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Study The Prevalence Of Hypocalcaemia In Polytrauma Patients In Emergency Department

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Abstract:
Background*: Polytrauma is a major global health challenge, often resulting in life-threatening complications.[1] Hypocalcaemia is an under recognized yet, critical electrolyte disturbance is increasingly observed in severely injured patients.[2] This study investigates the prevalence of hypocalcaemia in polytrauma patients and explores its associations with coagulopathy, complications, transfusion requirements, and patient outcomes.*
Objectives *: To determine the prevalence of hypocalcaemia among polytrauma patients presenting to the Emergency Department (ED) and evaluate associated complications, coagulopathy incidence, and transfusion needs.*
Methods*: A prospective observational study was conducted on patients presenting with polytrauma to the ED. Ionized calcium levels were measured on admission. Data regarding coagulopathy parameters, transfusion requirements, complications, and outcomes were collected and analyzed.*
Results*: Among the polytrauma patients evaluated, hypocalcaemia was found to be highly prevalent. A significant correlation was noted between hypocalcaemia and the incidence of coagulopathy, increased transfusion requirements, and higher complication rates. Patients with hypocalcaemia had notably poorer clinical outcomes compared to normocalcaemic counterparts.*
Conclusion*: Hypocalcaemia is a common and clinically significant finding in polytrauma patients upon ED arrival. It is associated with worsened coagulation profiles, increased transfusion demands, and adverse outcomes. Early recognition and correction of calcium imbalance may improve survival and reduce complications in this vulnerable population. These findings support routine calcium level assessment in initial trauma management protocols.*
Keywords: *Hypocalcaemia; Polytrauma; Emergency Department; Coagulopathy; Trauma Resuscitation; Ionized Calcium; Blood Transfusion.*

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I. Introduction

Polytrauma is a major global health burden, particularly affecting young adults due to road traffic accidents and increasingly the elderly due to falls and frailty[3, 4]. Despite advancements in trauma care, it remains a leading cause of mortality and morbidity worldwide[5]. The Emergency Department (ED) plays a crucial role in the initial stabilization of these patients, where timely recognition and management of complications are essential. Hypocalcaemia, defined as low ionized calcium levels, is frequently observed in polytrauma patients but often under recognized.[6] Calcium is vital for coagulation, myocardial function, and neuromuscular activity. Its depletion, due to hemorrhage, transfusion of citrate-containing blood products, or physiological stress, can exacerbate coagulopathy, increase transfusion requirements, and worsen clinical outcomes.[7] Coagulopathy, a common consequence of severe trauma, further complicates management by impairing hemostasis and increasing bleeding risk. Additionally, significant blood loss in these patients often necessitates transfusions, contributing to calcium imbalance.[8] This study aims to evaluate the prevalence of hypocalcaemia in polytrauma patients presenting to the ED and examine its association with coagulopathy, blood transfusion needs, and related complications, providing insights to guide early interventions and improve outcomes.

II. Material And Methods

The prospective cross-sectional study was conducted in the Emergency Department of MGM Medical College and Hospital, Navi Mumbai from August 2022 to December 2023. A total of 99 adult subjects (both male and females) of aged ≥ 18, years were for in this study.

Study Design: Prospective cross-sectional open label observational study.

Study Location: This was a tertiary care teaching hospital based study done in Emergency Department of MGM Medical College and Hospital, Navi Mumbai.

Study Duration: August 2023 to December 2024

Sample size: 99 patients.

Sample size calculation: The sample size was calculated based on the prevalence of hypocalcemia in polytrauma patients, estimated from previous studies to be 56.2%. Using the formula N=4PQD2N = \frac{4PQ}{D^2}N=D24PQ, where P=56.2%P = 56.2\%P=56.2%, Q=100−56.2=43.8Q = 100 - 56.2 = 43.8Q=100−56.2=43.8, and DDD (allowed error) = 10%, the required sample size was determined to be approximately 99 patients.

