

UTILITY OF LACTATE LEVELS AND SEQUENTIAL ORGAN FAILURE ASSESSMENT SCORE IN PREDICTING OUTCOMES IN PATIENTS ADMITTED IN INTENSIVE CARE UNIT OF A TERTIARY CARE HOSPITAL OF NORTH INDIA

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Abstract

Background: In hospitals, emergency department plays a crucial role to handle critically ill patients. The laboratory blood gas analysis results and physiological characteristics could aid the doctors in their triage. Of these, serum lactate is easily determined in a laboratory setting and is a byproduct of the metabolic process in acute illness situations. Present study attempted to ascertain the utility of peripheral arterial lactate (PAL) and Sequential Organ Failure Assessment (SOFA) score in predicting outcomes in patients admitted in intensive care unit (ICU) of a tertiary care hospital of north India. **Materials and Methods:** This retrospective record-based study was conducted in 2023 on 62 “critically ill patients consecutively admitted in ICU”. Lactate levels measured at the time of admission over a period of 6 months were noted. The data of the subjects until ICU discharge or death was extracted from records. We measured serum lactate and SOFA score in the inpatients consecutively admitted in ICU and “used the objective endpoint of all-cause mortality. The categorical and continuous variables were analyzed using Chi-square test. **Results:** Of the 62 critically ill patients, 21 patients (33.9%) died. Highest mortality was observed in dengue (80%) and chronic kidney disease (50%). Mortality rate increased with a rise in the lactate levels. Higher peripheral arterial lactate levels and SOFA scores individually corresponded to higher mortality (p value- 0.006 and p value- 0.008 respectively). Additionally, lactate levels also showed a positive correlation with early mortality, i.e., within 3 days of admission. No correlation was found between lactate levels and the sex or the diagnoses of the subjects. **Conclusion:** Peripheral arterial lactate levels and SOFA score emerged as robust predictors of mortality in critically ill patients irrespective of the diagnoses.

INTRODUCTION

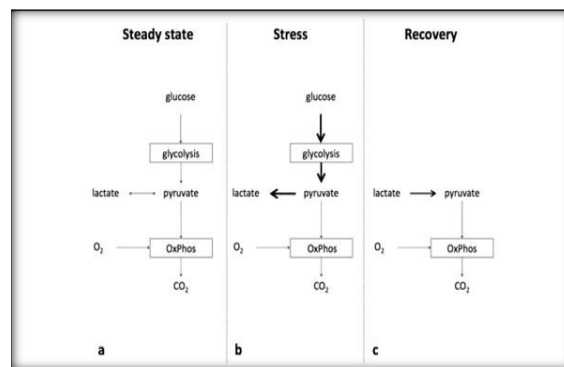
In any hospital, the “intensive care unit (ICU) deals with critically ill patients at extremes of physiological deterioration”, requiring care involving resuscitation. Hence, their evaluation before admission is essential to ensure proper management. This is facilitated by predictive scoring systems based on critical care clinical variables by assigning a “numerical value or severity score to predict the course of the patient in the ICU. These prognostication tools also assist in the assessment of quality-of-care” for various interventions. Administratively, these are useful tools to manage hospital resources cost-effectively.^[1-3]

Sequential Organ Failure Assessment (SOFA) is one such tool. It refers to objective and quantitative evaluation of the degree of organ dysfunction in ICU patients. SOFA scoring scheme assigns 1-4 points each parameter (0 =physiological function,^[4] =worst values). Serum bilirubin, creatinine, platelet count, “Glasgow Coma Scale score, and mean arterial pressure value”; PaO₂/FiO₂ ratio indicate multi-organ dysfunction (hepatic, respiratory, renal, haematology, circulatory, and central nervous system). SOFA “score ranges from 0 to 24 points” for predicting mortality. Patient survival rate has been shown to be “directly proportional to the SOFA scores in the ICU”.^[4] This system has been extensively validated.^[5]

In our body, normally, lactate produced by tissues like muscles is cleared from the bloodstream by the liver. Being a glycolysis product, serum lactate levels increase in anaerobic metabolism states. Any medical emergency like shock, infection, shock, seizure, liver disease, and medication toxicity will also elevate blood lactate levels due to tissue hypoperfusion. Many factors are responsible for this, e.g., hypermetabolism, macro- and microcirculatory dysfunction mitochondrial dysfunction. 1-3 Hence, lactate level measurements are utilized as a diagnostic tool / bedside marker to predict morbidity, mortality in ICU admissions. Serum lactate had been shown to have a better sensitivity as compared to heart rate and/or blood pressure measurements. During the initial stages of resuscitation, lactate levels appear to have a stronger correlation with patient outcomes than commonly utilized hemodynamics, such as oxygen consumption and delivery. Elevated lactate levels are also used as indicator of injury severity and of poor prognosis.^[6] Lack of clearance of elevated lactate levels indicates a higher risk of mortality within the first 24 h of hospital admission. Even the resuscitation procedures aiming at lactate clearance as an endpoint among patients with sepsis and trauma have been shown to be beneficial, though the evidence is inconclusive.

