



# Critical Care Management of Polytrauma Patient: A Comparison of Opioid based Analgesic Versus Multimodal Approaches

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## KEYWORDS

Polytrauma,  
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## ABSTRACT:

**Background:** Polytrauma patients require effective and safe analgesia for optimal recovery in critical care. Opioid-based analgesia, while effective, is associated with several side effects. Multimodal analgesia, which uses a combination of drugs acting via different mechanisms, has been proposed as a safer and equally effective alternative.

**Aim:** To compare the effectiveness of opioid-based analgesic therapy versus multimodal analgesia in polytrauma patients admitted to the ICU, focusing on pain control, opioid use, complications, and recovery outcomes.

**Methods:** This retrospective observational study included 200 polytrauma patients admitted to the ICU of a tertiary care center from January to December 2023. Patients were divided into two groups: opioid-based analgesia (n=100) and multimodal analgesia (n=100). Outcomes assessed included pain scores (VAS), total opioid consumption (MMEs), incidence of complications, ICU stay duration, extubation time, and opioid dependence at discharge. Statistical analysis was performed using t-tests and chi-square tests, with  $p < 0.05$  considered significant.

**Results:** Patients receiving multimodal analgesia had significantly lower pain scores at 12, 24, and 48 hours ( $p < 0.01$ ) and reduced opioid consumption (45.3 MMEs vs. 85.7 MMEs,  $p < 0.0001$ ). Complications such as respiratory depression (8% vs. 22%,  $p = 0.011$ ) and nausea (13% vs. 28%,  $p = 0.022$ ) were lower in the multimodal group. ICU stay (5.1 vs. 6.4 days,  $p = 0.008$ ) and extubation time (13.9 vs. 18.2 hours,  $p = 0.003$ ) were also significantly reduced. At 3-month follow-up, persistent pain and opioid use at discharge were lower in the multimodal group.

**Conclusion:** Multimodal analgesia provides superior pain relief with fewer complications and better recovery outcomes than opioid-based monotherapy in the ICU management of polytrauma patients. These findings support broader implementation of multimodal strategies in trauma care protocols.

## Introduction

Polytrauma refers to a condition where a patient suffers from multiple traumatic injuries, often involving different body systems and requiring complex and coordinated critical care management. These patients

often present with both life-threatening and non-life-threatening injuries, making their management challenging. The management of polytrauma patients in the intensive care unit (ICU) requires a multidisciplinary approach, involving timely interventions, proper pain management, and stabilization of vital functions. A key



aspect of critical care in these patients is the effective management of pain, which significantly impacts patient comfort, recovery, and outcomes.<sup>[1][2]</sup>

One of the primary components of pain management in polytrauma patients is the use of analgesics. Traditionally, opioid-based analgesics have been the cornerstone of pain management in trauma patients due to their potent analgesic effects. Opioids, such as morphine, fentanyl, and oxycodone, provide effective pain relief by binding to opioid receptors in the central nervous system, thereby reducing the perception of pain. Despite their efficacy, opioids have several drawbacks, including potential for dependency, respiratory depression, and other systemic side effects such as gastrointestinal disturbances, urinary retention, and altered mental status. Furthermore, in the setting of polytrauma, these drugs can cause complications like hypotension, which complicates the management of other traumatic injuries, especially in patients with hemorrhagic shock.<sup>[3][4]</sup>

The use of opioid-based analgesia has increasingly been scrutinized due to the opioid epidemic and the growing awareness of its adverse effects. As a result, there has been a growing interest in alternative pain management strategies that are equally effective but come with fewer risks. A promising approach is the multimodal analgesic approach, which uses a combination of different classes of analgesic agents to target pain through various mechanisms. Multimodal analgesia typically includes a combination of non-opioid analgesics, regional anesthesia, and adjuncts such as local anesthetics, nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, and even antidepressants or anticonvulsants in some cases. By using multiple agents with different mechanisms of action, the overall opioid requirement can be reduced, thereby minimizing opioid-related side effects while maintaining adequate pain control.<sup>[5]</sup>

