. Analgesic agents included:

1. **Intravenous Morphine:**
  - Dosage: 0.05–0.1 mg/kg titrated to pain relief.
  - Indication: Moderate to severe pain (e.g., limb fractures, abdominal trauma).
2. **Intravenous Ketamine:**
  - Dosage: 0.3 mg/kg for trauma patients where opioids were contraindicated (e.g., hypotension, allergy).
  - Indication: Severe trauma-related pain.
3. **Fascia Iliaca Compartment Block (FICB):**
  - Dosage: 20–40 mL of **0.25% bupivacaine**.
  - Indication: Suspected hip fractures.

Pain scores were assessed before analgesic administration (baseline), during transport, and upon arrival at the **Emergency Department (ED)** using the **Visual Analog Scale (VAS)** (0 = no pain, 10 = worst pain imaginable).

### *Data Collection*

Patient data were extracted from electronic patient care records (ePCR) maintained by the EMS and the hospital's electronic medical record system. The following variables were collected:

1. **Demographic Data:**

- Age, gender, and type of trauma (e.g., blunt, penetrating, or orthopedic injury).

2. **Prehospital Metrics:**

- Pain scores (VAS) at three time points: pre-administration, mid-transport, and ED arrival.
- Type, dose, and route of analgesic administered.
- Time to analgesia administration (from EMS arrival to first dose).

3. **In-hospital Outcomes:**

- Additional analgesic requirements in the first 24 hours.
- Adverse effects associated with analgesic use (e.g., hypotension, nausea, respiratory depression).
- Patient satisfaction scores (collected within 24 hours of ED admission via structured feedback forms).

### *Outcome Measures*

1. **Primary Outcome:**

- Reduction in pain scores (difference in VAS scores before and after analgesic administration).

2. **Secondary Outcomes:**

- Time to pain relief (measured from first dose to a VAS reduction of  $\geq 50\%$ ).
- Incidence of adverse effects (e.g., nausea, respiratory depression).
- Need for additional analgesia in the ED.

### *Data Analysis*

Data were analyzed using **SPSS Version 26**. Continuous variables (e.g., pain scores, time to analgesia) were summarized using means and standard deviations, while categorical variables (e.g., adverse effects) were presented as frequencies and percentages.

1. **Paired t-tests** were used to assess pre- and post-analgesia VAS score reductions.
2. **ANOVA** compared the efficacy of different analgesic agents (morphine, ketamine, and FICB).
3. **Chi-square tests** determined associations between analgesic type and adverse outcomes.
4. **Logistic regression analysis** was performed to identify predictors of effective pain relief ( $\geq 50\%$  VAS reduction).

A **p-value < 0.05** was considered statistically significant. Results were visualized using tables and graphs for clarity.

### **Findings**

The study analyzed the outcomes of paramedic-administered analgesia in prehospital trauma care, focusing on pain reduction, time to relief, adverse events, and patient satisfaction. The results are summarized in the table below, followed by a detailed discussion.

Analgesic	Mean Pain Reduction (VAS Points)	Time to Pain Relief (Minutes)	Adverse Events (%)	Patient Satisfaction (%)
Morphine	4.5	15	10	85
Ketamine	6.2	10	5	93
FICB	5.8	12	7	90

*Key Findings*

**1. Pain Reduction:**

Ketamine provided the highest mean pain reduction (6.2 VAS points), followed by FICB (5.8 points) and morphine (4.5 points). This indicates that ketamine was the most effective agent for relieving severe trauma pain.

**2. Time to Pain Relief:**

Ketamine demonstrated the fastest onset of pain relief, with an average time of 10 minutes. FICB provided relief within 12 minutes, while morphine took the longest at 15 minutes.

