Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/tb8fcv26

A COMPARATIVE STUDY: RANSON'S CRITERIA AND MODIFIED COMPUTED TOMOGRAPHY SEVERITY INDEX FOR PROGNOSIS PREDICTION IN ACUTE PANCREATITIS

Dr. Ashrathi B.[1*], Dr. Kalpana Shridhar Murulya[2]

[1*]Postgraduate, Department of General Surgery, AJ Institute of Medical Sciences and Research Center, Mangalore, Karnataka, India.
[2]Professor, Department of General Surgery, AJ Institute of Medical Sciences and Research Center, Mangalore, Karnataka, India.

***Corresponding Author:** Dr. Ashrathi B.
*Postgraduate, Department of General Surgery, AJ Institute of Medical Sciences and Research Center, Mangalore, Karnataka, India.

ABSTRACT

Background: Acute pancreatitis is an inflammatory condition of the pancreas that can range in severity from mild to life-threatening. Early identification of high-risk patients is critical, as they often need intensive care and aggressive treatment. Scoring systems like Ranson's criteria and the Modified Computed Tomography Severity Index (CTSI) help predict severity and prognosis. Ranson's criteria evaluates eleven parameters, with higher scores indicating greater mortality risk. The Modified CTSI uses CT imaging for objective assessment of pancreatic damage.

Methods: A cross-sectional study of 60 adults with acute pancreatitis compared Ranson's criteria and modified CTSI for prognostic accuracy. Data from medical records included demographics, clinical findings, scores, and outcomes. Exclusions were chronic pancreatitis, trauma, or surgery. Outcomes assessed included necrosis, organ failure, ICU need, and mortality.

Results: The study evaluated 60 acute pancreatitis patients, analyzing clinical features, CT findings, and scoring systems. MCTSI showed high predictive value for pancreatic necrosis (AUC 0.943, sensitivity 100%), while Ranson's score at 48 hours was more accurate for severity (AUC 0.884) and mortality (AUC 0.828). Ranson's score had higher sensitivity and specificity for mortality, while MCTSI was superior in detecting necrosis. Overall, each score demonstrated strengths in different clinical outcomes, highlighting the importance of context-based application.

Conclusion: The study compares the Ranson criteria and the Modified Computed Tomography Severity Index (MCTSI) in predicting outcomes for acute pancreatitis. The Ranson score is effective for predicting early mortality, whereas the MCTSI better detects local complications like pancreatic necrosis. Using both scores together may improve the evaluation of severity and patient outcomes.

Keywords: Acute Pancreatitis, Ranson Criteria, MCTSI, CTSI, Pancreatic Necrosis, Pancreatic Complication

INTRODUCTION

Acute pancreatitis is a multifaceted inflammatory condition affecting the pancreas, exhibiting a spectrum of severity ranging from mild, self-limiting episodes to severe, life-threatening instances.[1] Accurate prediction of prognosis in acute pancreatitis is crucial for effective clinical management,

enabling timely intervention and resource allocation.[2] The inability to accurately assess the severity of the disease at the outset contributes to increased mortality rates.[3] Early identification of patients at risk for developing severe acute pancreatitis is critical because these individuals often require intensive care unit admission, aggressive fluid resuscitation, nutritional support, and, in some cases, surgical or interventional radiological procedures.[4] Several scoring systems have been developed to predict the severity and prognosis of acute pancreatitis, including Ranson's criteria, the Acute Physiology and Chronic Health Evaluation II system, the Bedside Index for Severity in Acute Pancreatitis, and the Computed Tomography Severity Index.[5,6] These scoring systems utilize various clinical and laboratory parameters to stratify patients into different risk categories. Early stratification of patients can help clinicians determine the appropriate level of care, predict potential complications, and guide therapeutic decisions. The Ranson criteria, one of the earliest and most widely used scoring systems, incorporates a variety of simple laboratory parameters measured upon admission and within 48 hours.[7] Ranson's criteria and the Modified Computed Tomography Severity Index are two commonly used scoring systems.

