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Research Article

Role of Serum Lactate, APACHE II And Modified CTSI Score in Predicting Severity and Morbidity of Acute Pancreatitis: A Prospective Observational Study in A Rural Tertiary Care Hospital in South India

Dr Brindya S[1], Dr Jenimol C Varghese[2], Dr Aswathi Kani[3], Dr Hanumanthappa M B[4]

[1]PG Resident, Department of General Surgery, Dr Moopen's Medical College, Wayanad
[2]Assistant Professor, Department of General Surgery, Dr Moopen's Medical College, Wayanad
[3]Associate Professor, Department of General Surgery, Dr Moopen's Medical College, Wayanad
[4]Professor, Department of General Surgery, Dr Moopen's Medical College, Wayanad

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Corresponding Author:

Dr Brindya S
PG Resident, Department of General Surgery, Dr Moopen's Medical College, Wayand

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ABSTRACT

Background: Acute pancreatitis is a common and potentially life-threatening pancreatic inflammatory condition. Although numerous methods exist, no singular measure or scoring system has demonstrated efficacy in reliably predicting outcomes across all patients. This study aims to assess the efficacy of serum lactate, APACHE II, and modified CTSI scores in forecasting the severity, morbidity, and mortality associated with acute pancreatitis.

Materials and methods: This study was conducted among 59 patients diagnosed with acute pancreatitis. Serum lactate levels, APACHE II, and Modified CTSI scores were compared across severity categories and outcome variables using appropriate statistical tests. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic accuracy of the three biomarkers for predicting mortality, organ failure, and necrosis, with calculation of sensitivity, specificity, PPV, NPV, and AUC.

Results: The comparison of biomarkers across severity levels revealed a statistically significant increase in APACHE II and Modified CTSI scores with increasing disease severity, whereas serum lactate did not differ significantly. In relation to organ failure, all three markers—serum lactate, APACHE II, and Modified CTSI—showed significantly higher mean values in patients with organ failure compared to those without. Similarly, all three markers were significantly elevated in patients who died compared to survivors, with p-values indicating statistical significance.

In terms of diagnostic accuracy, serum lactate showed good predictive ability for mortality, organ failure, and necrosis, particularly with high specificity and NPV in all outcomes. APACHE II had high sensitivity and NPV for predicting mortality, whereas its specificity and overall AUC were moderate.

Conclusion: Modified CTSI demonstrated the highest AUC for mortality prediction and also showed excellent specificity across all outcomes. These findings support the potential role of all three biomarkers in clinical prediction models, with varying degrees of diagnostic performance

Keywords*: Modified CTSI, APACHE II, Acute pancreatitis, Mortality, organ failure.*

INTRODUCTION

Acute pancreatitis is a common and potentially life-threatening pancreatic inflammatory condition characterized by sudden onset of abdominal pain and elevation of pancreatic enzymes in the blood. The clinical course can vary markedly, from a mild, self-limiting sickness to a severe variety characterized by considerable local consequences and systemic

organ failure. The global incidence of acute pancreatitis is estimated to be between 13 and 45 instances per 100,000 individuals yearly, with increasing trends observed in both industrialized and developing nations due to lifestyle alterations, alcohol use, and metabolic disorders.[1]

In India, acute pancreatitis has become one of the most prevalent reasons of gastrointestinal-related hospital admissions. The escalating burden is primarily due to alcohol consumption, gallstone disease, and idiopathic factors. Research undertaken in Indian tertiary care facilities has indicated disparate incidence rates, highlighting regional and etiological variability.[2] Despite the widespread occurrence of the disease, forecasting its severity upon presentation poses a considerable problem for clinicians, especially in rural and resource-limited environments where early diagnostic capabilities may be restricted.

