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A Comparative Study on Role of Serum Lactate Vs Sofa Score in Assessing the Prognosis of Critically Ill Patient's

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KEYWORDS

SOFA score, critically ill patient, S.Lactate , Sepsis, critical care ICU.

ABSTRACT:

Background: The SOFA score is a vital tool in critical care for assessing multi-organ dysfunction, particularly in sepsis, with higher scores indicating increased mortality risk. Despite limitations in cases like isolated respiratory failure, it remains a widely endorsed prognostic marker. Lactate, a key indicator of tissue hypoxia and metabolic stress, rises in critical illness due to impaired oxygen delivery and clearance, especially in sepsis and shock. Monitoring both SOFA scores and lactate levels provides valuable insights into patient prognosis and guides clinical decision-making in intensive care.

Methods: This comparative, observational cross-sectional study was conducted in the MICU and Critical Care ICU of the General Medicine Department at ASRAM Hospital, Eluru, from July 2022 to June 2024, involving 60 critically ill patients. Inclusion was based on Early Warning Score (EWS) criteria such as hypotension, abnormal heart or respiratory rates, low SpO_2, or sudden altered consciousness. Exclusion criteria included pregnant women and individuals under 18 years of age. Statistical analysis involved sensitivity, specificity, and Chi-square testing.

Results: In our observational study at ASRAM Hospital's Critical Care ICU, SOFA scores and serum lactate levels emerged as strong prognostic markers among 60 critically ill patients. Patients with SOFA scores ≥10 and lactate levels ≥5 mmol/L had significantly higher mortality. SOFA showed superior sensitivity (91%) and specificity (67%) compared to lactate (78% and 62%, respectively). Key clinical parameters like bilirubin, GCS, and creatinine were also significantly associated with outcomes, reinforcing the utility of combining these markers for critical care prognosis.

Conclusion: This study underscores the superior prognostic accuracy of SOFA scores over serum lactate levels in critically ill patients, with sensitivities of 91% and 78% respectively. While lactate reflects metabolic instability, SOFA more comprehensively captures organ dysfunction. Together, they offer a synergistic approach for improving critical care outcomes and guiding clinical decisions.

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INTRODUCTION

Critically sick patients frequently exhibit complicated, quickly changing physiological abnormalities that necessitate early detection of organ failure in order to inform treatment choices. One of the most popular methods for accurately measuring organ failure in critical care environments is the Sequential Organ Failure Assessment (SOFA) score. Vincent JL *et al.*[1] The SOFA score, which was first created by the European Society of Intensive Care Medicine, rates the severity of six major organ systems: respiratory, cardiovascular, hepatic, coagulation, renal, and neurological. The total score ranges from 0 to 24. SOFA is a useful measure for prognostication and tracking changes in organ failure over time since higher scores are closely correlated with higher mortality. Ferreira FL *et al.*(2001)[2]

The Sepsis-3 criteria, which highlighted organ failure as a key element of sepsis, increased the significance of the SOFA score. An rise in SOFA score ≥2 points was highlighted by the consensus task force as a crucial biomarker of organ failure associated to sepsis, supporting its clinical significance and widespread use in intensive care units around the globe." Singer M *et al.*(2016)[3] The score does have certain restrictions, though. Its prediction accuracy may be affected by variables including sedation, localised respiratory impairment, or pre-existing organ failure. Despite these limitations, SOFA's simplicity, repeatability, and proven predictive accuracy across a range of critical care populations make it useful. Raith EP *et al.* (2017)[4]

Parallel to the SOFA score, **serum lactate levels** have gained prominence as a rapid and sensitive marker of tissue hypoxia, metabolic stress, and systemic illness severity. Lactate is primarily produced during anaerobic glycolysis, especially in conditions of impaired oxygen delivery or increased metabolic demand. Although traditionally viewed as a product of tissue hypoperfusion, modern understanding recognizes that lactate elevation can occur through both **hypoxic** and **non-hypoxic pathways**, including accelerated glycolysis, mitochondrial dysfunction, catecholamine surge, and impaired hepatic clearance. Suetrong B *et al.* (2016)[5] A summary of these mechanisms is shown in Table.

