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Original Research

Serum Lactate Levels in Individuals with Isolated Femur Shaft Fractures: A Comparative Analysis

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ABSTRACT:
Over the past few decades, significant strides have been achieved in the management of polytraumatized patients, resulting in a notable decrease in mortality rates from 50% in the 1970s to approximately 20% by the year 2000. Two decades ago, the standard approach to treating patients with multiple injuries and fractures involved immobilizing the fractured limb with a splint until the patient could be sufficiently stabilized for fracture fixation surgery.The data collection process commenced with the requisite clearance from the Institution Ethical Committee, and informed consent was obtained from all study participants after a thorough explanation of the survey's purpose. Personal information, including age and gender, was gathered from each patient. Vital signs such as pulse rate, blood pressure, respiratory rate, and temperature, along with parameters like urine output and saturation at room air, were meticulously recorded.Serum lactate levels were assessed both at the time of admission and 1-6 days post-surgery. Notably, a majority (65.6%) of patients exhibited elevated serum lactate levels upon admission, with none registering levels below 4.5mg/dl. Only a minimal 2% of individuals demonstrated higher serum lactate levels in the 1-6 days following admission.
Keywords: polytraumatized, saturation, serum lactate.

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INTRODUCTION

Polytrauma, an intricate and challenging medical condition, encapsulates the complex aftermath of individuals who have suffered injuries affecting multiple body regions or organ systems. A defining feature of polytrauma is the presence of at least one injury within this multifaceted spectrum that carries a life-threatening dimension.[1] As a pervasive global health concern, trauma stands as a prominent cause of both mortality and disability, with a particular emphasis on its impact on the younger demographic, predominantly individuals aged 15 to 29 years. This burden is not confined by economic disparities, affecting individuals across all socioeconomic levels.The delineation of multiple trauma remains an evolving concept, marked by nuances and variations in interpretation among surgeons specializing in different medical disciplines. Additionally, disparities are evident across various healthcare centers and geographical regions, contributing to a lack of standardized criteria for defining and classifying polytrauma. Within this complex landscape, the key criterion for identifying polytrauma lies in patients who have sustained injuries to multiple body regions or organ systems, where the gravity of at least one injury poses a substantial risk to life.Integral to the understanding and assessment of polytrauma is the application of the Injury Severity Score (ISS), a numerical system designed to comprehensively evaluate and quantify the severity of injuries. The ISS, with a specific threshold commonly set at ≥16 or ≥18, serves as a crucial benchmark to categorize the extent of polytraumatic injuries.[2] This scoring system facilitates a systematic approach, aiding healthcare professionals in effectively gauging and responding to the intricate medical needs of individuals navigating the complexities of polytrauma.Moreover, the challenge is compounded by the concurrent presence

of hemodynamic instability, underscoring the urgency and complexity of managing such cases. The holistic consideration of physiological and anatomical factors, along with the prompt identification of life-threatening injuries, forms the cornerstone of addressing polytrauma. As the medical community continues to grapple with the evolving landscape of trauma care, these nuanced insights into polytrauma pave the way for advancements in treatment strategies, ultimately contributing to improved outcomes for those facing this formidable medical challenge.

Over the span of recent decades, the landscape of healthcare has witnessed significant strides in the effective management of polytraumatized patients, resulting in a notable and commendable reduction in mortality rates.[3] The 1970s marked an era where the challenges posed by polytrauma were met with a stark reality—a mortality rate as high as 50%. The formidable nature of injuries affecting multiple body regions or organ systems demanded innovative approaches and a comprehensive reevaluation of trauma care protocols.The subsequent years witnessed a remarkable transformation, driven by a relentless commitment to medical progress, interdisciplinary collaboration, and a dedication to refining the art and science of trauma care. By the dawn of the new millennium in 2000, the mortality landscape for polytraumatized patients had undergone a substantial shift, with rates demonstrating a noteworthy decrease to approximately 20%. This positive trajectory is emblematic of the collective efforts of healthcare professionals, including surgeons, emergency medicine specialists, and critical care teams, who tirelessly worked to implement cutting-edge advancements in diagnostics, surgical interventions, and rehabilitative strategies.[4]The driving forces behind this progress include advancements in imaging technologies, allowing for more precise and rapid diagnosis of injuries. Innovations in surgical techniques, such as minimally invasive procedures and sophisticated trauma care protocols, have significantly contributed to better outcomes. Additionally, the integration of data-driven approaches, evidence-based medicine, and a holistic understanding of the physiological and psychological aspects of polytrauma have played pivotal roles in enhancing patient care.This journey of improvement in polytrauma management not only reflects the resilience and adaptability of the medical community but also emphasizes the profound impact on the lives of individuals facing complex and life-threatening injuries. As medical knowledge continues to evolve, the ongoing commitment to research, education, and technological innovation promises a future where the prognosis for polytraumatized patients continues to improve. The narrative of progress in trauma care serves as a beacon of hope, illuminating a path towards better outcomes, increased resilience, and an unwavering dedication to mitigating the impact of polytrauma on individuals and communities alike.