The Revised Atlanta Classification offers a consistent framework for categorizing acute pancreatitis into mild, moderately severe, and severe classifications based on clinical, biochemical, and radiological data. This classification is retrospective and often impractical in the initial stages of the disease. Consequently, prompt forecasting of illness severity is essential to implement suitable therapies, enhance resource distribution, and mitigate morbidity and mortality. In this context, several clinical and radiological scoring systems, including the Acute Physiology and Chronic Health Evaluation II (APACHE II), Ranson's criteria, the Bedside Index for Severity in Acute Pancreatitis (BISAP), and the Modified CT Severity Index (CTSI), have been utilized for prognostication.

APACHE II is one of the most comprehensive and extensively utilized scoring systems, owing to its dynamic characteristics and relevance at the time of admission. It integrates physiological and laboratory factors, facilitating early risk classification and monitoring of disease development.[3] The CTSI, developed by Balthazar et al., delivers an anatomical and morphological evaluation utilizing contrast-enhanced computed tomography, elucidating pancreatic necrosis and related problems.[4,5] Moreover, serum biomarkers have garnered attention in recent years for their potential to enhance scoring systems in forecasting disease severity. Lactate is a byproduct of anaerobic metabolism and a signal of tissue hypoperfusion, serving as a potential early sign of severe illness and imminent organ failure in acute pancreatitis.

Although numerous methods exist, no singular measure or scoring system has demonstrated efficacy in reliably predicting outcomes across all patients. Numerous existing models necessitate comprehensive laboratory studies or radiological imaging, which may not be readily available in rural healthcare environments. Therefore, it is imperative to find and validate straightforward, dependable, and economical prognostic indicators that can inform early clinical decision-making.

This study aims to assess the efficacy of serum lactate, APACHE II, and modified CTSI scores in forecasting the severity, morbidity, and mortality associated with acute pancreatitis. This method seeks to create a trio of biochemical, physiological, and radiological markers to improve the precision of early prognostication. The study, conducted at a rural tertiary care facility in South India, illustrates the viability and applicability of these markers in resource-constrained settings. The incorporation of these techniques may assist doctors in early identification of high-risk patients, optimizing intensive care admissions, and enhancing overall patient outcomes.

MATERIALS AND METHODS

This study was designed as a prospective observational investigation carried out over a period of eighteen months. It was conducted in the Department of General Surgery at Dr. Moopen's Medical College, located in Naseera Nagar, Meppadi, Wayanad, Kerala. Ethical committee clearance was obtained prior commencing the study.

Primary objective of this study was to predict the severity and morbidity of acute pancreatitis based on serum lactate, APACHE II and modified CTSI scoring. Secondary objective was to evaluate demographic pattern of acute pancreatitis, to determine the causes and types of acute pancreatitis, the need for ICU management acute pancreatitis in rural tertiary care center in South India and the complications of acute pancreatitis.

Individuals of both genders aged 18 to 75 years, diagnosed with acute pancreatitis according to the Atlanta classification, were included. The diagnosis necessitated a minimum of two of the following criteria: distinctive abdominal discomfort, serum amylase or lipase levels over three times the upper normal range, and radiographic evidence indicative of acute pancreatitis. Exclusion criteria encompassed patients with chronic pancreatitis, recurrent pancreatitis, hematological problems, malignancies, severe comorbidities, and individuals unwilling to provide consent.

The sample size was determined based on the sensitivity of the APACHE II score (81%) for predicting the severity of acute pancreatitis, as reported in the literature: "Cho JH, Kim TN, Chung HH, Kim KH. Comparison of scoring systems in predicting the severity of acute pancreatitis.[6]" A sample size of 59 was determined with a precision of 10% and a confidence range of 95%.

Diagnosis was made based on Atlanta classification, requiring any two of three findings: typical abdominal pain, elevated pancreatic enzymes (amylase or lipase), and compatible imaging findings. Serum lactate levels were measured at admission. APACHE II score was calculated at presentation and periodically reassessed during the hospital stay. Contrast-enhanced CT of the abdomen was performed at or after 48 hours to assess for necrosis and to calculate the modified CTSI. Patients were assessed for complications, ICU admission, duration of hospital stay, organ failure, and mortality. Follow-up was continued till discharge or death, documenting all relevant clinical outcomes and interventions during the hospital stay.