The multimodal approach has gained popularity in the management of various surgical and trauma-related pain scenarios, including after major orthopedic surgeries, abdominal trauma, and thoracic injuries. Studies have shown that multimodal analgesia can lead to better pain control, reduced opioid consumption, and fewer complications such as opioid-related respiratory depression. However, the adoption of multimodal

analgesia in polytrauma care remains variable, and further evidence comparing the outcomes of opioid-based analgesia and multimodal approaches in this patient population is necessary.<sup>[6]</sup>

## **Aim**

To compare the effectiveness of opioid-based analgesic therapy versus multimodal analgesia in the critical care management of polytrauma patients, focusing on pain control, opioid consumption, complications, and recovery outcomes.

## **Objectives**

1. To evaluate the efficacy of opioid-based analgesic therapy versus multimodal analgesia in providing adequate pain relief in polytrauma patients.
2. To assess the incidence of opioid-related side effects and complications (e.g., respiratory depression, gastrointestinal issues) in polytrauma patients receiving opioid-based analgesia versus multimodal approaches.
3. To compare the recovery times and overall outcomes, including ICU stay and long-term pain management needs, between the two analgesic strategies.

## **MATERIAL AND METHODOLOGY**

### **Source of Data:**

The data for this study was collected from polytrauma patients admitted to the Intensive Care Unit (ICU) of XYZ Hospital between January 2023 and December 2023. These patients were selected from the hospital's trauma registry, with additional data from the hospital's electronic medical records (EMR) system. The records provided detailed information about the patient's clinical status, injury patterns, pain management protocols, and outcomes.

### **Study Design:**

This was a retrospective, observational, comparative study. The study aimed to evaluate and compare the pain management strategies used in polytrauma patients over the study period. All patients who received either opioid-based analgesia or multimodal analgesia during their ICU stay were included in the analysis. The primary outcomes measured were pain control, opioid consumption, complications, and recovery times.



## Study Location:

The study was conducted at a tertiary care teaching hospital located in the metropolitan region, which provides comprehensive trauma care and critical care services. The ICU of this hospital is equipped to handle critically ill patients with multiple injuries, offering a suitable setting for the research.

## Study Duration:

The study was conducted over a period of 12 months, from January 2023 to December 2023. Data collection began in January 2023, with patient information being retrieved from hospital records and analyzed until December 2023.

## Sample Size:

A total of 200 polytrauma patients were included in the study. The sample size was calculated based on an expected 20% difference in opioid consumption between the two groups (opioid-based vs. multimodal analgesia) with a power of 80% and an alpha of 0.05. The final sample was divided into two groups: 100 patients in the opioid-based analgesic group and 100 patients in the multimodal analgesia group.

## Inclusion Criteria:

- Polytrauma patients admitted to the ICU who required pain management during their hospitalization.
- Patients who were administered either opioid-based analgesia or multimodal analgesia as part of their pain management protocol.
- Age between 18 and 65 years.
- Patients who provided informed consent or whose guardians provided consent for participation in the study.

## Exclusion Criteria:

- Patients who were admitted with isolated injuries or non-trauma-related conditions.
- Patients who were under the age of 18 or over 65.
- Pregnant patients or those with significant comorbidities such as severe hepatic or renal dysfunction.

- Patients who received inadequate documentation or whose data were incomplete or missing.

- Patients who were managed with non-standard pain management protocols (i.e., those not strictly following either opioid-based or multimodal analgesic strategies).

## Procedure and Methodology:

- **Patient Classification:** Patients were classified into two groups based on the primary method of pain management they received. The first group received opioid-based analgesia (morphine, fentanyl, etc.), while the second group received multimodal analgesia involving a combination of opioids with other analgesic agents such as acetaminophen, NSAIDs, or regional anesthesia techniques.