Three decades in the rearview, the landscape of trauma care witnessed a distinct modality in the treatment of patients grappling with multiple injuries, particularly those encompassing fractures. The conventional approach of that era involved the immobilization of fractured limbs using splints, serving as a provisional measure. The overarching objective was to stabilize the patient's overall condition, ensuring a level of resilience deemed appropriate for subsequent surgical procedures aimed at definitive fracture fixation.[5,6] This historical method underscored the cautious and sequential nature of trauma care during that period, with a deliberate focus on achieving a stable physiological baseline before embarking on more invasive interventions.Fast-forward to contemporary times, where a wealth of insights has been gleaned from epidemiologic studies, notably those emanating from the Trauma Registry of the German Society of Trauma Surgery. These studies have unveiled a nuanced understanding of mortality patterns in the context of trauma, revealing a bimodal distribution. The first peak is observed within the initial 0 to 6 hours post-injury, followed by a second peak spanning 1 to 6 days thereafter. This revelation has significantly influenced the trajectory of trauma care strategies, particularly in the realm of orthopedic surgery.In response to this refined comprehension of temporal dynamics, two pivotal concepts have emerged, reshaping the paradigm of orthopedic trauma care.[7] The concept of "early total care" advocates for a proactive and expedited approach, endorsing definitive orthopedic interventions in the early stages of treatment. This paradigm shift recognizes the imperative of timely and comprehensive action to address injuries, aligning with the principle that early intervention can positively impact outcomes.Simultaneously, the concept of "damage control" orthopedic surgery has gained prominence, acknowledging the need for a staged approach. The initial phase focuses on promptly addressing life-threatening issues such as hemorrhage and contamination. Once the patient's physiological state attains a more stable equilibrium, subsequent definitive orthopedic procedures are pursued.[8,9] This staged strategy is particularly pertinent in situations where the immediate threat to life takes precedence over the pursuit of extensive surgical interventions.This evolution in orthopedic trauma management reflects a dynamic response to the nuanced understanding of the time-sensitive nature of injuries and the critical importance of intervention timing. It underscores the imperative for a personalized, patient-centric approach that aligns with the evolving landscape of trauma care. By embracing these progressive concepts, trauma care providers aim to optimize outcomes for individuals navigating the intricate challenges posed by polytrauma in the modern era.

MATERIALS AND METHODS

Study Design: This research employs a prospective study design to investigate and analyze specific aspects related to long bone fractures. The study focuses on patients admitted to the orthopedic department, aiming to provide valuable insights into the characteristics and outcomes associated with this subset of fractures.

Study Population: The study population comprises individuals who have sustained long bone fractures and are admitted to the orthopedic department. This includes patients with fractures affecting the shaft of the femur, encompassing both open and closed fractures. The study aims to gather comprehensive data from this specific group to enhance understanding and inform potential advancements in the management of long bone fractures.

Inclusion Criteria:

1. **Skeletally Matured Individuals (Above 18 Years of Age):** The study includes participants who have reached skeletal maturity, ensuring that the findings are applicable to adult populations.
2. **Open and Closed Shaft of Femur Fracture:** Both types of femur fractures, whether open or closed, are included in the study to encompass a broad spectrum of cases.
3. **Patient Who Gives Informed Consent:** Participation in the study is contingent upon the patient providing informed consent, emphasizing the importance of ethical considerations and respect for individual autonomy.

