

Role of Arterial Blood Lactate Level to Predict Outcome of Critically Ill Patients

Patel Karan I¹, Patel Rushi N², Patel Prakruti P³

¹3rd Year Post Graduate Resident, Department of Emergency Medicine, GCS Medical College, Hospital And Research Centre, Ahmedabad, Gujarat

²Assistant Professor, Department of Emergency Medicine, GCS Medical College, Hospital And Research Centre, Ahmedabad, Gujarat

³Assistant Professor, Department of Emergency Medicine, SVP Institute of Medical Sciences And Research, Ahmedabad, Gujarat

Received: 25-05-2024 / Revised: 23-06-2024 / Accepted: 26-07-2024

Corresponding Author: Dr. Patel Prakruti P

Conflict of interest: Nil

Abstract:

Background: Critically ill patients pose a significant diagnostic challenge for emergency physicians, who must manage them promptly. Advances in diagnostic tools and scoring systems, such as the APACHE II score and initial arterial blood lactate levels, facilitate patient assessment, guide therapy, and improve outcome prediction and counselling from the day of hospital admission.

Objective: To study to predict outcome in critically ill patients with APACHE II score >14 in Emergency Department with high Lactate Level (>2mmol/L).

Materials and Methods: A cross-sectional observational study was conducted from October 2023 to December 2023 involving 50 patients presenting to the Emergency Department with lactate values greater than 2.0 mmol/L in arterial blood gas analysis and an APACHE II score greater than 14.

Results: In this study involving 50 patients, the mean age was 61.8±14.65 years. The overall mean blood lactate level was 5.31±3.3. Patients who survived had a lower mean blood lactate level of 3.64±1.36 compared to non-survivors, who had a mean of 6.12±3.84. Additionally, the mean APACHE II score was 22.25±5.82 overall. Survivors had a lower mean APACHE II score of 19.5±4.6, whereas non-survivors had a mean score of 23.71±5.97. Out of the 50 patients, 18 (36%) survived while 32 (64%) did not.

Conclusion: To conclude higher lactate values are associated with higher hospital mortality. Initially taken blood lactate level was very helpful for stratifying critically ill patients presenting to emergency department.

Keywords: Lactate level, APACHE II Score, critically ill Patients, ER.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

The study investigates whether initial blood lactate levels independently predict mortality in critically ill patients upon presentation to the ER. [10,14] Lactate, produced via pyruvate metabolism by lactate dehydrogenase, serves as a critical biomarker in conditions like distributive shock, toxin ingestion, and trauma, correlating with increased morbidity and mortality. [3,10]

Clinical decision-making often stratifies lactate levels, with ≥ 2 mmol/L indicative of higher severity necessitating intensive treatment critically ill patients.[4] The APACHE II score is a reliable tool in emergency medicine for predicting mortality risk based on initial physiological parameters like vital signs and laboratory values. It helps prioritize care, guide treatment decisions, and inform patients and families about expected outcomes early in the emergency department setting. This structured

approach enhances triage efficiency and supports effective management of critically ill patient [15,17]. Despite the widely used APACHE II score for disease severity assessment, there is interest in understanding if lactate levels provide unique predictive insights in acute ED settings.

This research aims to fill gaps in existing knowledge by evaluating whether initial lactate levels independently predict mortality, offering potentially valuable prognostic information beyond established severity scores. Understanding the independent role of lactate in mortality prediction could influence treatment decisions and improve outcomes in critically ill patients.

Materials and Method

A cross sectional, observational study was conducted on 50 critically ill patients in whom

APACHE II score >14 and arterial blood lactate >2mmol/L on presentation at a tertiary care hospital over a 3 months period.

Inclusion Criteria:

- Patients aged >18 years
- Patients who are having lactate values of >2.0 mmol/L in arterial blood gas analysis
- Critically ill patients with APACHE II score >14 in non-operative patients presenting in ED
- Patients who gave consent for study

Exclusion Criteria:

- Patients who do not give consent for study
- Patients in whom APACHE II score <14, major trauma, toxin ingestion, post-operative patients, pregnant female and major burns within 48hrs

Statistical Analysis: Out of 110 critically ill patients we took 50 patients who were fit in our research methodology criteria. Data were entered in Microsoft Excel spreadsheet (Microsoft corporation 2007, Washington US). Analysis was done with help of statistical software IBM SPSS 26.0 version software (IBM SPSS statistics for windows version 28.0. Armonk, NY; IBM corp.).