- **Pain Measurement:** Pain intensity was assessed using the Visual Analog Scale (VAS) at regular intervals (at least every 4 hours) during the ICU stay. Pain scores were recorded for the first 72 hours post-admission.

- **Opioid Consumption:** Total opioid consumption was measured in morphine milligram equivalents (MMEs) over the first 72 hours and compared between the two groups.

- **Complications:** The incidence of opioid-related complications (e.g., respiratory depression, nausea, constipation) was recorded based on clinical observation and patient-reported symptoms. Additionally, any adverse events related to multimodal analgesia, such as local anesthetic toxicity or renal impairment, were also documented.

- **Outcome Measures:** Recovery time was measured as the time to extubation, length of ICU stay, and discharge from the hospital. Long-term follow-up (3 months) included assessing the persistence of pain, opioid use at discharge, and quality of life post-discharge.

## Sample Processing:

Data from the patients' medical records, including demographic information, injury details, pain management protocols, opioid consumption, complication rates, and outcomes, were extracted using a



structured data extraction sheet. The data were anonymized to ensure patient confidentiality.

#### Statistical Methods:

Descriptive statistics were used to summarize the demographic characteristics and baseline data of the study participants. For comparing the two groups, the independent t-test was used for continuous variables such as opioid consumption, ICU stay, and recovery times. The chi-square test was used for categorical variables, including complications and side effects. Statistical significance was set at  $p < 0.05$ . A regression analysis was

conducted to control for potential confounding factors such as age, sex, and severity of injuries.

#### Data Collection:

Data was collected retrospectively through hospital records. The data extraction team, consisting of trained medical professionals and research assistants, ensured accurate and consistent data collection using predefined protocols. Patient outcomes were monitored and recorded at multiple time points, including during ICU admission, discharge, and follow-up visits at 3 months.

## OBSERVATION AND RESULTS

**Table 1: Comparison of Effectiveness of Opioid-Based vs. Multimodal Analgesia (n=200)**

Parameter	Opioid-Based Analgesia (Mean±SD or n%)	Multimodal Analgesia (Mean±SD or n%)	Test of Significance	95% CI	P-value
Mean Pain Score (VAS)	6.8	4.9	t-test	(1.3 to 2.5)	0.001
Total Opioid Consumption (MMEs)	85.7	45.3	t-test	(36.7 to 45.1)	0.0001
Respiratory Depression	22 (22.0%)	8 (8.0%)	Chi-square	$\chi^2=6.41$	0.011
Nausea & Vomiting	28 (28.0%)	13 (13.0%)	Chi-square	$\chi^2=5.21$	0.022
Length of ICU Stay (days)	6.4	5.1	t-test	(0.7 to 1.9)	0.008
Time to Extubation (hrs)	18.2	13.9	t-test	(3.4 to 5.6)	0.003

**Table 1** presents a comparative overview of critical care outcomes. The mean pain score (VAS) was significantly lower in the multimodal analgesia group (4.9) than in the opioid group (6.8), with a highly significant p-value of 0.001 and a confidence interval (CI) of 1.3 to 2.5. Similarly, total opioid consumption was markedly reduced in the multimodal group (45.3 MMEs) compared to the opioid group (85.7 MMEs), with a CI of 36.7 to 45.1 and a p-value  $< 0.0001$ , indicating substantial

opioid-sparing effects. Complications such as respiratory depression (22% vs. 8%) and nausea/vomiting (28% vs. 13%) were significantly higher in the opioid group ( $p=0.011$  and  $p=0.022$ , respectively). Recovery outcomes favored the multimodal group, with shorter ICU stays (5.1 vs. 6.4 days,  $p=0.008$ ) and reduced time to extubation (13.9 vs. 18.2 hours,  $p=0.003$ ), demonstrating better recovery trajectories.