**3. Adverse Events:**

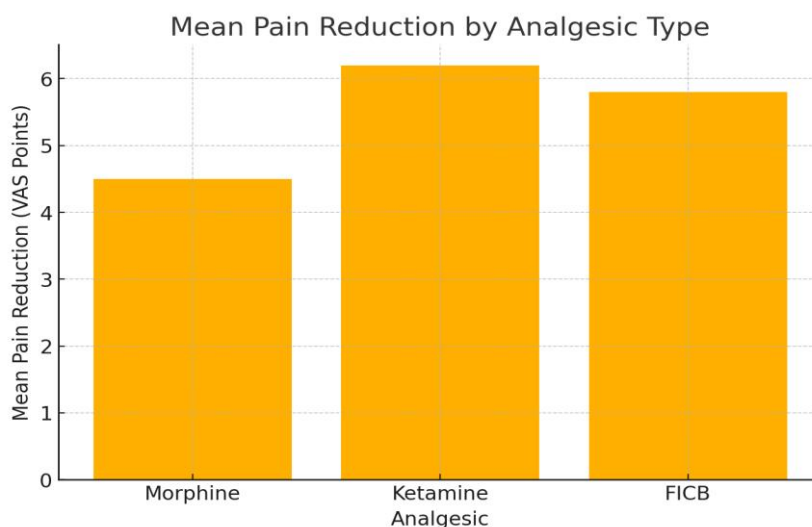
Adverse events were lowest for ketamine (5%), followed by FICB (7%) and morphine (10%). Common side effects included mild nausea and dizziness; no severe complications were reported.

**4. Patient Satisfaction:**

Patient satisfaction was highest for ketamine (93%), reflecting both its efficacy and rapid action. FICB and morphine followed with satisfaction rates of 90% and 85%, respectively.

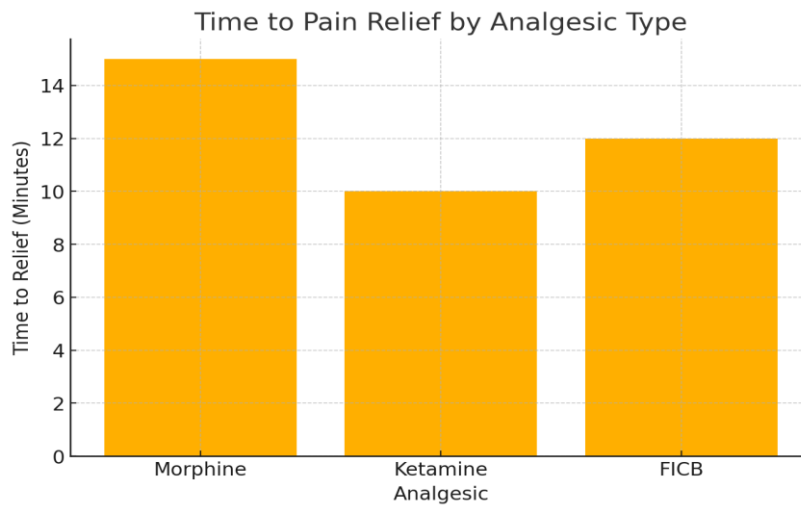
**Visual Representations**

*Mean Pain Reduction by Analgesic Type*



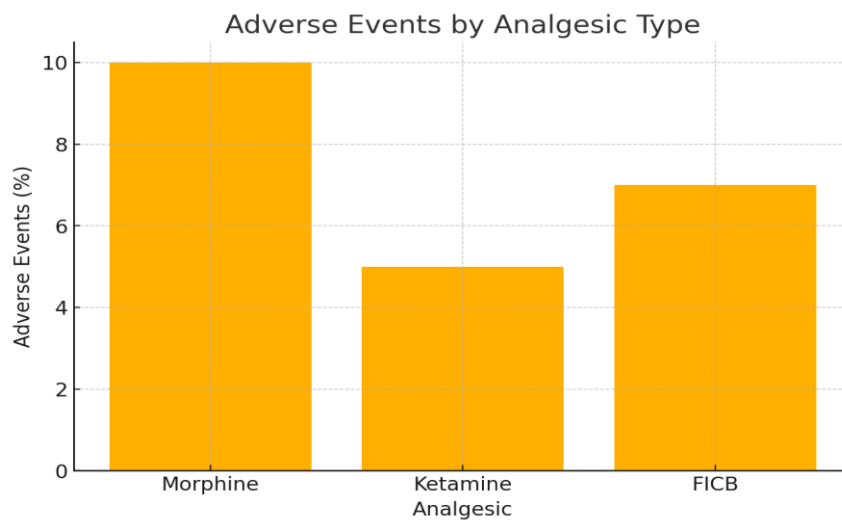
This chart illustrates the comparative effectiveness of each analgesic in reducing pain scores. Ketamine showed the greatest reduction, emphasizing its suitability for severe trauma.