Increased blood lactate levels (Hyperlactatemia) “are common in critically ill patients”. For evaluation of shock in the setting of trauma centres, lactate measurement is valuable as an adjunct to increase the chances of early identification of severe injury and occult hypoperfusion, especially in patients with no apparent traumatic shock. There are obvious benefits of handheld-point-of-care (POC) devices for lactate measurements in ICU patients. Lactate “concentrations are easily measured with a standard blood gas” analyser. This reduces the clinical decision-making and action time, thus improving patient outcome.

Glycolysis and oxidative phosphorylation (OxPhos), the two primary ATP-producing mechanisms that drive life, depend on lactate as a critical molecule. During glycolysis, glucose is converted into two pyruvate molecules and two ATP is produced. Pyruvate enters the mitochondria to undergo Krebs’s cycle and oxidative phosphorylation which further produces 36 ATPs. “Glycolysis and oxidative phosphorylation steadily metabolize glucose when conditions are stable (Figure 1a). Pyruvate molecule links these two reactions”. Due to its ability to rise two or three times quicker than oxidative phosphorylation, glycolysis can momentarily produce significantly more ATP. Excess pyruvate quickly builds up and is converted to lactate so that glycolysis can continue (Figure 1b). Pyruvate is produced from lactate during the recovery process (Figure 1c). Lactate dehydrogenase catalyzes this action in both directions. Therefore, lactate acts as a vital buffer to enable glycolysis to speed up when significant amounts of energy are needed quickly, such as in situations of cellular stress.



Figures 1a-c: Glycolysis and oxidative phosphorylation process

Several clinical “conditions have been associated with impaired clearance of lactate, e.g., liver dysfunction, patients following cardiac surgery. Also, sepsis, in addition to increased glucose metabolism and thus lactate production, may impair lactate” clearance.

Against this background the present study was conducted.

Objective

To ascertain the utility of peripheral arterial lactate (PAL) and SOFA score in predicting outcomes in patients admitted in ICU of a tertiary care hospital of north India

MATERIALS AND METHODS

We conducted a retrospective record-based study in 2023 at the “Shri Ram Murti Smarak Institute of Medical Sciences (SRMSIMS), Bareilly, India”. The data of the subjects until ICU discharge or death was extracted from records. Peak PAL levels along with SOFA scores were then superimposed against outcomes in subjects and the correlation between the two was ascertained. ICU mortality was the outcome variable used for analysis. “All the patients admitted in study period were included as per the admission criteria. There was no random sampling involved. Sample size was not calculated as it was a short-term study”. We measured serum lactate and SOFA score in 62 critically ill inpatients consecutively reporting at ICU over a period of 6 months.

A statistical “analysis was performed manually using number (percentage) or mean (standard deviation). The categorical and continuous variables were analyzed using Chi-square test. A P value < 0.05 was considered significant.”

The Institutional “Ethics Committee waived the requirement for informed consent due to the anonymous and non-interventional” data-based nature of the study.

RESULTS

Of the 62 critically ill patients, 25 (40%) were males and 37 (60%) females. Their mortality rates were not significantly different. Overall, 21 patients (33.9%)

died; 41(66.1 %) survived. Highest mortality was observed in patients having dengue (80%) and chronic kidney disease (50%). Mortality rate increased with a rise in the lactate levels. Pneumonia, chronic kidney disease, coronary artery disease,--- were the main diagnostic categories. Higher PAL levels and SOFA scores individually corresponded to higher mortality (p value- 0.006 and

p value- 0.008 respectively). PAL levels also showed a positive correlation with early mortality, i.e., within 3 days of admission. thus indicating the need for rapid and aggressive intervention. No correlation was found between PAL levels and the sex or the diagnoses of the subjects. [Table 1]

Table 1: Co-relation of variables with outcome of critically ill patients

Variables	Levels	Outcome				Total		p-value
		Survived		Death		n	%	
		n	%	n	%			
Sex	Female	14	56	11	44	25	40.32	0.166
	Male	27	72.97	10	27.03	37	59.68	
Diagnosis	Pneumonia	13	76.47	4	23.53	17	27.42	0.186
	Chronic Kidney Disease	6	50	6	50	12	19.35	
	Coronary Artery Disease	8	80	2	20	10	16.13	
	Abdomen	5	71.43	2	28.57	7	11.29	
	Chronic Obstructive Pulmonary Disease	3	60	2	40	5	8.06	
	Dengue	1	20	4	80	5	8.06	
	Others	5	83.33	1	16.67	6	9.68	
Highest Lactate level	0.5 - 2.0	25	80.65	6	19.35	31	50.00	0.006
	2.0 - 5.0	13	65	7	35	20	32.26	
	> 5.0	3	27.27	8	72.73	11	17.74	
SOFA Score	0 TO 6	14	93.33	1	6.67	15	24.19	0.008
	7 TO 9	10	76.92	3	23.08	13	20.97	
	10 TO 12	10	66.67	5	33.33	15	24.19	
	13 TO 15	4	44.44	5	55.56	9	14.52	
	16 TO 24	2	25	6	75	8	12.90	
Total		41	66.13	21	33.87	62	100.00	