Results

In this study, 18 patients (36%) survived while 32 patients (64%) did not. The mean age of all patients was 61.8 ± 14.66 years. Survivors had a mean age of 63.85 ± 15.68 years, compared to 60 ± 14.49

years for those who died. Out of the 50 patients, 31 (62%) were female and 19 (38%) were male. The overall mean blood lactate level was 5.31 ± 3.3 mmol/L, with survivors having a mean level of 3.64 ± 1.36 mmol/L and non-survivors having 6.12 ± 3.84 mmol/L.

The mean APACHE II score was 22.25 ± 5.82 ; survivors had a mean score of 19.5 ± 4.6 , while non-survivors had a mean score of 23.71 ± 5.97 . The overall mean Glasgow Coma Scale (GCS) score was 12.16 ± 3.75 , with survivors scoring a mean of 13.94 ± 2.23 and non-survivors 11.46 ± 3.81 .

Among the patients, 29 had acute kidney injury (AKI), with 5 (12.5%) surviving and 24 (87.5%) dying. Of the 20 patients on inotropic support, 5 (25%) survived and 15 (75%) died. Ten patients were intubated, with 1 (10%) surviving and 9 (90%) dying. Chronic organ insufficiency or immunocompromise was present in 38 patients; of these, 12 (28%) survived and 26 (72%) died. All 5 patients with hypertensive surge put on nitroglycerin (NTG) infusion support were survived. Of the 8 patients on non-invasive ventilation (NIV) support, 5 (62.5%) survived and 3 (37.5%) died. The average length of stay for all patients was 7.52 ± 3.22 days. For patients who did not survive, the average length of stay was 10.5 ± 3.77 days, while those who survived had an average length of stay of 8.55 ± 2.61 days.

Table 1 Demographic and Clinical Characteristic of Patients

	Survived	Not survived
Number of patients (n=50)	18(36%)	32(64%)
Mean Age (years)	63.8 ± 15.68	60 ± 14.49
Sex		
Male	13(42%)	18(58%)
Female	5(27%)	14(73%)
Mean Lactate level (mmol/l)	3.64 ± 1.36	6.12 ± 3.84
Mean Apache II SCORE	19.6 ± 4.6	23.71 ± 5.97
Mean GCS	13.94 ± 2.23	11.46 ± 3.81
Inotropic support	5(25%)	15(75%)
AKI	5(12.5%)	24(87.5%)
Invasive ventilation	1(12%)	9(88%)
Chronic organ insufficiency Or immunocompromise	12(28%)	26(72%)
NIV support	5(62.5%)	3(37.5%)
NTG	5(100%)	0
Mean Length of hospital stay (in days)	8.55 ± 2.61	10.5 ± 3.77

Table 2: statistical comparison of APACHE II score, Lactate level and GCS with outcome

	Death		Discharge		Independent t test p value
	Mean	SD	Mean	SD	
APACHE II score	23.96	5.79	19.5	4.63	0.007
Lactate level (>2 mmol/L)	6.09	3.78	3.77	1.45	0.016
GCS	12.62	2.82	14.22	1.3	0.029