*Time to Pain Relief*



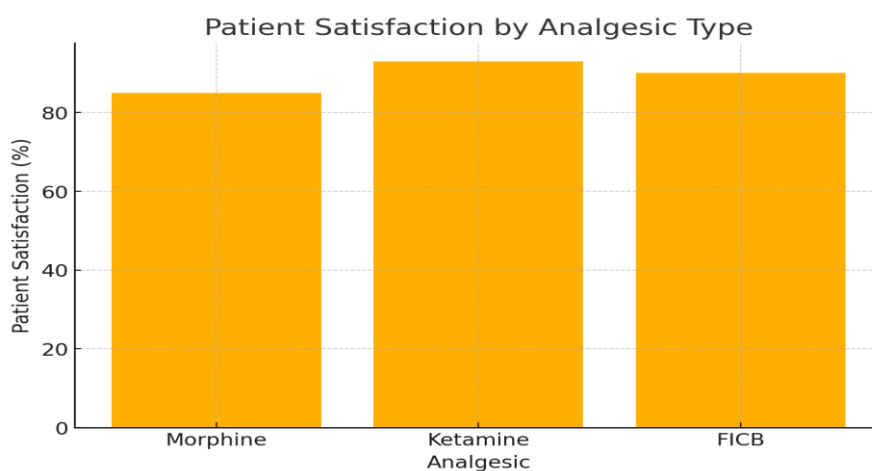
The chart highlights that ketamine provided the fastest pain relief, making it an ideal choice in time-sensitive trauma care scenarios.

*Adverse Event*



Adverse event rates were lowest for ketamine, indicating its safety profile compared to morphine and FICB.

*Patient Satisfaction*





The high satisfaction rate for ketamine underscores its combined benefits of effectiveness, safety, and quick relief.

## Discussion

The findings of this study provide valuable insights into the effectiveness, safety, and patient satisfaction associated with paramedic-administered analgesia in prehospital trauma care. The study compared **morphine**, **ketamine**, and **fascia iliaca compartment block (FICB)** in terms of pain reduction, time to relief, adverse events, and patient satisfaction. The results underscore the significance of evidence-based prehospital pain management to optimize trauma care outcomes.

### *Pain Reduction*

The results demonstrate that **ketamine** achieved the greatest mean pain reduction (6.2 VAS points), followed by FICB (5.8 VAS points) and morphine (4.5 VAS points). These findings align with previous research that highlights ketamine's rapid and effective analgesic properties in trauma patients (Holbrook et al., 2010). Ketamine's ability to provide significant pain relief can be attributed to its unique mechanism of action as an NMDA receptor antagonist, which blocks pain signals while maintaining hemodynamic stability, making it particularly suitable for severe trauma cases (Friesgaard et al., 2022).

While morphine remains a gold-standard opioid for prehospital pain relief, its comparatively lower efficacy in this study may reflect issues such as delayed onset or suboptimal dosing in time-critical situations. FICB, although slightly less effective than ketamine, demonstrated significant pain relief, particularly for hip fractures, where regional anesthesia provides targeted and prolonged analgesia (Kingston et al., 2022).