Subjects & selection method: Patients were recruited as they presented to the Emergency Department with polytrauma and met the inclusion criteria. A dedicated research team member approached each eligible patient or their legal representative to explain the study, answer any questions, and obtain informed consent.

Inclusion Criteria:
1. Patients presenting with polytrauma.
2. Patients with systolic blood pressure (SBP) less than 90 mmHg.
3. Patients aged 18 years or older.
4. Patients who provided informed consent.

Exclusion Criteria:
1. Patients with hypotension due to non-traumatic causes, such as burns, septic shock, or cardiogenic shock.
2. Patients under 18 years of age.
3. Patients who had received blood products prior to the initial ionized calcium measurement.

Procedure Methodology

This prospective observational study was conducted on polytrauma patients presenting to the Emergency Department (ED). Data were systematically collected using a structured proforma specifically designed for the study. The proforma included sections covering demographic details such as age, sex, and mode of arrival (e.g., via Emergency Medical Services or self-transportation).

Clinical history was recorded, including the alleged cause of injury—such as road traffic accidents, self-falls, or workplace injuries—and associated symptoms like vomiting, headache, seizures, amnesia, ENT bleeding, and loss of consciousness. Initial clinical assessment included evaluation of airway patency, respiratory rate and pattern, oxygen saturation (SpO_2), blood pressure, pulse rate, and Glasgow Coma Scale (GCS) score.

Interventions performed in the ED were documented, including intubation, administration of blood products (number of units of packed red blood cells [PRBC], fresh frozen plasma [FFP], and random donor platelets [RDP]), and other treatments as required.

The primary study intervention was the measurement of serum ionized calcium levels at three time points: on arrival, at 24 hours, and at 48 hours post-admission. Coagulation parameters (Prothrombin time [PT] and international normalized ratio [INR]) were also measured at these intervals. Additionally, lactate levels were assessed at presentation, 6 hours, and 24 hours to evaluate tissue perfusion and metabolic derangements. Electrocardiogram (ECG) findings were recorded on arrival and at 24 hours to detect any cardiac changes related to hypocalcemia.

Patient outcomes, including the development of complications such as coagulopathy and mortality, were also tracked to determine clinical correlations with hypocalcaemia.

Statistical Analysis

All collected data were entered into a Microsoft Excel database and analyzed using SPSS software. Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. The prevalence of hypocalcemia was calculated, and its association with various outcomes, such as coagulopathy and mortality, was analyzed using Chi-square tests for categorical variables and paired t-tests for continuous variables.

III. Result

Table no.1: The mean age of patients presenting with polytrauma in the Emergency Department was calculated to be 42.07 +/- 12.78 years, highlighting the diversity of ages within this population. The majority of cases were observed in the age groups of 31-50 years, collectively constituting 28.28% of the patients. Notably, individuals aged 31-40 years comprised the highest percentage at 28.28%, followed closely by those aged 41-50 years at 27.27%. Patients aged 19-30 years accounted for 15.15% of the cases, while those aged 51-60 years and over 60 years represented 18.18% and 11.11% of the total, respectively. This distribution underscores the broad spectrum of age groups affected by polytrauma and emphasizes the importance of age demographics in understanding the incidence and management of traumatic injuries in the ED.

Table 1: Age distribution of patients presenting with Polytrauma at ED

Age Group (years)	Frequency (n=99)	Percentage (%)
19-30	15	15.15
31-40	28	28.28
41-50	27	27.27
51-60	18	18.18
>60	11	11.11
Total	99	100%

