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A Study on Significance of Blood Lactate Levels and Lactate Clearance in the Prognosis of Polytrauma Patients

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Abstract: ***Introduction: Polytrauma involves injuries across multiple body regions, often life-threatening, and remains a major cause of mortality, especially among individuals aged 15–29. Identifying markers of hypoperfusion is crucial in the management of such patients. Serum lactate, a byproduct of anaerobic metabolism, has been widely studied as an indicator of tissue hypoxia. This study evaluates the prognostic value of serial lactate clearance in polytrauma patients. Methods: A prospective observational study was conducted on 100 polytrauma patients (ISS >16) admitted to the Emergency Department at Alluri Sitarama Raju Academy of Medical Sciences between July 2022 and June 2024. Lactate levels were recorded at admission, 2, 24, and 48 hours, and clearance was calculated at each interval. Patients were followed up for 30 days. Statistical analysis was performed using the Mann-Whitney test, with a significance level set at p<0.05. Results: Lactate clearance at 2 hours (29.87±28.17 in survivors vs. 13.53±8.23 in non-survivors, p=0.0501) and 24 hours (54.52±12.76 vs. 37.07±11.27, p=0.0482) showed statistically significant differences. Lactate levels at admission, 2, 24, and 48 hours were significantly higher in non-survivors. Clearance at 48 hours did not show statistical significance (p=0.7532). Failure to normalize lactate was associated with increased mortality. Conclusions: Lactate clearance, particularly at 2 and 24 hours, is a valuable prognostic marker in polytrauma patients and correlates significantly with survival outcomes. Early lactate normalization indicates better prognosis, while persistent elevation is associated with higher mortality. Further multicentric studies are needed to strengthen these findings and integrate lactate clearance into trauma management protocols.***

Keywords: Polytrauma, lactate clearance, hypoperfusion, trauma prognosis, emergency care, serum lactate, injury severity score

1. Introduction

Polytrauma is characterized by injuries sustained across multiple regions of the body or organs, often involving at least one injury that poses a serious threat to life. These injuries can result from various incidents such as accidents, falls, or assaults. Trauma, including polytrauma, represents a major cause of both death and long-term impairment on a global scale [1]. It particularly affects individuals in the age group of 15 to 29 years, regardless of their socioeconomic status[1].

To assess the severity of polytrauma, medical professionals commonly use an injury severity score (ISS). This score helps in quantifying the extent of injuries sustained by a patient. Typically, a polytrauma case is defined by an ISS of 16 or higher, although in some systems, this threshold may be set at 18. Given the complexity and potentially life-threatening nature of polytrauma, prompt and comprehensive medical intervention is crucial for optimal patient outcomes[2]. Effective management often involves a multidisciplinary approach, including emergency care, surgical intervention, rehabilitation, and ongoing medical support to address the diverse array of injuries and their associated complications[3].

The main objectives of caring for trauma patients are to detect any traumatic injuries, reduce the impact of shock, and identify and treat bleeding as early as possible. The body's response to trauma often leads to a decrease in oxygen supply, a condition known as hypoxia. In response, the body resorts to anaerobic metabolism, resulting in the production of lactate as a byproduct[4].

Elevated lactate levels in trauma victims have been associated with increased mortality rates and may indicate the need for blood products such as hemoderivatives. Monitoring lactate levels alongside blood pressure can serve as a valuable indicator of the severity of injury. Studies have suggested that lactate levels exceeding 4 mmol/L are a significant marker of severity and survival likelihood, rarely present in stable patients, even those with underlying health conditions[5].

Therefore, lactate serves as a valuable marker for assessing oxygen availability and demand in traumatic situations. Changes in lactate levels can effectively guide resuscitation strategies, even in patients with seemingly stable vital signs.

2. Methods

This is a Prospective study on 100 Polytrauma patients presenting to the Alluri Sita RamaRaju Academy of Medical Sciences Emergency Room from time period of 2years (1st July 2022 -30th June 2024).

Inclusion criteria

- Adult patients both males and females who underwent Polytrauma with INJURY SEVERITY SCORE >16 presenting to the Casualty.

- In this study we defined trauma as involving at least one organ system (Chest, Abdomen and Pelvis, Head and/or long bones)

Exclusion criteria

- Pediatric age group patients
- Patients with minor injuries and whose INJURY SEVERITY SCORE <16

On admission to the Emergency Department, after a valid written consent from the patient / attenders as deemed necessary, following details were recorded

- Age and Sex
- Trauma characteristics and time since trauma
- Pulse, Respiratory Rate and Systolic Blood Pressure
- Peripheral Blood Oxygen Saturation
- Serum Venous/ Arterial Lactate measurements recorded from ABG
- Serum Lactate was again obtained at 2, 24 and 48 hour intervals from the time of admission.
- Finally Lactate clearance was calculated using the formula.

