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MODIFIED CT SEVERITY INDEX AND EXTRAPANCREATIC NECROSIS VOLUME IN ACUTE PANCREATITIS: PREDICTIVE VALUE FOR CLINICAL OUTCOMES

Radiology

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ABSTRACT

Background: Accurate early assessment of severity in acute pancreatitis (AP) is essential for guiding management and improving outcomes. Traditional scoring systems have limitations, prompting interest in imaging-based tools such as the Modified CT Severity Index (MCTSI) and extrapancreatic necrosis volume (EPNV). This study evaluates the prognostic utility of MCTSI and EPNV in predicting clinical outcomes in AP. **Methods:** This prospective observational study was conducted at Amrita Institute of Medical Sciences, Kochi, India, between January 2023 and June 2024. A total of 69 patients with AP, diagnosed per the Revised Atlanta Classification, underwent contrast-enhanced CT (CECT) or non-contrast CT. MCTSI and EPNV were independently scored by two blinded radiologists. EPNV was calculated using 3D Slicer software, with ≥100 mL used as a severity threshold. Primary outcomes included organ failure, infection, ICU admission, interventions, and mortality. Statistical analysis included Spearman's correlation, chi-square tests, and ROC curve analysis. **Results:** Among 69 patients (mean age 45.3 ± 12.7 years; 60.9% male), 49.3% had severe AP. MCTSI significantly correlated with hospital stay ($r = 0.682$, $p < 0.001$), ICU admission, organ failure ($p = 0.013$), and interventions ($p < 0.001$). EPNV ≥100 mL was associated with infection ($p = 0.005$), persistent organ failure ($p = 0.003$), and mortality ($p = 0.007$). ROC analysis showed EPNV had an AUC of 0.80 for both infection and organ failure with 100% sensitivity. EPNV also demonstrated excellent interobserver agreement ($\kappa = 0.82$), higher than MCTSI ($\kappa = 0.78$) and CTSI ($\kappa = 0.75$). **Conclusion:** MCTSI and EPNV are reliable predictors of AP severity. EPNV offers high sensitivity and non-contrast CT compatibility, making it particularly valuable in settings with renal impairment or limited resources. Their integration into routine imaging protocols could enhance early risk stratification and inform timely clinical decisions in AP management.

KEYWORDS

Radiologic Assessment, Severity Stratification, Necrotizing Pancreatitis, Predictive Analytics in Imaging

INTRODUCTION

Acute pancreatitis (AP) is an acute inflammatory condition of the pancreas that can range from a mild, self-limiting illness to a severe, life-threatening disease(1). Globally, the incidence of AP has been increasing, with current estimates ranging from 34 to 110 cases per 100,000 individuals annually(2). In severe cases of acute pancreatitis, mortality rates may range from approximately 10% to 20%, depending on factors such as patient age, comorbidities, and the severity of organ dysfunction(3). Gallstones and chronic alcohol consumption remain the predominant etiologies, collectively accounting for around 70–80% of all cases globally(4).

The pathophysiology of AP is characterized by the premature activation of pancreatic proenzymes, particularly trypsinogen, within the acinar cells, leading to autodigestion of pancreatic tissue. This triggers a cascade of local inflammation, cytokine release, microvascular injury, and in severe cases, pancreatic necrosis and systemic inflammatory response syndrome (SIRS)(5). Early and accurate assessment of disease severity is critical in the management of AP, as it guides decisions regarding hospitalization level, monitoring intensity, and the need for specialized interventions. Timely identification of patients at risk for severe disease allows for appropriate triage, intensive monitoring, and intervention, which can significantly improve outcomes(3,6).

Several clinical scoring systems have been developed to predict the severity of AP, including Ranson's criteria, the Acute Physiology and Chronic Health Evaluation II (APACHE II), and the Bedside Index for Severity in Acute Pancreatitis (BISAP). Although these tools are instrumental in stratifying patients based on risk, each has inherent limitations. These include dependence on laboratory or clinical parameters that may not be immediately available at the time of presentation, inter-observer variability, and differing levels of predictive accuracy across populations and clinical settings(7,8).