Data were collected prospectively using a structured proforma designed for the study. All collected data were entered into Microsoft Excel and analyzed with SPSS, ensuring accuracy and completeness. Regular audits were conducted during data entry to minimize errors. Patients were continuously monitored, and progress was recorded until discharge or death. All data were anonymized and securely stored.

RESULTS

The demographic profile of the study population showed that the majority of patients were aged 30–60 years, with males constituting about two-thirds of the participants. Almost half of the individuals had no comorbidities, and alcohol and gallstones were the most common etiologies of pancreatitis. Most cases were clinically classified as severe, and a large proportion had organ failure and necrosis. Mortality was observed in a small fraction of the sample.

At a cut-off value of ≥3.2 for serum lactate, the sensitivity is 66.67%, specificity is 71.43%, positive predictive value (PPV) is 11.63%, and negative predictive value (NPV) is 97.3%, with an area under the curve (AUC) of 0.869. For APACHE II with a cut-off ≥19, the sensitivity is 100.0%, specificity is 73.21%, PPV is 16.67%, and NPV is 100.0%, with an AUC of 0.842. The Modified CTSI, at a cut-off
≥9, shows a sensitivity of 66.67%, specificity of 85.71%, PPV of 25.0%, and NPV of 96.0%, with the highest AUC of 0.899 among the three markers.