Lactate clearance = Lactate $_{t0}$ - lactate $t_{(2)}$/ lactate t_0 x 100
Lactate clearance = Lactate $_{t0}$ - lactate $t_{(24)}$/ lactate t_0 x 100
Lactate clearance = Lactate $_{t0}$ - lactate $t_{(48)}$/ lactate t_0 x 100

- Length of stay in ICU and Hospital has been recorded.
- Patients discharged from the hospital were followed up through telecommunication for a period of 30 days.
- Probability of Survival was calculated by *Trauma Related Injury Severity Score*.
- TRISS (Trauma Related Injury Severity Score)

Includes
1) Revised Trauma score
2) Injury Severity Score
3) Age of the patient
4) Mechanism of injury

Statistical analysis

- Statistical test used- Mann-Whitney test.
- Null Hypothesis-There is no significant difference between mean values of both tests.i.e.Η1=Η2.
- Level of significance value-0.05
- Decision Criterion-We compare P Value with level of significance. If P value <0.05 then we accept the Null hypothesis

Table 1: Serum Lactate Levels

Lactate	<1.5	1.5 – 3.0	3.0 – 4.5	>4.5
Admission	40	33	15	12
2hours	44	30	16	10
24hours	52	29	11	8
48 hours	60	27	8	5

Table 2: Serum Lactate Clearance Rate at 2hours

Clearance at 2 hours	Gender		Total
	Male	Female	
< 0	2	1	3
0 – 10	3	3	6
10.1 – 20	9	0	9
20.1– 30	25	5	30
>30	44	8	52

Table 3: Serum Lactate Clearance Rate at 24 hours

Clearance at 24 hours	Gender		Total
	Male	Female	
< 0	0	0	0
0 – 10	1	0	1
10.1 – 20	0	0	0
20.1– 30	2	4	6
>30	80	13	93

Table 4: Serum Lactate Clearance Rate at 48 hours

Clearance at 48 hours	Gender		Total
	Male	Female	
< 0	1	0	1
0 – 10	1	0	1
10.1 – 20	0	1	1
20.1– 30	0	0	0
>30	81	16	97

Table 5: Parameters comparison in survivors and non survivors

Parameter	Survivor	Non Survivor	P value
Lactate at admission	3.65±1.89	6.64±3.82	<0.0001
Lactate at 2hrs	2.56±1.15	6.02±3.65	<0.0001
Lactate at 24hrs	1.66±0.78	4.56±2.89	0.0452
Lactate at 48hrs	0.96±0.34	4.13±2.48	0.0468
Clearance at 2 hours	29.87±28.17	13.53±8.23	0.0501
Clearance at 24 hours	54.52±12.76	37.07±11.27	0.0482
Clearance at 48 hours	73.71±25.20	68.31±14.37	0.7532

3. Results

The lactate clearance for 2 hours is 29.87±28.17 in patients who survived with comparison to 13.53±8.23 value in non survivors, with a p value of 0.0501, which is statistically significant.

The lactate clearance at 24 hours is 54.52±12.76 in survivors, whereas the values in non survivors the value is 37.07±11.27, with a p value of 0.0482, which is statistically significant.

The lactate clearance for 48 hours is 73.71±25.20 in patients who survived with comparison to 68.31±14.37 value in non survivors, with a p value of 0.7532, which is statistically insignificant.

4. Discussion

Thus, it proves the hypothesis that lactate acts as an important prognostic indicator in assessing the outcome of a poly trauma patient.

Our study showed similar results in compared to various other studies in the literature.

In Jyothi e al study, the mortality rate was 17%, which is consistent with studies of seriously injured trauma patients, as compared to 8% in this study[6]. Their study showed that both serum lactate levels at ER admission (p >0.05) and Base Deficit levels at admission (p >0.05) were not statistically significantly associated with mortality, which is consistent with the study done by Freitas et al. However, serum lactate level at 12 hours was significantly higher in non survivors when compared to survivors.

In our study, there is a significant difference in the serum lactate levels at admission and 2 hours and 24 hours. This statistically significant data proves the point that the lactate levels can act as a significant prognostic marker of the outcomes of trauma.

We found that prolonged lactate normalization time was associated with higher mortality. The failure of a patient to normalize lactate is associated with a 100% mortality, which is consistent with the study done by Kunduri et al[7].

Serum lactate and base deficit (BD) levels play crucial roles in assessing the severity and prognosis of trauma patients, particularly those with multiple injuries (polytrauma)[10].

5. Conclusion

Throughout history, trauma care has evolved significantly, from ancient medical writings to pivotal advancements and the global adoption of protocols like the Advanced Trauma Life Support (ATLS) guidelines. A crucial challenge in trauma management remains the identification of reliable markers for hypoperfusion—a state of inadequate tissue perfusion and oxygenation. Lactate, a byproduct of anaerobic metabolism, is a recognized indicator of tissue hypoxia, and while spot lactate levels are commonly used, our study explored the added value of lactate clearance over time as a dynamic marker. Conducted on 100 patients in a single center, we measured lactate clearance at 2, 24, and 48 hours post-trauma, finding significant associations particularly at the earlier time points. Although promising, our findings warrant further validation through larger studies. By emphasizing the potential of lactate clearance in improving early diagnosis and guiding interventions, this study contributes meaningfully to ongoing efforts to optimize trauma care outcomes.

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