S.No	Hypoxic Causes	Non-Hypoxic Causes
01	Global hypoxia	Delayed clearance
02	Respiratory failure	Uncoupling of oxidative phosphorylation
03	Carbon monoxide poisoning	Pyruvate dehydrogenase dysfunction
04	Regional hypoperfusion	Accelerated aerobic glycolysis

Lactate levels stay around 1 mEq/L under normal physiological settings, while concentrations over 1.5–2 mmol/L have been linked to higher mortality, especially in trauma, septic shock, and multi-organ failure syndromes. Shapiro NI *et al.* (2005)[6] In addition to reflecting tissue hypoxia, elevated lactate also shows systemic stress responses that are mediated by catecholamines and inflammatory cytokines. Nearly 70% of the lactate in the blood is eliminated by the liver, with the remainder clearance coming from the kidneys and skeletal muscles. Lactate levels can also be further elevated by hepatic or renal dysfunction, exacerbating metabolic abnormalities in critically sick individuals.

It has been demonstrated that there is a high correlation between the results of sepsis and shock and the monitoring of lactate kinetics, including initial levels and changes throughout time. An established prognostic indicator that may perform better than static data alone is lactate clearance during the first six hours. Nguyen HB *et al.* (2004)[7] As a result, lactate functions as a dynamic biomarker that reflects both response to treatment and metabolic recovery. Comparing blood lactate with the SOFA score offers important insights into the relative and combined value of these two prognostic measures in predicting outcomes among critically sick patients because of their complimentary nature. SOFA offers a thorough evaluation of established organ failure, whereas lactate represents early metabolic stress and perfusion anomalies. In critical care situations, assessing their prognostic accuracy may thereby improve risk categorisation and direct prompt therapeutic measures.

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MATERIALS AND METHODS

Study Design and Setting

This comparative, observational, cross-sectional study was conducted in the Intensive Care Units (Medical ICU and Critical Care ICU) of the Department of General Medicine at ASRAM Hospital, Eluru. The study duration was two years, from July 2022 to June 2024. A total of **60 critically ill patients** who met the eligibility criteria were included.

Study Population

All patients admitted to MICU or Critical Care ICU during the study period were screened using the Early Warning Score (EWS) system. Eligible patients who fulfilled the EWS criteria for critical illness were enrolled after meeting the inclusion and exclusion criteria.

Inclusion Criteria

Patients identified as critically ill based on the Early Warning Scoring (EWS) system with one or more of the following parameters:

- Systolic blood pressure (SBP) < 90 mmHg
- Heart rate < 40 or > 130 beats/min
- Respiratory rate < 8 or > 30 breaths/min
- Peripheral oxygen saturation (SpO_2) < 90%
- Sudden decrease in level of consciousness

Exclusion Criteria

- Pregnant women
- Patients aged below 18 years

Data Collection and Variables

Relevant clinical data, laboratory investigations, SOFA scores, and serum lactate levels were collected at admission and analyzed for prognostic assessment. Data were tabulated systematically for interpretation.

Statistical Analysis

Data were analyzed using both descriptive and inferential statistical methods. Statistical analysis was performed using **SPSS software (Trial Version 26.0)**. Descriptive statistics such as frequencies and percentages were used for categorical variables.
The **Chi-square test** was applied to assess associations between categorical variables. Sensitivity and specificity were calculated to evaluate the prognostic accuracy of SOFA score and serum lactate. A **p-value ≤ 0.05** was considered statistically significant.

RESULTS

In our observational study conducted at the Critical Care ICU of ASRAM Hospital, Eluru, we analyzed data from 60 critically ill patients admitted for urgent care between July 2022 and June 2024. The cohort spanned a wide age range, with a notable predominance (29%) of patients aged 70 years and above, reflecting the increased vulnerability of the elderly to critical illness. The gender distribution was nearly equal, with 31 males (52%) and 29 females (48%), indicating a slight male predominance, which may be attributed to lifestyle factors, occupational exposure, or inherent biological differences.