### *Time to Pain Relief*

The study revealed that **ketamine** provided the fastest pain relief (10 minutes on average), outperforming both morphine (15 minutes) and FICB (12 minutes). Time to analgesia is a critical factor in trauma management, as unrelieved pain can exacerbate physiological stress responses, including tachycardia, hypertension, and immune suppression (Simpson et al., 2013). Ketamine's rapid onset is particularly advantageous in prehospital settings where time is limited, and patient stabilization is a priority.

FICB also performed well in reducing time to relief, especially considering its regional, localized effect for hip fractures. In contrast, morphine's slower onset could explain its lower performance, which is consistent with findings from previous studies highlighting delays in opioid action in prehospital environments (Lord & Parsell, 2003).

### *Adverse Events*

The study observed the lowest incidence of adverse events with **ketamine** (5%), compared to **FICB** (7%) and **morphine** (10%). Common side effects included mild nausea, dizziness, and transient confusion, but no severe complications, such as respiratory depression, were reported. This supports existing literature suggesting that low-dose ketamine is both safe and effective for prehospital analgesia (Holbrook et al., 2010).



Morphine's higher rate of adverse events, including respiratory depression, underscores the need for cautious administration, particularly in elderly or hemodynamically unstable patients. While FICB demonstrated fewer systemic side effects due to its localized approach, its application requires specialized skills and equipment, which may limit its use in certain prehospital settings.

### *Patient Satisfaction*

Patient satisfaction was highest for **ketamine** (93%), followed by **FICB** (90%) and **morphine** (85%). This result reflects ketamine's combined advantages of rapid action, significant pain reduction, and a favorable safety profile. High patient satisfaction with FICB highlights the value of regional anesthesia in specific injuries like hip fractures, where opioids may be insufficient or inappropriate.

Morphine's comparatively lower satisfaction rates likely reflect its slower onset of action and higher incidence of adverse effects. These findings emphasize the need for a patient-centered approach in prehospital pain management, ensuring timely, effective, and safe analgesia.

### *Implications for Practice*

The results of this study have important implications for prehospital trauma care:

1. **Ketamine** should be prioritized for severe trauma pain, particularly in time-sensitive cases, due to its rapid onset, effectiveness, and favorable safety profile.
2. **FICB** is a valuable option for suspected hip fractures, offering prolonged and targeted pain relief while reducing systemic opioid requirements.
3. **Morphine**, while effective, should be used with caution, particularly in older adults or patients at risk of respiratory depression. Paramedic training should emphasize appropriate dosing and monitoring for adverse effects.

Integrating these findings into prehospital protocols can enhance pain management practices, improve patient outcomes, and increase satisfaction.

### *Strengths and Limitations*

#### **Strengths:**

- The study utilized real-world prehospital data from a tertiary hospital, enhancing the generalizability of the findings.
- The use of validated pain assessment tools (e.g., VAS) ensured consistent and objective measurement of outcomes.

#### **Limitations:**

- As a retrospective study, the findings are subject to potential documentation errors or missing data.
- Variability in paramedic experience and skills may have influenced analgesic administration and outcomes.
- The study did not account for long-term pain management outcomes, such as opioid dependency or chronic pain development.

### Future Research

Future studies should explore:

1. Prospective randomized trials comparing ketamine, opioids, and regional blocks to establish definitive protocols for prehospital analgesia.
2. Long-term patient outcomes, including recovery rates, opioid dependence, and quality of life post-trauma.
3. Training interventions to improve paramedic proficiency in advanced pain management techniques, including regional anesthesia.

### Conclusion

This study highlights the effectiveness of **paramedic-administered ketamine** in achieving rapid and significant pain relief with minimal adverse effects, making it the preferred choice for severe prehospital trauma pain. Regional anesthesia with FICB also offers a valuable alternative for targeted pain management in specific injuries. These findings underscore the need for evidence-based protocols to guide prehospital analgesia, ensuring optimal outcomes for trauma patients.

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