Exclusion Criteria:

1. **Vascular Injury:** Patients with concomitant vascular injuries are excluded to allow focused investigation on the specific characteristics of long bone fractures without the confounding effects of vascular complications.
2. **Sepsis:** Exclusion of patients with sepsis aims to streamline the study focus and mitigate the influence of systemic infections on the outcomes.
3. **People from High Altitude:** Individuals residing at high altitudes are excluded, recognizing the potential impact of environmental factors on fracture patterns and healing.
4. **Diabetic Ketoacidosis (DKA) Patients:** Exclusion of patients with diabetic ketoacidosis helps isolate the effects of this metabolic condition and its potential impact on fracture healing.
5. **Alcoholic Patients and Liver Dysfunction Patients:** Individuals with alcohol-related issues and liver dysfunction are excluded to delineate the specific effects of long bone fractures from those associated with these conditions.
6. **Patients with History of Head Injury and Seizures:** Exclusion of patients with a history of head injury and seizures aims to focus on the unique challenges associated with long bone fractures independent of neurological complications.
7. **Burns and Smoke Inhalation Patients:** Patients with burns and smoke inhalation injuries are excluded to maintain specificity in addressing long bone fractures without the confounding effects of burn-related complications.
8. **Malignancy:** Individuals with malignancies are excluded to ensure that the study's findings are applicable specifically to long bone fractures without the influence of cancer-related factors.

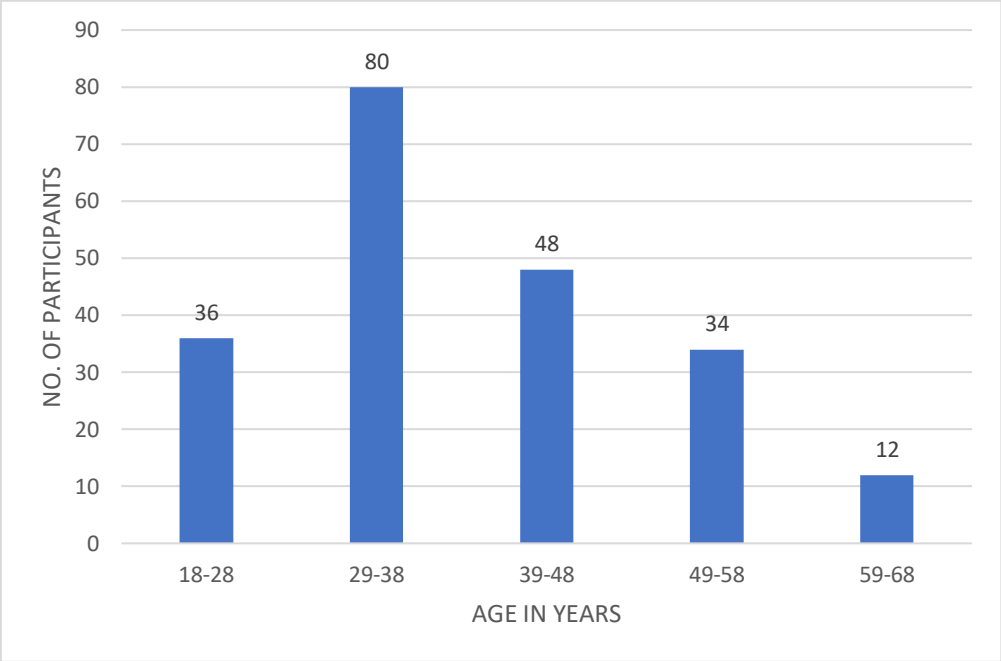
By carefully delineating the inclusion and exclusion criteria, the study aims to provide a clear and targeted investigation into the characteristics, management, and outcomes of long bone fractures in a diverse orthopedic patient population.