Imaging, particularly contrast-enhanced computed tomography (CECT), plays a pivotal role in the evaluation of AP. CECT is instrumental not only in confirming the diagnosis but also in delineating the extent of pancreatic inflammation, identifying areas of necrosis, and detecting extrapancreatic complications such as fluid collections, vascular involvement, or organ dysfunction. Its utility is especially significant in patients with uncertain clinical diagnosis, suspected complications, or worsening clinical status despite supportive therapy(3,9,10). The Balthazar grading system, introduced in 1985, was among the earliest attempts to quantify the severity of AP based on contrast-enhanced CT findings. This system evaluates pancreatic morphology, including gland enlargement, peripancreatic inflammation, and fluid collections, and assigns grades ranging from A (normal pancreas) to E (multiple fluid collections and/or gas in or adjacent to the pancreas). To enhance its prognostic utility, the CT Severity Index (CTSI) was subsequently developed by combining the Balthazar grade with the extent of pancreatic necrosis, thereby offering a more comprehensive and objective measure of disease severity and risk of complications(11–13).

Recognizing the limitations of earlier scoring methods and the need for a more streamlined and clinically applicable tool, the Modified CT Severity Index (MCTSI) was proposed. The MCTSI incorporates three key components: the degree of pancreatic inflammation, the extent of necrosis, and the presence of extrapancreatic complications such as pleural effusion, ascites, or vascular involvement. Studies have shown that the MCTSI demonstrates strong correlation with important clinical outcomes, including the need for surgical or percutaneous intervention, duration of hospitalization, incidence of organ failure, and mortality, thereby offering a practical alternative for prognostication in AP(9,11).

In recent years, growing attention has been directed toward the assessment of extrapancreatic necrosis volume (EPNV) as a novel radiologic marker for predicting the severity of AP. EPNV refers to the volume of necrotic collections located outside the pancreas, predominantly within the peripancreatic fat, mesentery, and retroperitoneal compartments. Unlike traditional CT-based severity indices that emphasize pancreatic parenchymal necrosis, quantifying EPNV offers additional prognostic value—particularly in cases where pancreatic necrosis is minimal or absent. Emerging evidence suggests that higher EPNV is significantly associated with increased rates of organ failure, need for intervention, and mortality(9,14).

The Revised Atlanta Classification, updated in 2012, offers a standardized and widely accepted framework for classifying the severity of AP. It stratifies AP into three categories: mild (no organ failure or local/systemic complications), moderately severe (transient organ failure or local complications), and severe (persistent organ failure >48 hours). This classification emphasizes the importance of integrating clinical assessment, laboratory parameters, and imaging findings to guide appropriate therapeutic decisions and predict patient outcomes more accurately(3,15).

Despite significant advancements in clinical scoring systems and

imaging modalities, accurately predicting the clinical trajectory of AP remains a challenge. Many existing tools, while informative, may lack practicality in resource-limited settings due to complexity or dependence on specialized investigations. Therefore, there is a growing need for prognostic tools that are both accurate and easily applicable across diverse healthcare environments. In this regard, the Modified CT Severity Index (MCTSI) and extrapancreatic necrosis volume (EPNV) have emerged as promising radiologic parameters, offering enhanced predictive value for disease severity, need for intervention, and overall clinical outcomes(11,15). This study aims to evaluate the prognostic value of MCTSI and EPNV in patients with AP. Specifically, it seeks to determine the correlation between these imaging-based parameters and clinical outcomes such as organ failure, infection, need for intervention, and mortality. By comparing MCTSI and EPNV with established scoring systems like Balthazar and CTSI, this research endeavors to identify reliable and practical tools for early risk stratification in AP.

MATERIALAND METHODOLOGY

Study Design and Setting: This was a prospective observational cohort study conducted at the Department of Radiology, Amrita Institute of Medical Sciences and Research Centre, Kochi, India—a tertiary care academic hospital. The study period spanned from January 2023 to June 2024. The primary objective was to evaluate the role of the Modified CT Severity Index (MCTSI) in predicting clinical outcomes in patients with acute pancreatitis (AP), and the secondary objective was to assess the diagnostic effectiveness of extrapancreatic necrosis volume (EPNV) as a prognostic tool. The study protocol was reviewed and approved by the Institutional Review Board (IRB-AIMS-2018-297) on 20 November 2018, and ethical clearance was granted(16). The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all study participants prior to inclusion.