The Ranson criteria, introduced in the 1970s, involves assessing a set of eleven clinical and laboratory parameters within 48 hours of admission.[8] Five parameters are assessed at admission: age, white blood cell count, blood glucose, serum lactate dehydrogenase, and aspartate aminotransferase.[9] The remaining six parameters are assessed during the first 48 hours after admission: hematocrit fall, blood urea nitrogen increase, serum calcium, base deficit, estimated fluid sequestration, and arterial PO2. A higher Ranson score indicates a greater risk of mortality and morbidity, thus helping in determining the need for more aggressive intervention. Ranson's score has been a cornerstone in the assessment of acute pancreatitis, despite its limitations, as it provided an initial framework for identifying high-risk patients. The Modified Computed Tomography Severity Index relies on imaging findings from contrast-enhanced computed tomography scans to evaluate the severity of pancreatic inflammation, necrosis, and fluid collections. This index assesses various factors, including the degree of pancreatic inflammation, the presence and extent of pancreatic necrosis, and the presence of extrapancreatic complications such as fluid collections or abscesses. The utilization of CT imaging allows for a direct visualization of the pancreatic morphology, offering an advantage over clinical and laboratory markers, which may be influenced by other factors[10] The modified CTSI offers a more objective assessment of the pancreatic damage.[11] Although both Ranson's criteria and the modified CTSI have been used extensively, they both possess inherent limitations. The Ranson score, for instance, necessitates a 48-hour observation period, potentially delaying critical interventions, whereas the modified CTSI involves exposure to ionizing radiation and contrast agents, which may not be suitable for all patients.

Comparative studies are needed to determine the relative accuracy and predictive value of these scoring systems in contemporary clinical practice.[12]

MATERIALS & METHODS

A cross-sectional study design was employed to compare Ranson's criteria and the modified CTSI in predicting prognosis among patients diagnosed with acute pancreatitis, thereby evaluating the accuracy of the ED-SAS score[13]. Data collection involved the retrospective review of medical records from patients admitted with a diagnosis of acute pancreatitis at a tertiary care center. A total of 60 participants were included in the study. The study population included adult patients (≥18 years of age) diagnosed with acute pancreatitis based on established clinical, laboratory, and radiological criteria.

Exclusion criteria encompassed patients with chronic pancreatitis, pancreatic trauma, or those who had undergone pancreatic surgery. Relevant data extracted from the medical records included demographic characteristics, clinical presentation, laboratory values, imaging findings, Ranson's criteria scores, modified CTSI scores, and clinical outcomes. Clinical outcomes of interest included the development of pancreatic necrosis, organ failure, length of hospital stay, need for intensive care unit admission, and in-hospital mortality. Ranson's criteria scores were calculated based on the

established criteria using data obtained within the first 48 hours of admission[14]. Modified CTSI scores were determined from contrast-enhanced computed tomography scans performed within 72 hours of admission, assessing the degree of pancreatic inflammation, necrosis, and the presence of fluid collections.

Statistical Analysis

Statistical analysis was performed to compare the predictive accuracy of Ranson's criteria and the modified CTSI for the selected clinical outcomes. Receiver operating characteristic curve analysis was used to assess the ability of each scoring system to discriminate between patients with and without adverse outcomes, such as pancreatic necrosis, severity, or mortality. The area under the ROC curve was calculated for each scoring system, with a higher AUC indicating better predictive performance. Sensitivity, specificity, positive predictive value, and negative predictive value were also calculated for both scoring systems at various cutoff points to evaluate their diagnostic accuracy.

Continuous variables were compared using appropriate statistical tests, such as t-tests or Mann-Whitney U tests, while categorical variables were compared using chi-square tests or Fisher's exact tests. Statistical significance was set at $p < 0.05$.

RESULTS

The result included 60 participants diagnosed with acute pancreatitis, with a comprehensive overview of the demographic and clinical characteristics of the study cohort, including age, gender, clinical presentation and relevant comorbidities, thereby establishing the context for evaluating the performance of the Ranson's criteria and modified CTSI scoring systems.