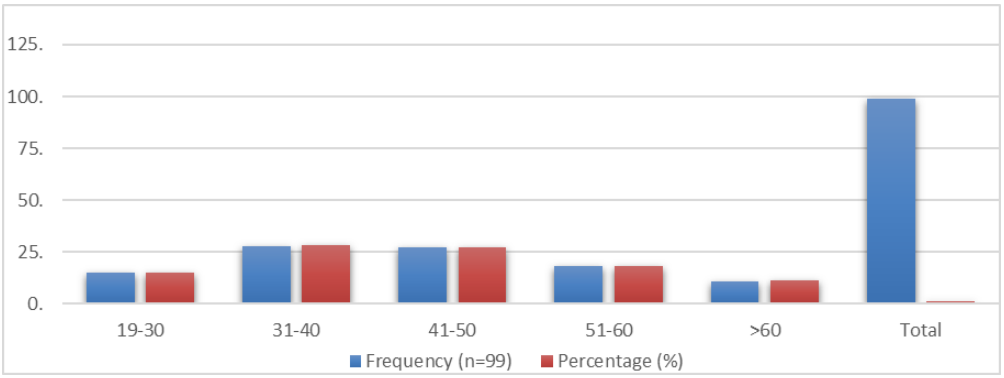


Table No. 2: The sex distribution among patients presenting with polytrauma in the Emergency Department (ED) reflects a predominantly male population, with males comprising 70.71% of the cases and females accounting for the remaining 29.29

Table 2: Sex distribution of patients presenting with polytrauma in ED

Gender	Frequency (n=99)	Percentage (%)
Male	70	70.71%
Female	29	29.29%
Total	99	100%

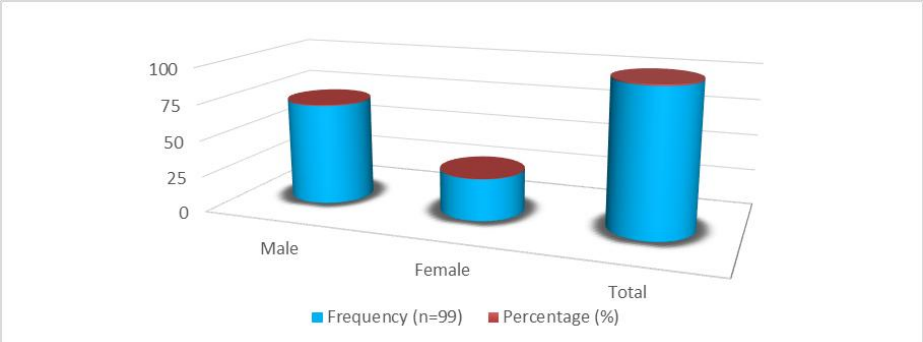


Table No.3: The laboratory reference range for serum calcium is 8.8 - 10.6 mg/dl. A serum calcium level below 8.8 mg/dl indicates significant hypocalcemia, which may require further evaluation and management to prevent potential complications. The study data on the prevalence of hypocalcemia among patients revealed significant findings. Overall, hypocalcemia (<8.8 mg/dL) was observed in 35.5% of the patients, with 20.2% at admission, increasing to 29.2% at 24 hours and remaining stable at 48 hours. Normo-calcemia (8.8–10.6 mg/dL) was the most common, present in 65% of patients overall, 77.7% at admission, and around 65.6% at both 24 and 48 hours. Hypercalcemia (>10.6 mg/dL) was less prevalent, observed in 8.8% overall, 3.3% at admission, and slightly rising to 6.6% at 24 and

48 hours. This data highlights the variability and prevalence of calcium level disturbances in the study population over time.

Table 3: Prevalence of hypocalcemia among study patients

Serum Calcium level	Overall Hypocalcem ia n (%)	At Admission n(%)	At 24 hours n (%)	At 48 hours n (%)
Hypocalcemia (<8.8 mg/dL)	35 (35.5%)	20 (20.2%)	29 (29.2%)	29 (29.2%)
Normo-calcemia (8.8–10.6 mg/dL)	65 (65%)	77 (77.7%)	65 (65.6%)	65 (65.6%)