Table 2: SOFA Scores

S. No	SOFA Scores	Survived	Death
01	<10	30	9
02	≥10	03	18
		33	27

Statistical analysis revealed several significant associations between clinical parameters and patient outcomes. Serum bilirubin ($p = 0.0055$), Glasgow Coma Scale (GCS) scores ($p = 0.0018$), serum creatinine levels ($p = 0.029$), and serum lactate values ($p = 0.0025$) all demonstrated statistically significant correlations with mortality or survival. In contrast, mean arterial pressure (MAP) levels showed no significant association ($p = 0.176$). Platelet count showed a borderline association ($p = 0.051$), suggesting a potential but not definitive link with outcomes. Notably, lactate levels showed a stark prognostic distinction: patients with lactate values below 5 had a survival rate of 72.2%, whereas those with values of 5 or higher had a significantly lower survival rate of 29.2%.

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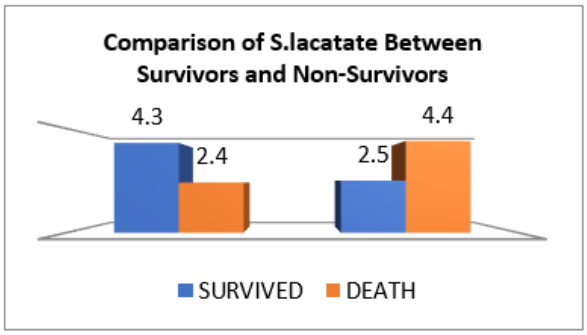

Figure 1

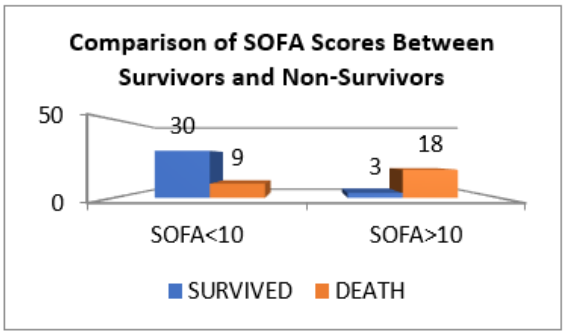

Figure 2

Table 3: S Lacate

S. No	S Lacate	Survived
01	<5	26
02	≥5	7
Total		33

The SOFA score emerged as a robust prognostic indicator, with an exceptionally low p-value (0.000012), underscoring a strong association with patient outcomes. Its sensitivity was high at 91%, effectively identifying patients likely to survive, while the specificity was 67%, indicating reasonable accuracy in identifying patients with poor prognoses. Additionally, the lactate test showed a sensitivity of 78% and specificity of 62%, further validating its clinical relevance. Overall, these findings reinforce the value of using a combination of clinical markers, particularly SOFA score and lactate levels, for guiding prognosis and management in critically ill patients.

DISCUSSION

The present study, conducted in the emergency department of ASRAMS, Eluru, meticulously investigated the prognostic utility of Sequential Organ Failure Assessment (SOFA) scores and serum lactate levels in critically ill patients requiring urgent intervention. Our results show a strong and statistically significant correlation between these biomarkers and clinical outcomes, highlighting their significance as essential instruments in the classification of critically sick patients. A clear demographic pattern showed that a significant percentage of patients were 50 years of age or older, with the ≥70 age group having the highest density. The nearly equal gender distribution confirms that the data may be used to both sexes.. Vincent JL *et al.*[1]

The SOFA score, with a p-value approximating 0.000012, exhibited an exceptionally strong correlation with patient prognosis. This association, reinforced by a sensitivity of 91% and specificity of 67%, indicates that the SOFA score not only effectively identifies patients likely to survive but also reasonably distinguishes those at elevated risk of mortality. Singer M *et al.*(2016)[3] These results are consistent with the Sepsis-3 consensus guidelines, which support using SOFA as a standard for risk assessment and sepsis diagnosis. Our findings are supported by comparative research; Ferreira FL *et al.* (2001)[2] showed that while static or declining scores predict favourable outcomes, a rise in SOFA score during the first 48 hours of ICU admission is directly linked to mortality risk. Additionally, in the seminal research that introduced SOFA, Vincent *et al.* (1996)[1] highlighted its importance in tracking the course of organ failure, especially in septic patients.