Variable	Counts	% of Total
Gender		
Males	42	70.0 %
Females	18	30.0 %
Pain abdomen		
Radiating	50	83.3 %
Non-radiating	10	16.7 %
Symptoms		
Nausea	8	13.3 %
Vomiting	42	70 %
Distended abdomen	36	60 %
Etiology		
Alcoholic	30	50.0 %
Biliary	20	33.3 %
Idiopathic	10	16.7 %
Comorbidities		
Diabetes Mellitus	8	13.3%
Hypertension	8	13.3 %
Severity		
Mild	13	21.7 %
Moderate	28	46.7 %
Severe	19	31.7 %
ICU admission		
Yes	42	70.0 %
No	18	30.0 %

Table 1: Demographic distribution of the patient with acute pancreatitis

Variables	Counts	% of Total
Pancreatic inflammation		
Focal or diffuse enlargement of the pancreas	22	36.7 %
Peripancreatic inflammation	20	33.3 %
Single acute fluid collection	8	13.3 %
Two or more acute fluid collections	10	16.7 %
Pancreatic necrosis		
None	29	48.3 %
<30%	23	38.3 %
30-50%	4	6.7 %
>50%	4	6.7 %
Extra-pancreatic complications		
No	44	73.3 %
Yes	16	26.7 %

Table 2: CT scan finding of patient with acute pancreatitis

A higher percentage of males (70.0%) compared to females (30.0%) were noted in the study. Most patients reported radiating pain (83.3%), while a smaller percentage experienced non-radiating pain (16.7%). Vomiting was notably common, reported by 70% of patients. Alcohol consumption was identified as the most common cause (50%). Diabetes Mellitus and hypertension were reported in 13.3% of the patients each. The BMI data shows an average of 21.3 with a standard deviation of 1.59. The minimum is 19.0, and the maximum is 24.0, all within the normal range. Overall, the group has a healthy BMI distribution.

The majority of patients experienced moderate severity (46.7%), with some reporting severe (31.7%) and mild (21.7%) conditions. A significant portion of patients (70.0%) required admission to the Intensive Care Unit (ICU). Over half of the patients had a decrease in hematocrit (55.0%) and an increase in blood urea nitrogen (BUN) levels (55.0%). The most common CT scan findings included focal or diffuse enlargement of the pancreas (36.7%) and peripancreatic inflammation (33.3%). A smaller proportion had single (13.3%) or multiple (16.7%) acute fluid collections.

Average hospital stay is 10.7± 3.39 days, with a minimum of 5 days and a maximum of 15 days. Median and IQR are not provided.

Score	Counts	% of Total
MCTSI score		
0-2	22	36.7
2-4	18	30.0
6 and more	20	33.3
Total Ransons Criteria		
0-2	16	26.7
3-4	20	33.3
5-6	18	30.0
7-8	6	10.0

Table 3: Categorisation of Patients according to RANSONS Criteria and MCTSI score (N = 60)

AUC (95% CI)	Severity (A)	Mortality (B)	Pancreatic necrosis (C)
Ranson Score on Admission	0.619(0.474-0.763)	0.926(0.863-0.989)	0.505(0.357-0.653)
Ranson score at 48 hours	0.884(0.8-0.968)	0.828(0.725-0.931)	0.546(0.546-0.397)
MCTSI	0.773(0.645-0.901)	0.578(0.420-0.737)	0.943(0.889-0.997)
Total RANSON score	0.848(0.744-0.952)	1	0.509(0.361-0.657)

Table 4: AUC of collected score in diagnosisng severity, mortality and pancreatic necrosis

The data presents the area under the curve (AUC) values with their corresponding 95% confidence intervals (CI) for various scoring metrics used to evaluate the severity and mortality risk associated with pancreatitis, as well as the diagnosis of pancreatic necrosis.

1. Ranson Score on Admission
For assessing severity, the AUC is 0.619 (95% CI: 0.474-0.763), indicating a moderate predictive capability. For mortality prediction, the AUC is significantly higher at 0.926 (95% CI: 0.863-0.989), reflecting a strong ability to predict patient outcomes. In terms of identifying pancreatic necrosis, the score demonstrates a poor predictive value with an AUC of 0.505 (95% CI: 0.357-0.653).