DISCUSSION

Globally, healthcare systems face a challenge of managing critically ill patients facing high mortality rates. It is imperative to identify cost-effective, easily available, easy to interpret biomarkers with good sensitivity and specificity for prognosis prediction of ICU patients. PAL is one such biomarker which fulfils all these criteria.^[1-3]

Hospital emergency departments (ED) have a crucial role in treating critically ill patients. ICU physicians need some handy laboratory blood gas analysis results and values of various physiological parameters to assess their risk of mortality and to determine the hospitalization needs.^[7]

Present study attempted to test its utility along with SOFA score in predicting outcomes in critically ill patients admitted in ICU of a tertiary care hospital in North India. Our findings indicated that the higher PAL levels and SOFA scores individually corresponded to higher mortality in ICU patients. There was no correlation between PAL levels and the sex or the diagnoses of the subjects. Mortality rate increased with a rise in the lactate levels. The serum lactate level and SOFA “score were useful to identify patients who were at increased risk of death within a 3-day period; thus, our findings indicated that this population certainly deserves rapid attention and perhaps aggressive intervention”. In our study gender wise mortality rates were not significantly different. Highest mortality was observed in dengue (80%) and chronic kidney disease (50%).

Across the world, “simple clinical assessment systems for outcome prediction in ICUs are gaining popularity.” These aim to evaluate the critically ill patients being admitted in ICU through measurement of serial lactate levels. Association of highest values of lactate with different morbidities / mortality has been investigated. Lactate has also been shown to be a useful marker in patients admitted in ICU to evaluate the efficacy of resuscitation.^[1]

A systematic review by Baxter et al also supported the advantage of serum lactate measurement for evaluating ICU patients. They showed “an association between elevated lactate and risk of mortality”. Decreased incidence of pulmonary complications, improved survival, and reduced occurrence of multi-organ failure has been shown when early detection and rapid correction of lactic acidosis was attempted. Also, lactate levels were significantly higher in non-survivors than survivors in ICU patients.^[6]

In ICUs, peripheral arterial lactate monitoring is common as an indirect tissue hypoxia marker. “The predictive value of a single elevated blood lactate on mortality is demonstrated in several studies in patients admitted to ICU”.^[1-4]

Accelerated glycolysis and tissue hypoxia is reflected by high serum lactate levels as a predictor of mortality.^[8]

Peripheral arterial lactate has been reported as a promising risk-stratification tool in patients admitted to ICU.^[9]

Bou Chebl showed that rising PAL value is associated with a higher mortality for patients

presenting to the ED.^[10] A systematic review by Minne et al showed that in ICU patients, the use of SOFA-based models to predict the mortality risk is also increasing in recent years.^[5]

Fuchs et al provided evidence that higher SOFA scores correlate with a compromised outcome in all ICU patients.^[1]

In their study, Jain et al. showed a significant relationship between day 1 SOFA values and mortality.^[2] This suggests that the SOFA score upon admission can be used to forecast the future outcome and measure the level of dysfunction or failure already present on ICU admission. Thus, the patients can be categorized into risk groups based on their initial SOFA score for additional care and resource allocation.

The highest “SOFA score can identify the critical point at which patients exhibit the highest degree of organ dysfunction during their ICU” stay.

Jain et al found that the maximum score in survivors (3.92 ± 2.17) was significantly lower than non-survivors (8.9 ± 3.45).^[2] Studies have also demonstrated a strong correlation of maximum SOFA score with mortality outcome. “SOFA score on admission has shown a strong correlation with the outcome, and can help triage patients. Maximum SOFA indicates the most critical point of time in the stay of a patient in the” ICU.^[7,11-14]

For risk-stratification of ICU patients’ disease severity lactate level may be used. Here, higher risk of mortality is indicated by elevated lactates which are easy to measure in the laboratory. This will facilitate identification of patients needing additional monitoring.

One limitation of our study is “the inherent bias of the single-centre design of the study” with a small sample size.

CONCLUSION

PAL and SOFA score emerged as robust predictors of mortality in ICU patients irrespective of the diagnoses. “SOFA score is a simple, but effective prognostic indicator and evaluator for patient progress in ICU. Day 1 SOFA can triage the patients into risk” categories.

We hope that “our study can be used by clinicians in interpreting the association between patient’s clinical state and the possibility of death in the ICU” using serum lactate level and SOFA score. Prospective studies with larger sample size and ea trial format are needed to validate our results.

Conflicts of Interest: None.

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