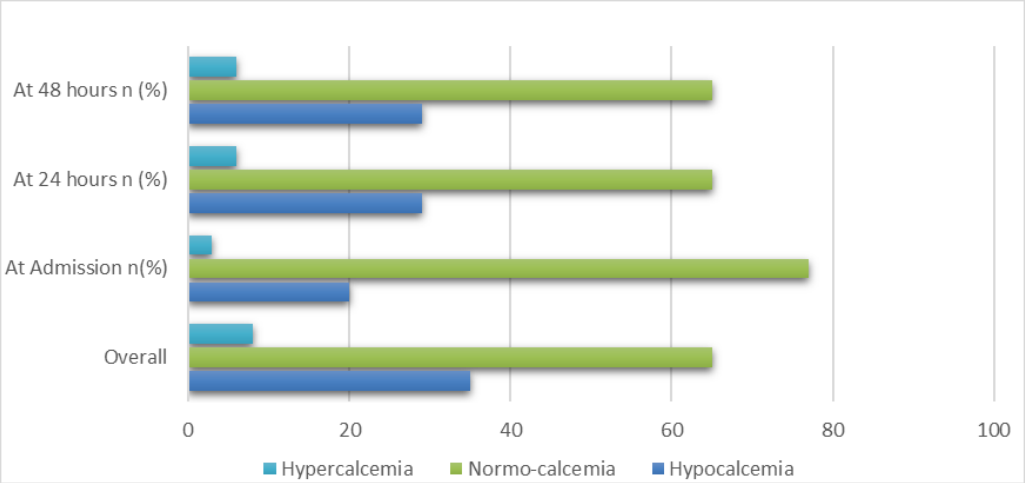


Table No.4: Among the cases studied, various modes of injury were identified, each representing a significant proportion of the total. Hypothermia (<34°C) accounted for 29% of cases, indicating a notable incidence of cold-induced injury. Metabolic acidosis, with a pH below 7.5, was observed in 99% of cases, suggesting a substantial prevalence of acid- base disturbances. Serum lactate levels exceeding 2mmol/L were found in 97% of cases, indicating tissue hypoperfusion and anaerobic metabolism. Coagulopathy, defined by a PT (INR) greater than 1.3, affected 14% of cases, highlighting the presence of clotting abnormalities in a notable proportion of patients. These findings underscore the multifactorial nature of injuries encountered in the studied population, necessitating comprehensive assessment and management strategies tailored to address the diverse manifestations of trauma.

Table 4: Complications associated with hypocalcemia among polytrauma patients at ED

Complications	Frequency (n)	Percentage (%)
Hypothermia (<34°C)	29	29.3%
Metabolic acidosis (pH<7.5)	99	99.9%
Serum lactate level (>2mmol/L)	97	97.9%
Coagulopathy (PT(INR)>1.3)	14	14.14%