2. Ranson Score at 48 Hours
The predictive capability for severity improves markedly to 0.884 (95% CI: 0.800-0.968), indicating high reliability. For mortality, the AUC is 0.828 (95% CI: 0.725-0.931), which still reflects good but slightly weaker predictive power compared to the admission score. The score's ability to detect pancreatic necrosis is again low, with an AUC of 0.546 (95% CI: 0.546-0.397).

3. Modified CT Severity Index (MCTSI)
The MCTSI exhibits an AUC of 0.773 (95% CI: 0.645-0.901) for severity assessment, indicating good predictive ability. For mortality, it has an AUC of 0.578 (95% CI: 0.420-0.737), which suggests moderate predictive capability. In contrast, the index is highly effective in predicting pancreatic necrosis, with an AUC of 0.943 (95% CI: 0.889-0.997).

4. Total Ranson Score
The Total Ranson Score shows an AUC of 0.848 (95% CI: not provided), indicating a good overall predictive ability for both severity and mortality in patients with pancreatitis.

	Severity	Mortality	Pancreatic necrosis
MCTSI			
Sensitivity	89.4	65.9	100
Specificity	48.7	43.7	75.86
Positive predictive value	44.7	76.3	81.58
Negative predictive value	90.9	31.8	100
Diagnostic accuracy	61.6	60	88.33
Total Ranson Criteria			
Sensitivity	94.74	95.45	70.97
Specificity	41.46	100.00	31.03
Positive predictive value	42.86	100.00	52.38
Negative predictive value	94.44	88.89	50.00
Diagnostic accuracy	58.33	96.67	51.67

In MCTSI scoring, a score of more than 4 was considered as cut-off and for Ranson's score, a score of 3 and more was considered as cutoff to calculate predictive accuracy.

1. Sensitivity

This indicates how effectively a test identifies true positives. A higher sensitivity means that the test is good at detecting those who have the condition. For the MCTSI, sensitivity is quite high for pancreatic necrosis (100%) but lower for mortality (65.9%). The Total Ranson score shows a high sensitivity for both severity (94.74%) and mortality (95.45%), suggesting it is very effective at identifying patients at risk of severe outcomes.

2. Specificity

This reflects the test's ability to correctly identify those without the condition (true negatives). Higher specificity indicates fewer false positives. The MCTSI has lower specificity values (e.g., 48.7% for pancreatic necrosis), meaning it may give more false positives. The Ranson score has a perfect specificity (100%) for mortality, indicating it accurately identifies patients not at risk.

3. Positive Predictive Value (PPV)

This value tells us the probability that patients with a positive test truly have the condition. The MCTSI has a lower PPV for pancreatic necrosis (44.7%), suggesting that among those identified as at risk, fewer actually have it, whereas it's higher for mortality (76.3%). The Total Ranson score shows good PPV for mortality (100%), meaning every test result indicating risk was accurate.

4. Negative Predictive Value (NPV)

This indicates the likelihood that patients with a negative test result truly do not have the condition. The MCTSI has a high NPV for pancreatic necrosis (90.9%), suggesting it is reliable in ruling out the disease. The Ranson score also shows a high NPV for severity (94.44%).

5. Diagnostic Accuracy

This summary statistic reflects the overall correctness of a test. The MCTSI has moderate diagnostic accuracy (61.6% for severity), while the Total Ranson score appears to perform better (88.33% for mortality).

DISCUSSION

Acute pancreatitis is a complex inflammatory condition of the pancreas that can manifest with varying degrees of severity, ranging from mild, self-limiting episodes to severe, life-threatening conditions.[15] The incidence of acute pancreatitis has been on the rise globally, underscoring the importance of accurate and timely assessment to guide clinical management and improve patient outcomes.[16] Early stratification of patients based on the predicted severity of their condition is crucial for optimizing resource allocation and tailoring treatment strategies.[17] The Ranson criteria and the Modified Computed Tomography Severity Index are two widely used scoring systems for assessing the severity and prognosis of acute pancreatitis.[18] Both scoring systems have their strengths and limitations, and this study aims to compare their accuracy in predicting prognosis in patients diagnosed with acute pancreatitis. The activation of inflammatory cells triggers the cascade release of a large number of inflammatory factors, leading to the disorder of pro-inflammatory and anti-inflammatory states, which can induce lethal severe acute pancreatitis characterized by systemic inflammatory response syndrome and multiple organ dysfunction syndrome.[19]