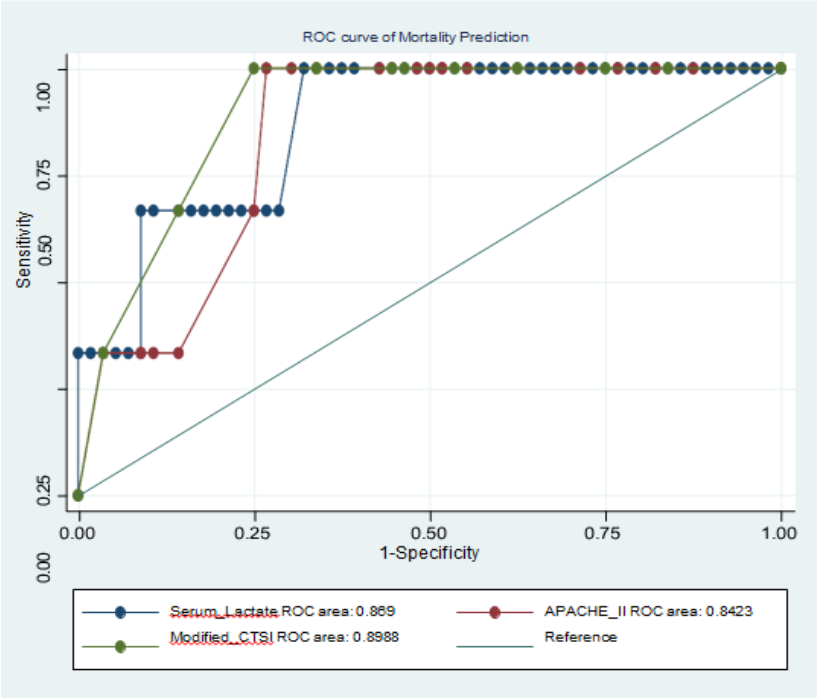

Figure 1: ROC curve of mortality prediction

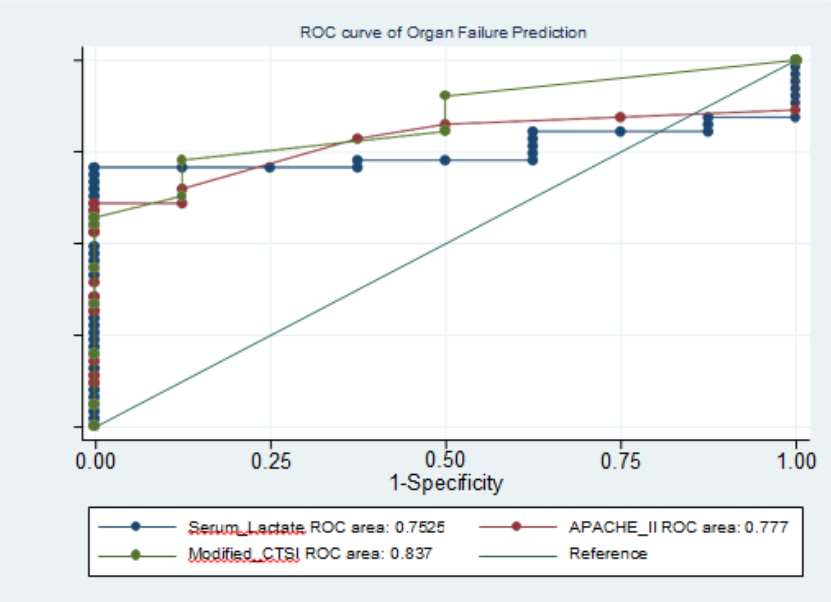

Figure 2: ROC curve of organ failure prediction

At a cut-off value of ≥2.5, serum lactate has a sensitivity of 70.59%, specificity of 100.0%, PPV of 100.0%, and NPV of 64.0%, with an AUC of 0.7525. For APACHE II, a cut-off of ≥13 yields a sensitivity of 60.78%, specificity of 100.0%, PPV of 100.0%, and NPV of 47.06%, with an AUC of 0.777. Modified CTSI at a cut-off ≥5 demonstrates a sensitivity of 56.86%, specificity of 100.0%, PPV of 100.0%, and NPV of 44.44%, with the highest AUC in this set at 0.837.

Serum lactate at a cut-off of ≥2.5 shows a high sensitivity of 83.72%, specificity of 100.0%, PPV of 100.0%, NPV of 46.88%, and an AUC of 0.9186. APACHE II, with a cut-off of ≥13.0, yields a sensitivity of 58.14%, specificity of 62.5%, PPV of 87.5%, NPV of 34.04%, and a relatively low AUC of 0.5392. Modified CTSI at a cut-off ≥7.0 shows a sensitivity of 51.16%, specificity of 100.0%, PPV of 100.0%, NPV of 39.47%, and an AUC of 0.8212, indicating strong specificity and overall accuracy.