**Table 2: Efficacy in Providing Adequate Pain Relief (VAS Scores) (n=200)**

Time Point	Opioid-Based Analgesia (Mean±SD)	Multimodal Analgesia (Mean±SD)	Test Significance	95% CI	P-value
At 12 hours	7.2 ± 1.1	5.4 ± 1.2	t-test	(1.3 to 2.3)	0.001
At 24 hours	6.3 ± 1.3	4.7 ± 1.1	t-test	(1.1 to 2.0)	0.002
At 48 hours	5.6 ± 1.4	3.9 ± 1.3	t-test	(1.2 to 2.3)	0.001

**Table 2** focuses specifically on the efficacy of pain relief using VAS scores over 48 hours. At all time points—12, 24, and 48 hours—multimodal analgesia consistently demonstrated significantly lower VAS scores (5.4, 4.7, and 3.9, respectively) than opioid-based therapy (7.2,

6.3, and 5.6), with p-values of 0.001, 0.002, and 0.001, respectively. The confidence intervals for all time points confirmed statistically significant reductions in pain intensity in favor of multimodal strategies.

**Table 3: Incidence of Side Effects and Complications (n=200)**

Complication	Opioid-Based Analgesia n(%)	Multimodal Analgesia n(%)	Test Significance	95% CI	P-value
Respiratory Depression	22 (22.0%)	8 (8.0%)	Chi-square	$\chi^2=6.41$	0.011
Nausea & Vomiting	28 (28.0%)	13 (13.0%)	Chi-square	$\chi^2=5.21$	0.022
Constipation	19 (19.0%)	7 (7.0%)	Chi-square	$\chi^2=4.85$	0.028
Delirium	15 (15.0%)	6 (6.0%)	Chi-square	$\chi^2=3.67$	0.055

**Table 3** outlines the incidence of side effects and complications. Opioid-related adverse effects were significantly more prevalent. Respiratory depression was recorded in 22% of patients on opioids compared to 8% in the multimodal group (p=0.011). Similarly, nausea and vomiting were more frequent in the opioid group (28%

vs. 13%, p=0.022). Constipation (19% vs. 7%, p=0.028) and delirium (15% vs. 6%, p=0.055) were also higher in the opioid group, though the latter was only borderline significant. These findings emphasize the reduced burden of systemic side effects with multimodal therapy.

**Table 4: Comparison of Recovery Outcomes Between the Two Strategies (n=200)**

Outcome	Opioid-Based Analgesia (Mean±SD or n%)	Multimodal Analgesia (Mean±SD or n%)	Test Significance	95% CI	P-value
ICU Stay (days)	6.4 ± 1.8	5.1 ± 1.5	t-test	(0.7 to 1.9)	0.008



Time to Extubation (hrs)	18.2 ± 3.7	13.9 ± 3.2	t-test	(3.4 to 5.6)	0.003
Persistent Pain at 3 months	21 (21.0%)	10 (10.0%)	Chi-square	$\chi^2=4.92$	0.026
Opioid Use at Discharge	34 (34.0%)	16 (16.0%)	Chi-square	$\chi^2=6.88$	0.009

**Table 4** evaluates recovery outcomes. Patients in the multimodal analgesia group had significantly shorter ICU stays ( $5.1 \pm 1.5$  days vs.  $6.4 \pm 1.8$  days,  $p=0.008$ ) and earlier extubation times ( $13.9 \pm 3.2$  hours vs.  $18.2 \pm 3.7$  hours,  $p=0.003$ ). Importantly, long-term outcomes also favored the multimodal group. Persistent pain at 3 months was reported in only 10% of multimodal patients versus 21% in the opioid group ( $p=0.026$ ), and opioid use at discharge was significantly lower (16% vs. 34%,  $p=0.009$ ). These results underline the sustained benefits of multimodal analgesia in reducing chronic pain and opioid dependence post-discharge.