The Ranson criteria, introduced in the 1970s, represent one of the earliest attempts to stratify the severity of acute pancreatitis using a combination of clinical and laboratory parameters.[20] This scoring system evaluates various factors, including age, white blood cell count, glucose levels, lactate dehydrogenase, and aspartate aminotransferase levels upon admission, as well as changes in hematocrit, blood urea nitrogen, arterial oxygen pressure, base deficit, and fluid sequestration within

the first 48 hours of hospitalization.[21] A higher Ranson score indicates a greater risk of developing severe complications and a poorer prognosis.[22] While the Ranson criteria have been used for decades, they have several limitations, including the need for a 48-hour observation period before a final score can be calculated, which can delay timely intervention in rapidly deteriorating patients. Moreover, the reliance on a predefined set of parameters, assessed at specific time points, may not fully capture the complex and dynamic pathophysiological processes that characterize the early stages of acute pancreatitis, potentially affecting its predictive accuracy.

In contrast, the Modified Computed Tomography Severity Index is an imaging-based scoring system that assesses the extent of pancreatic inflammation, the presence of peripancreatic fluid collections, and the degree of pancreatic necrosis on contrast-enhanced computed tomography scans. The MCTSI assigns points based on these findings, with higher scores indicating more extensive pancreatic involvement and a greater risk of complications. One of the key advantages of the MCTSI is its ability to provide a comprehensive assessment of pancreatic morphology and pathology early in the course of acute pancreatitis, allowing for more timely risk stratification and treatment planning. The revised Atlanta classification of acute pancreatitis meticulously defines the clinical diagnosis, describes the clinical course, and defines the clinical severity of acute pancreatitis.[23,24] This classification defines three degrees of severity: mild acute pancreatitis, moderately severe acute pancreatitis, and severe acute pancreatitis.[25] While the MCTSI offers valuable insights into the structural changes associated with acute pancreatitis, it also has certain limitations. The APACHE II score can be repeated daily, and uncomplicated attacks demonstrate falling scores in association with clinical improvement, in contrast to the rising scores associated with clinical deterioration in those dying early.[26] The accuracy of the MCTSI depends heavily on the quality of the CT imaging and the expertise of the interpreting radiologist. Additionally, the MCTSI may not fully capture the systemic inflammatory response and the presence of organ failure, which are important determinants of prognosis in acute pancreatitis[25]. Newer scoring systems such as SAPS3, APACHE IV, and MPM0-III were published in 2005, 2006, and 2007, respectively.[27] However, these more recent models have not shown superior performance compared to the older, simpler ones.[27]

The current study aims to compare the accuracy of the Ranson criteria and the MCTSI in predicting prognosis in patients diagnosed with acute pancreatitis. By evaluating various clinical outcomes, this research seeks to provide valuable insights into the relative strengths and weaknesses of these two scoring systems, ultimately informing clinical decision-making and improving patient care. Acute pancreatitis and its complications involve a dynamic process involving two phases, early and late.[23] During the early phase, the inflammatory response predominates. During the late phase, local complications such as pancreatic necrosis, pseudocyst formation, and infection are present. The majority of the population with acute pancreatitis in this study was male gender predominant. The most common etiological factor for acute pancreatitis being alcohol and biliary disease in the study group. Since alcohol is one of the leading cause of acute pancreatitis in Indian subcontinent.[28,29]

The inflammatory response not only affects the pathogenesis but also the course of the disease.[30] Acute pancreatitis is a severe disease with high mortality.[31] Majority of patient presented in this study had abdominal pain as a common symptom and the severity of disease ranged from moderate to severe. Due to the high severity majority of the patients required ICU admission and increasing the hospital stay. Early identification of severity and etiological factors can reduce morbidity and mortality.[32,33]

In this study RANSON score was calculated at the time of admission and after 48 hours, MCTSI score was calculated based on CT findings done within 72 hours of admission and the outcomes were compared. The focus is on systemic inflammation and the presence of organ failure, which are important determinants of prognosis in acute pancreatitis, and whether the existing scoring systems adequately capture these elements 3. The cross sectional study is planned to determine the accuracy of Ranson criteria and Modified Computed Tomography Severity Index in predicting the prognosis of acute pancreatitis, thereby aiding in better clinical management and patient outcomes.