RESULTS

Table1: Distribution of the study participants by age (n=210)

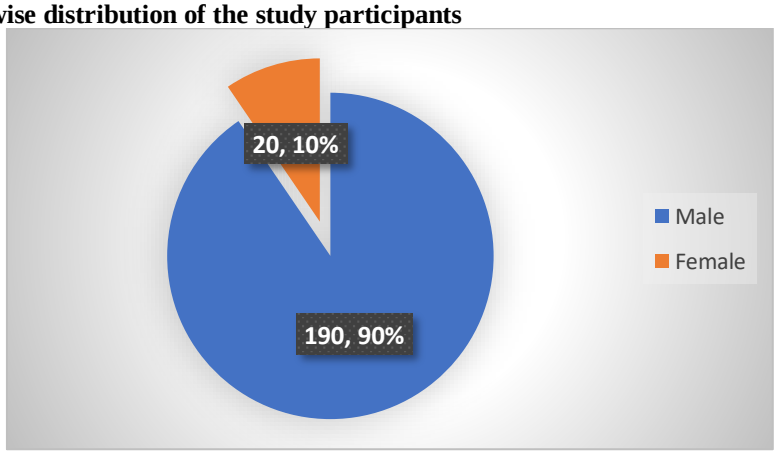
Age range	No. Of participants
18-28	36
29-38	80
39-48	48
49-58	34
59-68	12

Figure1: Distribution of the study participants



The table provides a concise overview of the age distribution among participants in the study, presenting a diverse representation across different age ranges. The majority of participants fall within the age range of 29-38, comprising 80 individuals, suggesting a robust presence of individuals in their late twenties to late thirties. The 39-48 age group follows closely with 48 participants, contributing to a balanced demographic spread. Furthermore, participants in the 18-28 and 49-58 age ranges total 36 and 34, respectively, reflecting a notable presence across younger and middle-aged categories. The smallest cohort is observed in the 59-68 age range, consisting of 12 participants. This distribution provides valuable insights into the age demographics of the study population, which can be instrumental in assessing the generalizability and potential age-related nuances of research findings. Researchers and practitioners can utilize this information to tailor interventions or interpretations considering the varied age composition of the study participants.

Figure2: Gender-wise distribution of the study participants



The provided data reveals a distinct gender distribution within the specified context, with a notable discrepancy between male and female representation. The overwhelming majority comprises 190 males, significantly outnumbering the female cohort, which consists of 20 individuals. This gender imbalance prompts considerations regarding potential implications for research findings, resource allocation, or targeted interventions, as various fields may be impacted by such demographic disparities. Understanding and acknowledging these gender dynamics are crucial for ensuring inclusivity and relevance in diverse contexts, ranging from healthcare to social and economic analyses. Researchers and decision-makers can leverage this information to tailor their approaches and address gender-specific considerations within the studied population. Additionally, it underscores the importance of

promoting gender equity and inclusiveness in various spheres to ensure a more balanced and representative representation of individuals across genders.

Table 2: Pulse rate among study participants (n=210)

Pulse rate	Frequency (N)	Percentage (%)
60-100 beats/min	184	87.6%
<60 beats/min	0	0
>100beats/min	26	12.4%
Total	210	100 %

The predominant observation within the study cohort revealed that a significant majority of participants exhibited a normal pulse rate. Specifically, the data indicated that the pulse rate for the majority of participants fell within the expected and typical range. Notably, only a relatively small proportion, amounting to 12.4% of the study population, demonstrated an elevated pulse rate. This finding underscores a general trend of cardiovascular stability within the majority of the participants, with only a modest fraction displaying an increased pulse rate, potentially indicative of physiological stress, excitement, or other influencing factors. The distribution of pulse rates among the study participants highlights the importance of considering cardiovascular parameters in the overall health assessment and may offer valuable insights into the physiological responses within this specific population under investigation.