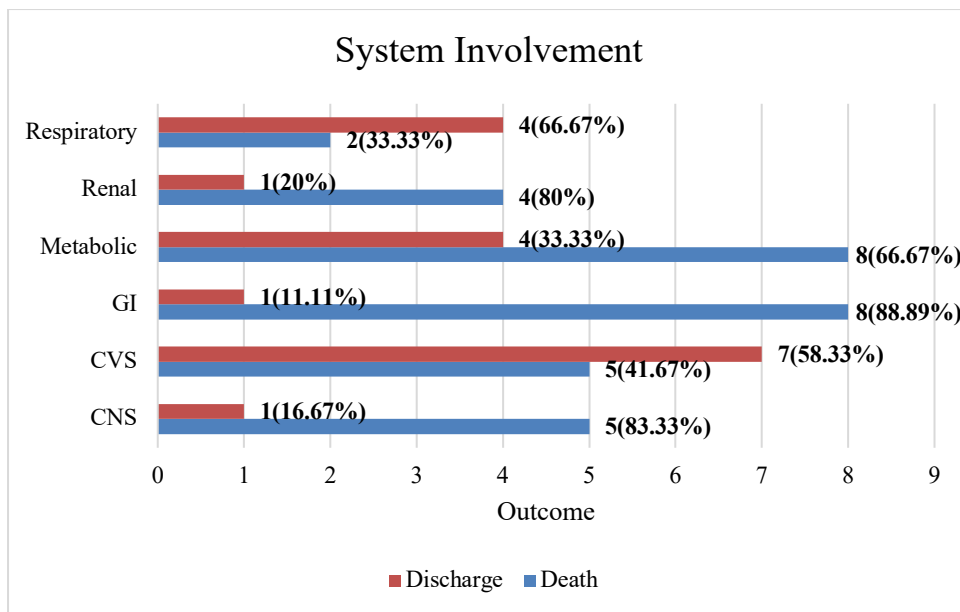


Figure 1: Comparison between system involvement and outcome

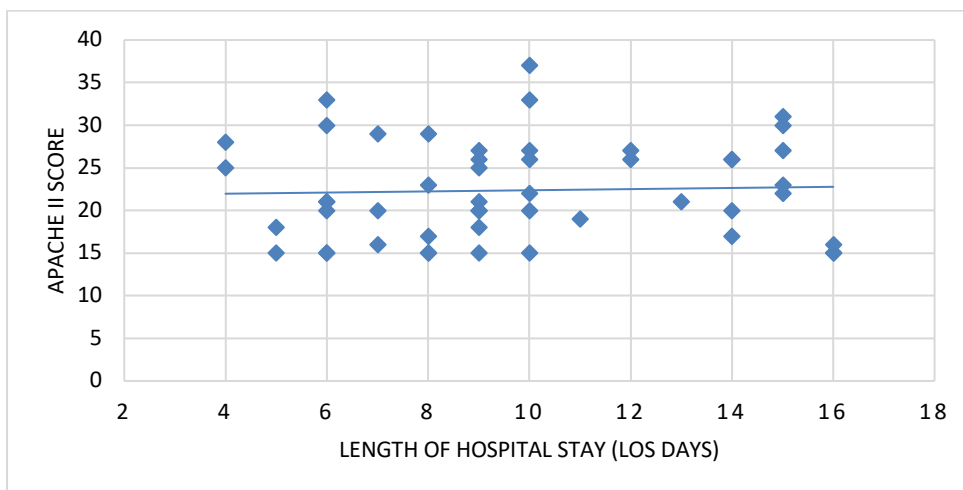


Figure 2: Correlation of APACHE II score with length of hospital stay (days)