- **Ranson Score vs. MCTSI – Predictive Accuracy** A study by *Bollen et al. (2007)* compared multiple scoring systems in AP and concluded that the MCTSI had superior accuracy in identifying **local complications** such as pancreatic necrosis and peripancreatic collections compared to Ranson's criteria.[34] In line with this, our findings show that:
  - **MCTSI had the highest AUC (0.943)** for predicting pancreatic necrosis with **100% sensitivity and 75.86% specificity**, making it an excellent tool for identifying structural damage.
  - Conversely, **Ranson's score at admission and at 48 hours** showed poor ability to predict necrosis (AUC: 0.505 and 0.546), consistent with Bollen's conclusion that clinical scores lack anatomical insight.

- **Predicting Mortality and Severity** In a prospective study by *Wu et al. (2008)* in *Gastroenterology*, Ranson's criteria had strong predictive power for **mortality**, especially when evaluated at 48 hours (AUC ~0.83–0.90).[35] This is mirrored in our data:
  - **Ranson at admission** had an excellent AUC of **0.926** for mortality, while **Ranson at 48 hours** retained a strong predictive value (AUC: 0.828).
  - In contrast, **MCTSI had a relatively low AUC of 0.578** for mortality, indicating it may not capture the systemic physiological deterioration as effectively.

Additionally, **Total Ranson Score** had a diagnostic accuracy of **96.67% for mortality**, and a **sensitivity of 95.45%**, emphasizing its clinical utility in prognostication, particularly in resource-limited settings where imaging may be delayed or unavailable.
This study observed that the Ranson Score is particularly effective in predicting mortality, especially when assessed at 48 hours, while it has limited effectiveness in diagnosing pancreatic necrosis. In contrast, the Modified CT Severity Index (MCTSI) excels at identifying pancreatic necrosis but shows moderate effectiveness in other predictive areas. The Ranson Score appears to be a more reliable tool for predicting mortality, whereas the MCTSI has limitations, especially regarding specificity and positive predictive value (PPV). The data indicate that both scoring systems can be valuable in different contexts; however, caution should be exercised when interpreting positive results from the MCTSI. Ultimately, employing both scoring systems could offer a more comprehensive assessment, enhancing the precision of severity stratification and prognosis prediction in acute pancreatitis.[36]

CONCLUSION

The study provides a comprehensive comparative analysis of the Ranson criteria and the Modified Computed Tomography Severity Index (MCTSI) in predicting the prognosis of acute pancreatitis. The findings indicate that each scoring system has distinct strengths and clinical applications. The Ranson score, particularly when assessed at 48 hours, demonstrated high sensitivity and specificity for predicting mortality, making it a valuable tool for early identification of patients at risk of poor outcomes, especially in resource-limited settings. However, it showed limited ability to predict pancreatic necrosis due to its reliance on systemic and biochemical parameters without imaging input. On the other hand, the MCTSI proved highly accurate in identifying local complications such as pancreatic necrosis, with excellent sensitivity but moderate specificity. While it offers a timely anatomical assessment of pancreatic damage, its lower accuracy in predicting mortality suggests that it may not fully capture systemic inflammatory and organ dysfunction processes.
The Ranson score is superior in predicting mortality, while the MCTSI is more effective in identifying local pancreatic complications. Therefore, the combined use of both scoring systems may provide a more holistic and accurate assessment of disease severity, aiding clinicians in optimizing management strategies, improving prognostication, and ultimately enhancing patient outcomes in acute pancreatitis.

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