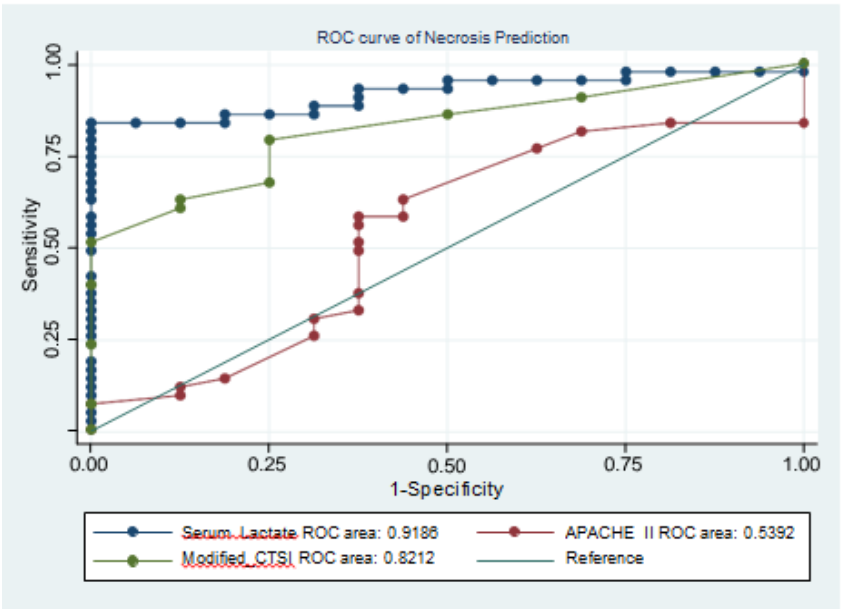

Figure 3: ROC curve of necrosis prediction

DISCUSSION

The current study evaluated the prognostic utility of serum lactate, APACHE II score, and Modified CTSI in predicting mortality, organ failure, and necrosis in patients with acute pancreatitis. These markers were selected based on their accessibility and clinical relevance in assessing disease severity. Several prior studies have investigated the predictive accuracy of similar scoring systems and biomarkers, and the findings from our study align with some while differing from others in important ways.

In our study, APACHE II score showed significant differences across severity grades and outcomes, including organ failure and mortality. This is consistent with the findings of Chatterjee et al., who reported that APACHE II performed well in predicting severe acute pancreatitis and correlated with patient outcomes. Similarly, Zhou et al. concluded that APACHE II was useful in early phase prognostication in acute pancreatitis, highlighting its sensitivity in detecting severe cases.[7,8]

However, some studies have questioned the superiority of APACHE II. Wu et al., for instance, compared various prognostic scoring systems and found that although APACHE II had moderate predictive value, its complexity and the need for multiple parameters limited its practicality in certain clinical settings.[9] Our study also highlighted that although APACHE II had high sensitivity for mortality, its specificity and PPV were relatively lower compared to other markers.

Modified CTSI showed statistically significant associations with severity and outcomes such as organ failure and necrosis in our study. This finding echoes the results of Mortele et al., who introduced the Modified CTSI and demonstrated its improved correlation with patient outcomes compared to the original CTSI. Bollen et al. also supported its superiority over traditional scoring systems in capturing local and systemic complications.[10,11]

In contrast, Shaikh et al. pointed out that although Modified CTSI is useful, it may underestimate disease severity if imaging is done too early before necrotic changes become radiologically apparent.[12] This limitation was considered in our study by using contrast-enhanced imaging after 72 hours, ensuring adequate time for necrosis visualization.

Serum lactate, a biochemical marker often underexplored in pancreatitis, demonstrated high diagnostic accuracy in predicting necrosis and mortality in our findings. This aligns with the work of Valverde-López et al., who found that lactate levels were associated with severe outcomes and could be a cost-effective early marker. Likewise, Gravito-Soares et al. identified lactate and related indices as significant prognostic indicators in acute pancreatitis.[13,14]

Nevertheless, our findings diverge slightly from Arif et al., who emphasized the superiority of BISAP over biochemical markers like lactate for early severity prediction, particularly within 24 hours of admission.[15] It is worth noting that lactate levels may fluctuate due to systemic conditions such as sepsis or hypoperfusion, potentially limiting their standalone use.

The combination of high sensitivity and negative predictive value observed in Modified CTSI and serum lactate suggests their potential use in excluding severe disease. This is particularly valuable in triaging patients in emergency settings, where early discharge or conservative management decisions may hinge on such predictions. The findings are comparable to those of Wu et al., who advocated for biomarkers that provide reliable NPV to reduce unnecessary ICU admissions.[16]

When evaluating organ failure, our study showed that Modified CTSI had the highest AUC, followed closely by APACHE II and serum lactate. Similar findings were reported by Zhou et al., where radiologic scoring outperformed clinical indices in predicting persistent organ failure.[17] However, Teng et al. highlighted the superiority of SOFA scores over Modified CTSI and APACHE II, especially in ICU-based cohorts[18].

Interestingly, our study revealed that serum lactate had excellent specificity (100%) in predicting organ failure and necrosis, despite relatively moderate sensitivity. These findings support its role as a confirmatory marker. A study by Valverde-López et al. also showed high specificity of lactate for severe pancreatitis, reinforcing our results[13].

APACHE II's high sensitivity (100%) for mortality prediction in our cohort mirrors observations by Leghari et al., who demonstrated that a threshold APACHE II score≥19 predicted 30-day mortality with significant accuracy[19]. However, their study reported higher PPV than ours, which may be attributed to their larger sample size and inclusion of ICU patients only.