Figure3: Serumlactatelevelsatthetime ofadmission

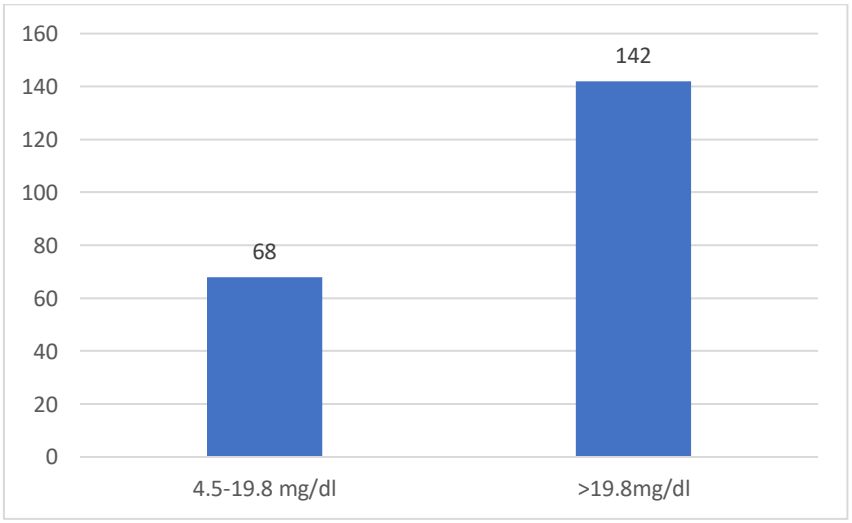
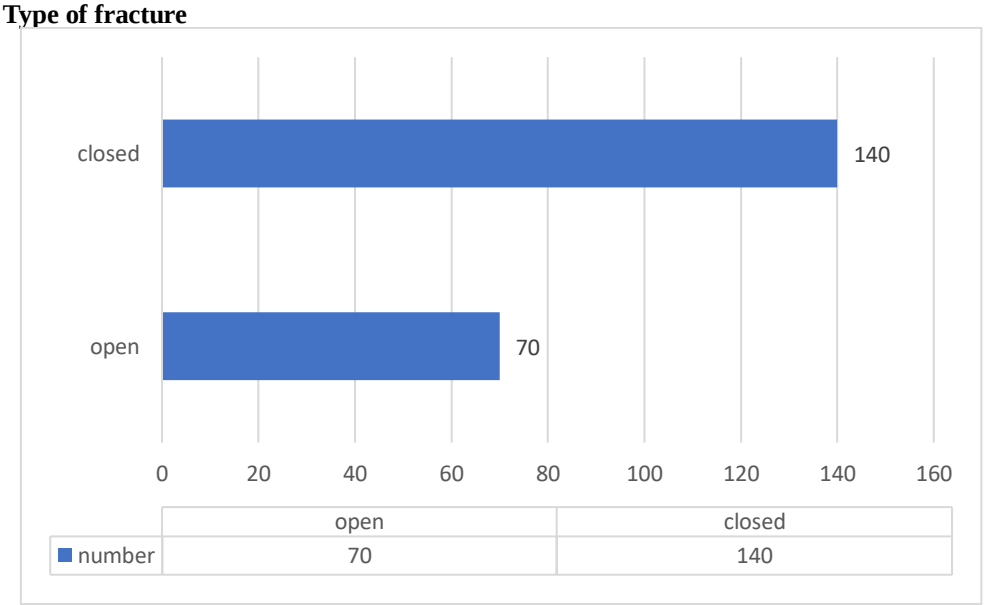