## DISCUSSION

### Pain Control and Opioid Consumption (Tables 1 & 2)

The present study found significantly lower VAS pain scores in the multimodal group across all time points (12, 24, and 48 hours) with  $p$ -values  $<0.005$ , demonstrating superior pain control. This aligns with the findings of Kehlet and Dahl (2003) who advocated for multimodal analgesia due to its synergistic pain control benefits by targeting different pain pathways<sup>[7]</sup>.

Furthermore, total opioid consumption was nearly halved in the multimodal group (45.3 MMEs vs. 85.7 MMEs,  $p<0.0001$ ), reinforcing findings by Buvanendran et al. (2010), who showed that preemptive use of multimodal analgesics significantly reduces postoperative opioid use<sup>[8]</sup>. A similar opioid-sparing effect was reported in trauma settings by Kang et al. (2015)<sup>[9]</sup>.

### Adverse Events and Complications (Table 3)

Adverse effects such as respiratory depression, nausea, vomiting, and constipation were significantly more prevalent in the opioid group. This is consistent with the work of Benhamou et al. (2008) who highlighted the high incidence of opioid-induced side effects and recommended opioid-sparing strategies to minimize complications in ICU patients [10]. The reduced rates of

delirium and respiratory depression also parallel the results from Devlin et al. (2018), who emphasized the risk of oversedation and its impact on ventilator weaning and ICU stay<sup>[11]</sup>.

### Recovery Outcomes (Table 4)

Patients receiving multimodal therapy showed shorter ICU stays (5.1 vs. 6.4 days,  $p=0.008$ ) and faster extubation (13.9 vs. 18.2 hours,  $p=0.003$ ), confirming trends reported in McEvoy et al. (2016), who demonstrated enhanced recovery and faster ICU turnover in patients managed with enhanced recovery protocols including multimodal analgesia<sup>[12]</sup>.

Moreover, the lower incidence of persistent pain at 3 months and opioid use at discharge in the multimodal group is echoed in studies like Schug and Chandrasena (2015) and Chou et al. (2016), both of which found that early incorporation of multimodal analgesia reduces the risk of chronic opioid dependence and long-term pain syndromes<sup>[13,14]</sup>.

## CONCLUSION

The present study demonstrates that multimodal analgesia is significantly more effective than opioid-based monotherapy in the critical care management of polytrauma patients. Patients receiving multimodal therapy experienced superior pain control, reduced opioid consumption, fewer opioid-related complications such as respiratory depression and gastrointestinal side effects, and showed faster recovery outcomes, including shorter ICU stays and earlier extubation. Additionally, long-term benefits included lower incidence of persistent pain and reduced opioid dependency at discharge. These findings support the integration of multimodal analgesia into critical care protocols for polytrauma, offering a safer, more efficient, and outcome-oriented approach to pain management.



## LIMITATIONS OF STUDY

1. **Retrospective Design:** The study was based on retrospective data collection, which may be prone to documentation errors, missing data, and information bias, limiting the ability to establish causality.
2. **Single-Center Study:** The research was conducted at a single tertiary care center, which may limit the generalizability of the findings to other hospitals or healthcare settings with different protocols and resources.
3. **Heterogeneity in Injury Severity:** Despite efforts to standardize patient selection, variations in the severity, type, and location of injuries among polytrauma patients could have influenced pain perception and response to analgesia.
4. **Limited Control Over Analgesic Protocols:** The choice and combination of multimodal analgesic agents were based on clinician discretion, leading to variability in drug regimens that may affect outcomes.
5. **Lack of Blinding:** As an observational study, there was no blinding of healthcare providers or data collectors, which could introduce bias in treatment administration and outcome assessment.
6. **Short-Term Follow-Up:** Although 3-month outcomes were recorded, longer-term follow-up could provide better insight into chronic pain, functional recovery, and sustained opioid dependence.
7. **Psychosocial Factors Not Considered:** Factors such as patient anxiety, prior pain tolerance, or psychological status were not evaluated, though they may influence pain perception and analgesic efficacy.

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