Modified CTSI also emerged as the best-performing overall tool in our study for predicting mortality, supported by findings from Capurso et al., who emphasized its value in post-test probability adjustments across diverse clinical settings[20]. Their meta-analysis confirmed the reliability of imaging-based scores, particularly in centers with access to timely CT imaging.

Another dimension to our study was the significant difference in mean scores of all three markers between survivors and deceased individuals. Similar patterns were noted in a study by Cho et al., who compared several scoring systems and found Modified CTSI to be significantly higher in fatal cases of acute pancreatitis[6].

When comparing the discriminative ability of all three markers using ROC curves, serum lactate and Modified CTSI had the highest AUCs across most outcomes. This concurs with findings by Wu et al., who emphasized the role of simple biochemical markers in early triage alongside radiological tools[9].

Although APACHE II remains widely used in ICUs, its dependency on numerous variables may limit its adoption in resource-limited settings. This concern was previously raised by Kumar et al., who recommended simpler and faster scoring systems like BISAP or Modified CTSI in busy emergency settings[21].

Our study also revealed that despite a lower AUC, APACHE II still maintained a high NPV for mortality, supporting its utility as a screening tool. Zhou et al. demonstrated similar findings where a high NPV was observed, though the specificity was variable depending on the cut-off used[17].

Additionally, the value of Modified CTSI in predicting necrosis aligns with prior studies, including those by Parida and Biswal, who found a strong correlation between Modified CTSI scores and radiological evidence of necrosis[22]. This underscores the role of imaging as a key component of outcome prediction in acute pancreatitis.

We observed a trend of increasing biomarker scores with rising clinical severity, which is consistent with observations by Li et al., who demonstrated escalating APACHE II and Modified CTSI values across mild, moderate, and severe cases. Such trends validate the clinical relevance of these tools in grading disease.

Our findings support the notion that no single tool may be sufficient alone. Chatterjee et al. proposed a combined approach using APACHE II and imaging-based scores for better risk stratification[7]. This multiparametric strategy may address limitations inherent in standalone indices.

The role of lactate as a metabolic biomarker has gained renewed interest. Zhou et al. showed that early elevation in lactate was associated with systemic inflammation and pancreatic necrosis[17]. Its inclusion in prognostic models may offer added value, especially in sepsis-prone pancreatitis.

While APACHE II had limited specificity in our cohort, its universality and broad acceptance in critical care still render it useful in early management. This was reinforced by Gravito-Soares et al., who emphasized its relevance in comprehensive evaluation when combined with other scores[14].

The small number of mortality events in our study is a limitation for predictive PPV interpretation, a point also noted by Capurso et al. in their review where PPV varied greatly in low-mortality cohorts[20]. Hence, findings should be interpreted within the context of local case-mix and disease burden.

Lastly, a consistent theme across studies, including ours, is the complementary nature of scoring systems. While APACHE II captures physiological derangements, Modified CTSI captures anatomical damage, and serum lactate reflects metabolic stress. Together, they form a triad of prognostic insight.

Thus, our study adds to existing literature by validating the role of serum lactate alongside conventional tools like APACHE II and Modified CTSI. This integration of biochemical and radiological tools provides a comprehensive framework for early prediction and tailored management of acute pancreatitis.

Limitations

- Single-center study limits generalizability
- Small sample size may affect statistical power
- Lack of long-term follow-up data prevents assessment of delayed complications

CONCLUSION

This study highlights the diagnostic utility of serum lactate, APACHE II, and Modified CTSI scores in assessing disease outcomes among patients with acute pancreatitis. Among the three markers, Modified CTSI showed the highest accuracy for predicting mortality, while serum lactate performed well in predicting necrosis and organ failure. These markers, particularly when used in combination, may help in early identification of high-risk patients.

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Conflict of interest: Nil

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