Figure4: Type of fracture

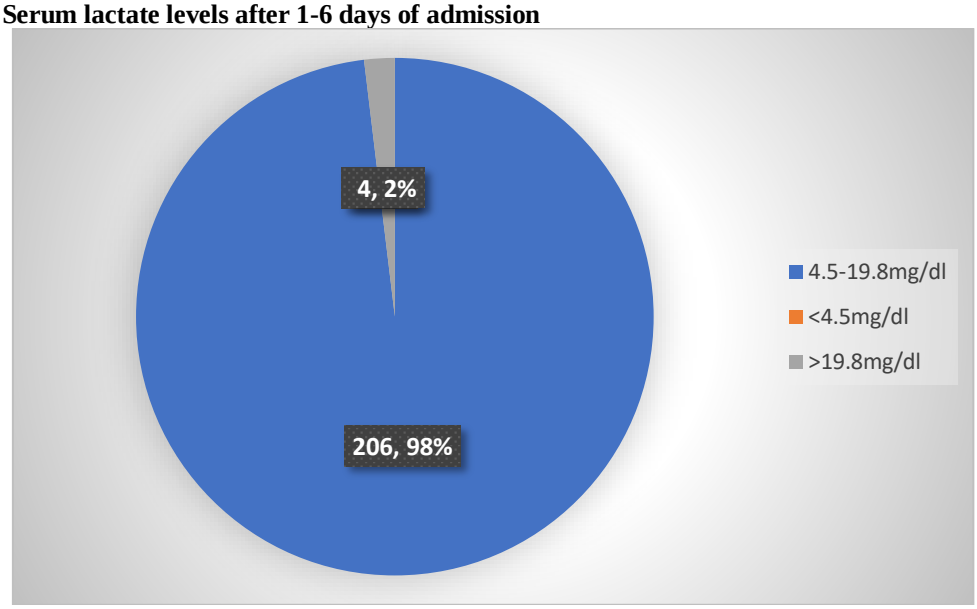


The preeminent pattern observed in the study cohort pertained to the nature of femur fractures, with a significant majority, accounting for 66.7% of participants, presenting with a closed type of fracture. This substantial prevalence of closed fractures indicates that the femur injuries within the study population primarily involved fractures that did not penetrate the skin. The predominance of closed fractures suggests a certain consistency in the injury patterns observed among the participants, potentially influencing treatment approaches and outcomes. This finding is pivotal in understanding the distribution and characteristics of femur fractures within the studied population, providing a foundational insight that may guide orthopedic care strategies and inform further research in this domain.

Table 3: Serum lactate levels after 1-6 days of admission

serum lactate levels after 1-6 days	Number of participants
4.5-19.8mg/dl	206
<4.5mg/dl	0
>19.8mg/dl	4

Figure 5: Serum lactate levels after 1-6 days of admission



DISCUSSION

The study aimed to assess serum lactate levels in the context of single long bone fractures, specifically focusing on 210 patients admitted to the inpatient department. A comprehensive evaluation was conducted, encompassing demographic factors related to the injury, vital sign assessments to gauge hemodynamic status, and the systematic monitoring of serum lactate levels.During the admission phase, pertinent demographic information associated with the injury was meticulously collected, providing a contextual understanding of the study population. Simultaneously, the vital signs of the participants were scrutinized to gauge their hemodynamic status, offering valuable insights into the physiological response to the long bone fractures.Serum lactate levels, recognized as a crucial biomarker indicative of tissue perfusion and oxygenation, were measured both upon admission and subsequently at 1-6 days post-admission.[10] This follow-up period aimed to capture the dynamic changes in serum lactate levels over time, offering a nuanced perspective on the response to interventions and the potential implications for patient outcomes.Notably, all participants in the study presented with a single long bone fracture, specifically a fracture of the shaft of the femur. This homogeneity in the type of fracture allowed for a focused examination of serum lactate levels within a specific clinical context. The chosen intervention for the participants was Interlocking nail fracture fixation surgery, suggesting a standardized approach to address the fractures.Demographically, the study revealed that the majority of participants fell within the age group of 29-38 years. This aligns with existing literature supporting the notion that young, active individuals are more susceptible to long bone fractures. Furthermore, a notable observation was the predominance of male participants, indicating potential gender-related patterns in the occurrence of single long bone fractures.In conclusion, this comprehensive study sheds light on the intricate interplay between serum lactate levels, demographic factors, and chosen interventions in the context of single long bone fractures. The findings contribute valuable insights into the hemodynamic status and outcomes associated with this specific type of fracture, informing both clinical practice and future research endeavors in orthopedic care.