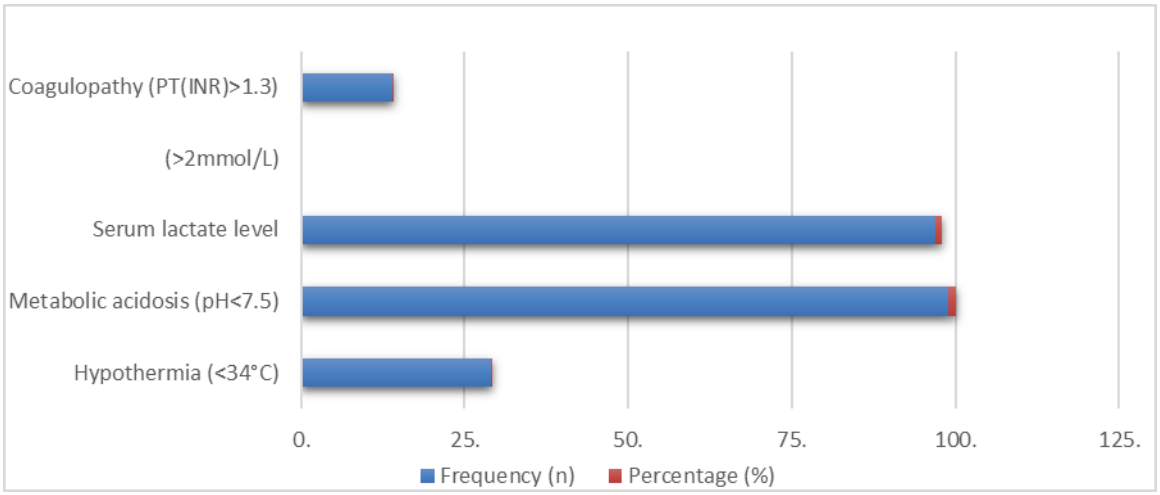


Table No.5: The prevalence of complications in hypocalcemic versus non-hypocalcemic patients indicates that hypocalcemia is associated with a higher frequency of coagulopathy (23.68% vs. 11.48%, p=0.023) and metabolic acidosis (65.79% vs. 59.02%, p=0.04). Additionally, hypocalcemic patients exhibit higher mean S. Lactate levels (7.36 mmol/L vs. 5.09 mmol/L, p=0.045), though there is no significant difference in mean INR between the groups (1.16 vs. 1.10, p=0.643). These results highlight the significant impact of hypocalcemia on certain complications in patients

Table 5: Prevalence of complications in hypocalcemic versus non-hypocalcemic patients

Complication	Non-hypocalcaemic (%) or mean	Hypocalcaemic(%) or mean	P-value
Coagulopathy (%)	11.48	23.68	0.023*
Metabolic Acidosis (%)	59.02	65.79	0.04*
Mean S. Lactate level (mmol/L)	5.09	7.36	0.045#
Mean INR	1.10	1.16	0.643#

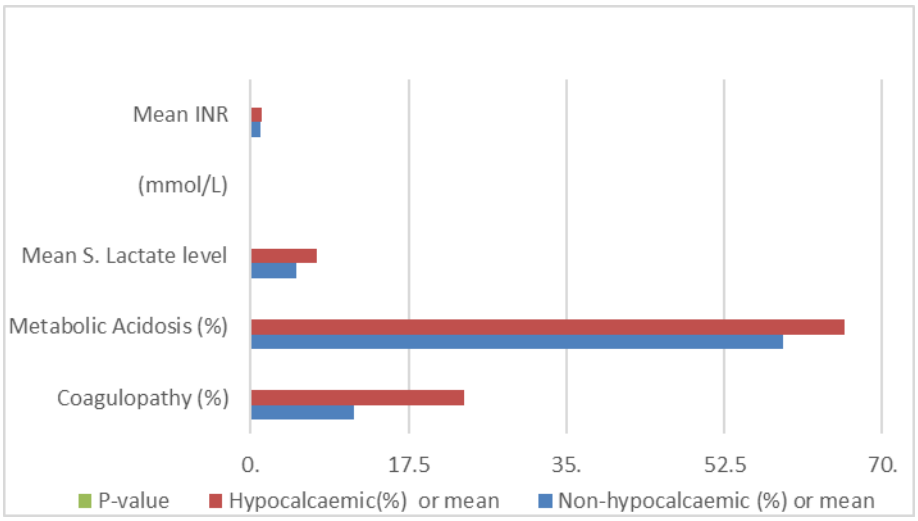


Table No.6: The study data on the requirement of blood transfusion among polytrauma patients at the Emergency Department (ED) shows significant findings. Out of the total patients, 42 (42.4%) required blood transfusion. Among those who needed transfusions, the components included Packed Cell Volume (PCV) in 73 units (73.73%), Random Donor Platelets (RDP) in 68 units (68.68%), and Fresh Frozen Plasma (FFP) in 66 units (66.6%).