Pearson correlation coefficient 0.125 and p value 0.338

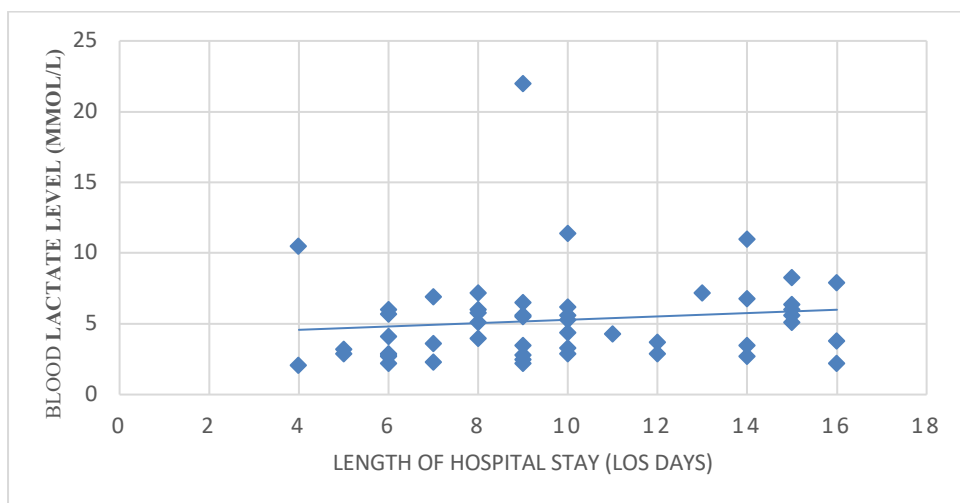


Figure 3: Correlation of Lactate level with length of hospital stay (days)

Pearson correlation coefficient 0.041 and p value 0.778.

Discussion

Our study found that elevated blood lactate levels (>2 mmol/L) in the emergency department are associated with an increased risk of mortality. The blood lactate level showed a statistically significant p-value of 0.016, indicating a direct effect on patient outcomes. Specifically, patients who did not survive had a mean blood lactate level of 6.12 ± 3.84 mmol/L. In Cao et al study it was 4.6 ± 2.5 . In our study survival group had lactate levels of 3.64 ± 1.36 , In Cao et al study it was 2.5 ± 2.0 . [18]

In our study Mean Apache II SCORE was 22.25 ± 5.82 , in Mumtaz et al study mean APACHE score was 31.7 ± 17.94 . In our study, the APACHE II score had a p-value of 0.007, which is statistically significant. This indicates that the APACHE II score has a direct effect on patient outcomes, in Mumtaz et al study mean APACHE II score p value was 0.05, it had a direct effect on mortality. [19] In our study Survival group APACHE II score was 19.6 ± 4.6 and in Non-survival group was 23.71 ± 5.9 . In the study by Cao et al., the APACHE II score was 13.0 in the survival group and 18.0 in the non-survival group. [18]

In contrast, our study found that blood lactate levels and APACHE II scores were not significantly correlated with the length of hospital stay. The p-value for the correlation between blood lactate levels and length of stay was 0.778, while the p-value for the correlation between the APACHE II score and length of stay was 0.388.

In our study, the average length of hospital stay was 8 days for the survival group and 10 days for the non-survival group. In contrast, the study by Cao et al. reported lengths of stay of 15 days for the survival group and 16 days for the non-survival group. [18]

Patients on inotropic support had a survival rate of only 25%, whereas all patients (100%) on nitroglycerin (NTG) support survived. Additionally, higher mortality was observed in patients who were hypotensive. Patient who needed oxygen support in that who were on NIV support had better chance of survival (62%) than intubated patient (12%).

In our study, patients with chronic organ insufficiency had a survival rate of 28%, compared to a 16% survival rate for those without chronic organ insufficiency.

A low Glasgow Coma Scale (GCS) score, with a mean of 11.46 ± 3.81 , was also associated with increased mortality. The GCS score showed a statistically significant p-value of 0.029, indicating a direct effect on patient outcomes. The overall

mean GCS in our study was 12.16 ± 3.75 , whereas in the study by Mansour and Hussein et al., the mean GCS was 10.5 ± 0.98 . [20]

Limitations of Study

This study was limited by its small sample size and single-centric design. Additionally, several patients with blood lactate levels greater than 2 mmol/L could not be included due to the study's selection and exclusion criteria, which also impacted the findings. To achieve more accurate results and a clearer understanding of the effect of blood lactate levels in critically ill patients, future research should involve larger sample sizes and multi-centric studies.

Conclusion

Based on data from our study, elevated lactate levels in critically ill patients are associated with increased mortality, regardless of age, sepsis, comorbidities or immunocompromised status. Also, this finding underscores the utility of arterial blood lactate levels in stratifying critically ill patients in the emergency department, helping to guide clinical decision-making and prioritize patient care.