Participants: Eligible participants included adult patients (≥18 years) presenting to the medical gastroenterology or emergency departments with clinical suspicion of AP. Patients were enrolled within 48 hours of symptom onset. Diagnosis was based on the Revised Atlanta Classification criteria, requiring at least two of the following three criteria:

1. Acute-onset epigastric pain consistent with AP (often radiating to the back),
2. Serum amylase or lipase levels ≥3 times the upper limit of normal,
3. Characteristic findings of AP on contrast-enhanced computed tomography (CECT), magnetic resonance imaging (MRI), or transabdominal ultrasound.

Exclusion Criteria Included:

1. Chronic calcific or atrophic pancreatitis,
2. Pregnancy,
3. Known hypersensitivity to iodinated contrast media,
4. Severe renal dysfunction (serum creatinine >300 μmol/L),
5. Patients who declined consent.

A total of 70 patients were initially enrolled. One patient withdrew consent, and 69 patients were included in the final analysis.

Imaging Protocol: All imaging was performed using a 128-slice Siemens SOMATOM Definition AS CT scanner. Patients underwent contrast-enhanced CT in the portal venous phase (60–70 seconds after intravenous administration of 100 mL of iohexol contrast agent, 350 mg iodine/mL) at an injection rate of 4 mL/sec using a power injector. In patients with renal impairment (n=8), only non-contrast-enhanced CT was performed. Images were acquired with 1-mm axial slice thickness and reconstructed in coronal and sagittal planes for detailed anatomical evaluation.

Radiological Assessment and Scoring Systems: All CT images were independently reviewed by two experienced radiologists (minimum 10 years in abdominal imaging), blinded to clinical data. Discrepancies were resolved by consensus. The following scoring systems were employed:

1. **Modified CT Severity Index (MCTSI):** This scoring system evaluates three key radiologic features: (i) degree of pancreatic inflammation, (ii) extent of pancreatic necrosis (categorized as none, <30%, or ≥30%), and (iii) presence of extrapancreatic complications including ascites, pleural effusion, vascular complications (e.g., thrombosis or pseudoaneurysm), or bowel involvement. Scores range from 0 to 10 and are classified as mild (0–2), moderate (4–6), or severe (8–10)(11).
2. **Extrapancreatic Necrosis Volume (EPNV):** Quantified using 3D Slicer v4.11 software. EPNV was defined as collections of necrotic tissue outside the pancreatic parenchyma, particularly within the peripancreatic fat, mesentery, or retroperitoneum, excluding peritoneal fluid. Necrotic areas were manually segmented using the "organ selection" and "erase" tools, followed by 3D reconstruction. A cutoff of ≥100 mL was used to define significant EPNV.
3. **CT Severity Index (CTSI) and Balthazar Grade:** The Balthazar classification (A–E) evaluated gland enlargement, peripancreatic inflammation, and fluid collections. The CTSI score (0–10) was calculated by combining the Balthazar grade with the percentage of pancreatic necrosis (none, ≤30%, 30–50%, >50%)(12,13).
4. **Interobserver Agreement:** The degree of agreement between the two radiologists was calculated using Cohen's kappa (κ) statistic(17).

Outcomes:

1. Primary clinical outcomes:
2. In-hospital mortality
3. Length of hospital stay (days)
4. ICU admission and duration
5. Organ failure, defined using the modified Marshall scoring system, with a score ≥2 in any of the three organ systems: respiratory (PaO_2/FiO_2), renal (serum creatinine), or cardiovascular (systolic blood pressure). Organ failure was categorized as transient (≤48 hours) or persistent (>48 hours).
6. Pancreatic infection, confirmed via image-guided fine needle aspiration with positive Gram stain or culture.
7. Need for intervention, defined as requirement of surgical, endoscopic, or percutaneous drainage.