Table 6: Requirement of Blood transfusion among polytrauma patients at ED

Requirement of Blood transfusion	No of Units (n)	Percentage (%)
Requirement of Blood Transfusion	42 patients	42.4%
Packed Cell Volume (PCV)	73 units	73.73%
Random Donor Platelets (RDP)	68 units	68.68%
Fresh frozen plasma (FFP)	66 units	66.6%

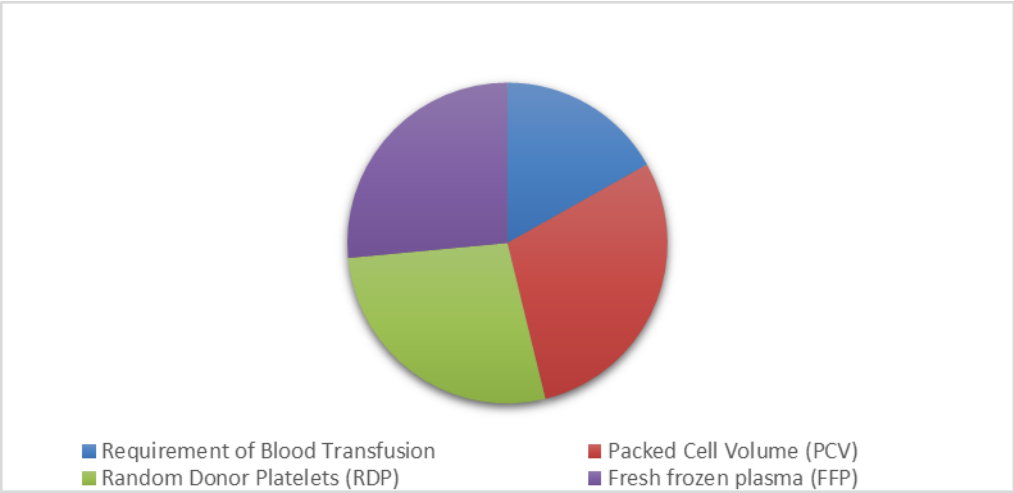
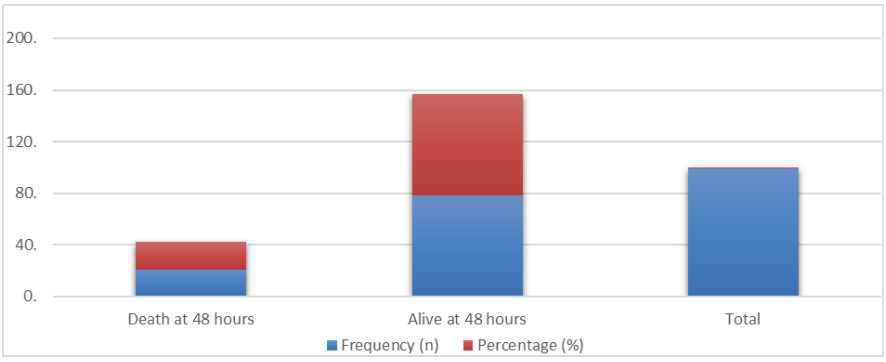


Table No.7: Among the polytrauma patients treated at the Emergency Department, outcomes varied, reflecting the diverse clinical trajectories observed in this population. Death occurred in 21% of cases, underscoring the severity of injuries and the potential for life- threatening complications. The majority of patients, comprising 78%, were alive at 48 hours.

Table 7: Outcome among polytrauma patients at ED

Outcome	Frequency (n)	Percentage (%)
Death at 48 hours	21	21.2
Alive at 48 hours	78	78.78
Total	99	100%



IV. Discussion

This study highlights the high burden of hypocalcemia and related complications among polytrauma patients presenting to the Emergency Department (ED). Polytrauma continues to pose a significant challenge to emergency care, particularly due to its association with hemorrhagic shock, coagulopathy, and multi-organ dysfunction.[9]

In our cohort, the mean age of patients was 42.07 years, with the majority in the 31–50 years age group

reflecting the active demographic most prone to high-energy trauma, especially road traffic accidents. These findings are consistent with prior studies by Rezaei et al.[10] and Abdulrahman et al.[11], which emphasize middle-aged adults as a key at-risk population.The sex distribution in our study showed a strong male predominance (70%), mirroring trends observed in both civilian and combat trauma populations. This disparity is well-documented and is often attributed to increased risk exposure among males due to occupational and behavioral factors.