Simultaneously, our investigation found that blood lactate levels were a strong predictive predictor. Lactate showed a significant correlation with survival outcomes with a p-value of 0.0025, which was further supported by a sensitivity of 78% and specificity of 62%. These measurements show predictive ability that is moderate yet therapeutically useful. 4 Our cohort's lactate-derived survival difference, which is 72.2% for patients with lactate <5 mmol/L and 29.2% for those with lactate ≥5 mmol/L, is consistent with findings from earlier research. According to Mikkelsen *et al.* (2009)[8], increasing serum lactate is independently linked to higher mortality even when hypotension is not present. 5 Additionally, Nguyen

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HB *et al.* (2004)[7] showed that lactate clearance over time is a dynamic and predictive indicator of treatment effectiveness and patient recovery. Shapiro NI *et al.* (2005)[6]

When combined, SOFA scores and serum lactate levels provide a multifaceted, synergistic approach to prognostication in critical care and emergency situations. Serum lactate adds a layer of metabolic information, especially in conditions of reduced perfusion or cellular hypoxia, whereas SOFA offers a comprehensive view of organ system disruption. Suetrong B *et al.* (2016)[5] Timely escalation of treatment and sophisticated clinical decision-making are made easier by the concurrent application of these factors. Therefore, our results support the need for a composite assessment framework in the critical care setting—one that uses metabolic indicators and organ failure grading systems to improve prediction accuracy. Raith EP *et al.* (2017)[4]

CONCLUSION

This study highlights the comparative prognostic value of serum lactate levels and SOFA scores in critically ill patients, demonstrating that SOFA scores possess superior predictive accuracy and stronger statistical correlation with patient survival. While elevated serum lactate levels (≥5 mmol/L) were associated with poorer outcomes, lower levels indicated greater metabolic stability and a higher likelihood of survival, with a sensitivity of 78%. In contrast, SOFA scores yielded a notably higher sensitivity of 91%, underscoring their robustness in assessing the extent of organ dysfunction. The integration of both markers—lactate for metabolic derangement and SOFA for systemic organ failure—offers a synergistic framework for enhancing clinical decision-making and tailoring patient management in intensive care, ultimately improving prognostic precision and patient outcomes.

LIMITATIONS OF THE STUDY

1. **Single-Center Design:** The study was conducted exclusively at ASRAM Hospital, Eluru, which may limit the generalizability of the results to other clinical settings with different patient populations, healthcare resources, and ICU practices.
2. **Relatively Small Sample Size (n = 60):** Although meaningful associations were observed, the limited number of participants reduces the statistical power and may affect the robustness of subgroup analyses.
3. **Cross-Sectional Nature:** The study assessed SOFA scores and lactate levels at the time of presentation. Serial measurements, which provide stronger prognostic insights (e.g., SOFA trends or lactate clearance), were not included.
4. **Potential Confounding Factors:** The study did not account for the influence of comorbidities such as chronic liver disease, renal impairment, or diabetes, which can independently alter lactate metabolism or organ dysfunction scores.
5. **Heterogeneous Case Mix:** Critically ill patients included in the study had varied underlying conditions (sepsis, shock, respiratory failure, etc.), which may have different pathophysiological impacts on both SOFA score and lactate levels.
6. **Use of a Trial Version of Statistical Software:** Although SPSS (trial version) and Microsoft Excel were used for analysis, more advanced statistical tools could potentially offer better predictive modeling.
7. **Lack of Long-Term Outcome Assessment:** The study focused only on in-hospital mortality and did not evaluate long-term outcomes such as 30-day or 90-day survival, organ support duration, or quality of life after discharge.

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