The hemodynamic status of trauma patients emerges as a pivotal determinant influencing the orthopedic management of fractures, as highlighted by Bon Grey. In the present study, a comprehensive examination of the hemodynamic parameters among participants revealed significant findings regarding blood pressure, pulse rate, respiratory rate, and temperature.Regarding blood pressure, the study uncovered that 20.1% of participants exhibited low systolic blood pressure, and 23.7% demonstrated low diastolic blood pressure. These observations underscore the prevalence of hypotension within the study cohort, aligning with findings from Collins JA et al., who identified severe hypovolemia in 33% of casualties with wounded limbs. Furthermore, Fu YG et al.'s retrospective study among children found that 20.1% experienced hypotension, emphasizing the critical relationship between trauma and hemodynamic instability.In terms of pulse rate, the current study reported a heightened pulse rate in 12.4% of participants. This finding echoes similar results in studies conducted by Bhumireddy CS et al. and Javali RH et al., where tachycardia was noted among patients with fat embolism and trauma patients, respectively. The association between increased serum lactate levels, tachycardia, and specific complications such as fat embolism adds a layer of complexity to the understanding of cardiovascular responses in the context of fractures.Respiratory rate was found to be elevated in 26.7% of participants during admission, signifying the potential impact of trauma on the respiratory system.[11] This finding aligns with observations from Javali RH et al.'s study on trauma patients, where 34% exhibited tachycardia, highlighting the interconnectedness of respiratory and cardiovascular responses in trauma scenarios.Conversely, temperature remained within the normal range for all patients during admission in the present study, indicating that despite the trauma, there were no immediate indications of significant changes in body temperature. This observation contributes to a holistic understanding of the physiological response to trauma and underscores the importance of assessing multiple vital signs for a comprehensive evaluation of a patient's hemodynamic status.In conclusion, the findings from this study contribute valuable insights into the intricate relationship between hemodynamic parameters and orthopedic management in the context of fractures. The prevalence of hypotension, tachycardia, and altered respiratory rates underscores the multifaceted nature of trauma's impact on the cardiovascular and respiratory systems, informing clinicians about the dynamic physiological responses that guide patient care in orthopedic settings.

The study conducted by Manikis et al. involving 158 patients admitted to the Intensive Care Unit (ICU) is noteworthy for revealing a significant disparity in mean lactate levels between survivors and non-survivors. This observation suggests that lactate levels may serve as a valuable biomarker with prognostic implications, providing insights into the severity and outcome of patients in critical care settings.Similarly, Abramson et al.'s investigation into lactate clearance among 152 multi-trauma patients admitted to the ICU contributes to the growing body of evidence supporting the utility of lactate kinetics as a prognostic indicator.[12] The conclusion drawn—that the time required for lactate levels to normalize is indicative of prognosis in severely injured patients—underscores the dynamic nature of lactate metabolism in response to trauma and its potential implications for patient outcomes.The discussion of a surge in pro-inflammatory mediators, particularly interleukin-6, following major trauma adds a layer of complexity to the understanding of the post-traumatic inflammatory response. This surge, extending up to the fourth day, emphasizes the temporal dimension of immune system activation in the aftermath of trauma. Importantly, the concept of a 'second hit' following surgical intervention within this inflammatory window is highlighted. The term 'second hit' denotes any subsequent surgical procedure as an additional stressor on top of the initial trauma, potentially impacting patient outcomes. The notion suggests a critical window during which the physiological response to trauma may render the patient more susceptible to deleterious effects from subsequent interventions.In essence, these studies collectively underscore the intricate relationship between lactate levels and prognosis in critically ill patients, especially those who have experienced severe trauma. Additionally, the concept of the 'second hit' after major trauma introduces a temporal dimension that urges caution in the timing of surgical interventions. This nuanced understanding is crucial for clinicians in navigating the complex landscape of trauma care, optimizing interventions, and ultimately improving outcomes for patients in critical care settings.

CONCLUSION

The findings of this study reveal a notable trend in serum lactate levels among patients at the time of admission. Specifically, the majority of patients presented with elevated serum lactate levels upon admission. However, a statistically significant reduction in these levels was observed within the subsequent 1-6 days of admission. This observed reduction is noteworthy and suggests a dynamic response in the physiological state of patients over the early phase of their hospitalization.The statistical significance of this reduction in serum lactate levels carries important implications, particularly in the context of surgical procedures. The correlation between the decrease in serum lactate levels and a potentially favorable outcome following surgical interventions is an intriguing aspect of the study's conclusion. It suggests that monitoring and managing serum lactate levels could serve as a valuable parameter in predicting and optimizing the success of

surgical procedures in this patient population.The temporal aspect of lactate levels, with a decline observed within the first 1-6 days of admission, may indicate a positive response to initial resuscitative measures or the natural course of healing and recovery. This dynamic pattern could potentially serve as an indicator of the evolving physiological state of patients, influencing decision-making in the timing and planning of surgical interventions.In essence, the study's conclusion suggests that tracking serum lactate levels over the early days of admission may offer valuable insights into the trajectory of patient outcomes, particularly in the context of surgical procedures. This information can be pivotal for clinicians in optimizing the timing and approach to interventions, ultimately contributing to more favorable outcomes for patients with long bone fractures.

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