Hypocalcemia is a common complication in polytrauma patients, resulting from both the initial injury and subsequent medical interventions, such as blood transfusions with citrate-containing products A study by Helsloot et al.[12] also noted a higher prevalence of male patients (71.7%) in their study on trauma-induced disturbances in ionized calcium levels. The consistent findings across these studies highlight the need for targeted prevention strategies for male populations, who are at higher risk.

Hypocalcemia, observed in 35.5% of our patients, showed a progressive increase over 48 hours post-admission. This trend aligns with previous findings by Vasudeva et al.[13] and Magnotti et al.[14], who demonstrated a high prevalence of admission hypocalcemia in trauma patients, associating it with coagulopathy and increased transfusion needs. The underlying pathophysiology involves citrate chelation from transfused blood products, intracellular calcium shifts due to metabolic stress, and impaired parathyroid hormone responses all contributing to reduced ionized calcium availability during critical resuscitation phases.[15]

Hypocalcemia not only exacerbates trauma-induced coagulopathy but also impairs cardiac contractility and vascular tone, thus worsening shock states. In our study, 59.86% of patients exhibited coagulopathy, reinforcing the observations by Puranik et al.[16] and Wray et al.[17], who proposed that calcium deficiency should be considered a fourth component of the traditional lethal triad of trauma—alongside acidosis, hypothermia, and coagulopathy.

Additionally, metabolic acidosis (99.9%), hyperlactatemia (97.9%), and hypothermia (29.3%) were frequently encountered. These findings reflect the profound systemic insult in polytrauma, with elevated lactate serving as a surrogate marker of tissue hypoperfusion. Our observations support prior evidence from Keel[9] and Trentz and Cornelius et al.[18], which suggest that hypocalcemia impairs perfusion and lactate clearance, further aggravating acid-base imbalance and organ dysfunction.

Blood transfusions were required in 42.4% of patients, with packed red blood cells being the most frequently administered component. This need reflects the severity of hemorrhage and further contributes to the risk of transfusion-induced hypocalcemia. These findings corroborate with those of Magnotti et al.[14] and Wray et al.[17], who emphasized the critical interplay between transfusion volume, calcium chelation, and coagulopathy in trauma care.

The mortality rate of 21.2% in our cohort underscores the lethal potential of polytrauma, especially when complicated by systemic inflammatory response syndrome (SIRS), compensatory anti-inflammatory response syndrome (CARS), and subsequent multiple organ dysfunction syndrome (MODS). It is observed that, this immune dysregulation in response to sequential "hits" following trauma (e.g., ischemia-reperfusion injury, surgery, infection) plays a pivotal role in adverse outcomes.[19, 20]

Despite the successful transfer of 78.78% of patients to the ward, the complexity of polytrauma necessitates vigilant ongoing care due to the risk of delayed complications such as infections, organ failure, and persistent coagulopathy. Early identification and correction of hypocalcemia should be integrated into trauma resuscitation protocols to optimize outcomes.[12, 14]

However, this study is not without limitations. The relatively small sample size and single-center design may limit generalizability. Furthermore, the reliance on total serum calcium, rather than ionized calcium the physiologically active form may have underestimated the true prevalence of hypocalcemia. The observational nature and lack of a control group also preclude causal inferences.

V. Conclusion

In conclusion, based on our findings, managing polytrauma patients requires a comprehensive approach to address the intricate pathophysiological challenges like acidosis, hypothermia, coagulopathy along with hypocalcemia they face. Effective early resuscitation, including timely blood transfusions and calcium supplementation, is critical for stabilizing patients and preventing further complications such as coagulopathy and cardiovascular dysfunction. Maintaining calcium homeostasis is essential for proper coagulation and cardiovascular function, while prompt management of metabolic acidosis and hypothermia is crucial for improving patient outcomes. Overall, our findings highlight the importance of a proactive, multifaceted strategy in the management of polytrauma patients to significantly enhance survival rates in the first 48 hours.

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