Author contributions

- Participated in research design
- Participated in the writing of the paper
- Participated in the performance of the research
- Participated in data analysis

References

1. Aduen J, Bernstein WK, Khastgir T, et al. The use and clinical importance of a substrate-specific electrode for rapid determination of blood lactate concentrations. *JAMA*. 1994; 272:1678–85.
2. Bakker J, Gris P, Coffernils M, et al. Serial blood lactate levels can predict the development of multiple organ failure following septic shock. *Am J Surg*. 1996; 171:221–6.
3. Kruse O, Grunnet N, Barfod C. Blood lactate as a predictor for in-hospital mortality in patients admitted acutely to hospital: a systematic review. *Scand J Trauma Resusc Emerg Med*. 2011; 19:74.
4. Lavery RF, et al. The utility of venous lactate to triage injured patients in the trauma center. *J Am Coll Surg*. 2000; 190(6):656–64.
5. Freitas AD, Franzone O. Lactate as predictor of mortality in polytrauma. *Arq Bras Cir Dig*. 2015; 28(3):163–6.
6. Guyette F, et al. Prehospital serum lactate as a predictor of outcomes in trauma patients: a retrospective observational study. *J Trauma*. 2011; 70(4): 782–6.
7. Aluisio AR, et al. The prognostic role of non-critical lactate levels for in-hospital survival

- time among ED patients with sepsis. *Am J Emerg Med.* 2016; 34(2):170–3.
8. Bhat SR, et al. Lactate Clearance Predicts Survival Among Patients in the Emergency Department with Severe Sepsis. *West J Emerg Med.* 2015; 16(7): 1118–26.
 9. Mikkelsen ME, et al. Serum lactate is associated with mortality in severe sepsis independent of organ failure and shock. *Crit Care Med.* 2009; 37(5):1670–7.
 10. Del Portal DA, et al. Emergency department lactate is associated with mortality in older adults admitted with and without infections. *Acad Emerg Med.* 2010; 17(3):260–8.
 11. Pro CI, et al. A randomized trial of protocol-based care for early septic shock. *N Engl J Med.* 2014; 370(18):1683–93.
 12. Dellinger RP, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. *Crit Care Med.* 2013; 41(2):580–637.
 13. Investigators A, et al. Goal-directed resuscitation for patients with early septic shock. *N Engl J Med.* 2014; 371(16):1496–506.
 14. Thomas-Rueddel DO, et al. Hyperlactatemia is an independent predictor of mortality and denotes distinct subtypes of severe sepsis and septic shock. *J Crit Care.* 2015; 30(2): 439 e1-6.
 15. Mehrzad B, Seyed Sajjad E, Nasrollah M, et al. Use of the APACHE II score for the assessment of outcome and mortality prediction in an Iranian Medical–Surgical Intensive Care Unit. *Arch Anesth Crit Care* 2018;4:521-526
 16. APACHE Score as an Indicator of Mortality Rate in Intensive Care Unit Patients: A Cohort Study [Electronic]. Research registry; 2022. Study registration details in the Research Registry. Accessed 1 September 2022. <https://www.researchregistry.com/browse-the-registry/#home/registrationdetails/632bf6090414f80021027ddb/>
 17. Farajzadeh M, Nasrollahi E, Bahramvand Y, et al. The use of APACHE II Scoring System for predicting clinical outcome of patients admitted to the intensive care unit: a report from a resource-limited center. *Shiraz E-Med J* 2021;22:e102858
 18. Bou Chebl R, El Khuri C, Shami A, Rajha E, Faris N, Bachir R, Abou Dagher G. Serum lactate is an independent predictor of hospital mortality in critically ill patients in the emergency department: a retrospective study. *Scandinavian journal of trauma, resuscitation and emergency medicine.* 2017 Dec; 25:1-7.
 19. Mumtaz H, Ejaz MK, Tayyab M, Vohra LI, Sapkota S, Hasan M, Saqib M. APACHE scoring as an indicator of mortality rate in ICU patients: a cohort study. *Annals of Medicine and Surgery.* 2023 Mar 1; 85(3):416-21.
 20. Hussein RM, El-Shahat HM, Mansour W, Nada MN. Blood lactate level as a predictor of patients' outcome at the Respiratory Intensive Care Unit of Zagazig University Hospitals. *Egyptian Journal of Bronchology.* 2017 Jun; 11:128-33.