Secondary Outcomes:

1. Incidence of extrapancreatic complications, including pleural effusion, ascites, venous thrombosis, pseudoaneurysm, and bowel edema.
   Sample Size Estimation: Sample size was determined to detect a correlation coefficient of at least 0.3 between MCTSI/EPNV and organ failure with 80% power and a 5% level of significance (α=0.05). A minimum of 65 patients was required; 69 were ultimately analyzed.
   Data Management and Statistical Analysis: Data were entered in Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0 and MedCalc software. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR) based on normality (assessed using the Shapiro–Wilk test). Categorical variables were summarized as frequencies and percentages.
2. Spearman's rank correlation was used to assess the association between MCTSI/EPNV and continuous outcomes (e.g., duration of hospitalization, CRP levels).
3. Chi-square test or Fisher's exact test was used for categorical comparisons (e.g., presence of organ failure or infection across severity strata).
4. Receiver Operating Characteristic (ROC) curve analysis was conducted to determine the predictive ability of MCTSI, EPNV, and CTSI for infection and organ failure. Results were reported as Area Under the Curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).
   A p-value <0.05 was considered statistically significant.

RESULTS

A total of 69 patients diagnosed with AP were enrolled in the study, comprising 42 males (60.9%) and 27 females (39.1%), with a mean age of 45.3 ± 12.7 years. Gallstones (37.7%) and chronic alcohol consumption (31.9%) were the predominant etiologies, followed by idiopathic causes (21.7%) and other less common factors (8.7%). Based on the Revised Atlanta Classification, 34 patients (49.3%) were categorized as having severe AP. The median duration of hospital stay was 12 days (interquartile range [IQR]: 7–18 days), and 22 patients (31.9%) required intensive care unit (ICU) admission for a median duration of 5 days (IQR: 3–9). Organ failure occurred in 17 patients (24.6%), of whom 13 (18.8%) had persistent organ failure. Infectious complications were documented in 10 patients (14.5%), and 15 patients (21.7%) required interventions, primarily percutaneous drainage (n = 12), with three patients undergoing surgical procedures. The overall in-hospital mortality rate was 5.8% (n = 4) (Table 1).

The MCTSI scores ranged from 2 to 10, with a median of 6 (IQR: 4–8). Nearly half of the patients (n = 34, 49.3%) were classified as having severe disease based on MCTSI. A significant positive correlation was observed between MCTSI score and length of hospital stay (Spearman's r = 0.682, p < 0.001). When stratified by MCTSI severity, ICU admission was more frequent in patients with severe scores (52.9%) compared to non-severe cases (11.4%; p = 0.002). Similarly, severe MCTSI scores were associated with higher rates of organ failure (38.2% vs. 11.4%; p = 0.013), infection (23.5% vs. 5.7%; p = 0.008), and percutaneous intervention (29.4% vs. 5.7%; p < 0.001) (Table 2).

Extrapancreatic complications were common among the cohort, with pleural effusion present in 58.0% of patients (n = 40) and significantly more prevalent in those with severe AP (88.2%) than in non-severe cases (28.6%; p < 0.001). Ascites was observed in 37.7% of patients overall and was markedly associated with severe disease (64.7% vs. 11.4%; p < 0.001). Other complications included venous thrombosis (14.5%), bowel wall edema (14.5%), and pseudoaneurysm formation (2.9%), though the latter two showed weaker associations with disease severity (Table 3).

The mean extrapancreatic necrosis volume (EPNV) was 235 mL, with a range from 0 to 800 mL. A threshold of ≥100 mL was exceeded in 59.4% of patients (n = 41). EPNV was significantly correlated with multiple adverse clinical outcomes, including longer hospital stays (r = 0.707, p < 0.001), infection (p = 0.005), organ failure (p = 0.003), percutaneous drainage (p < 0.001), and mortality (p = 0.007), with all four deaths occurring in patients with EPNV ≥100 mL.

Receiver operating characteristic (ROC) analysis demonstrated that EPNV ≥100 mL had an area under the curve (AUC) of 0.80 (95% CI: 0.63–0.97) for predicting infection, with 100% sensitivity and an overall diagnostic accuracy of 71.4%. For organ failure, the AUC for EPNV was also 0.80 (95% CI: 0.67–0.93), with similarly high sensitivity and negative predictive value. When compared with other scoring tools, Balthazar Grade E yielded the highest diagnostic accuracy for infection (90.4%, AUC = 0.93), whereas CTSI ≥7 had an AUC of 0.85. For organ failure prediction, CTSI showed an AUC of 0.78, and Balthazar grade had an AUC of 0.75 (Table 4).

Interobserver agreement was strong across all radiological scoring systems used. EPNV demonstrated an almost perfect agreement (Cohen's kappa = 0.82), while MCTSI and CTSI showed substantial agreement (κ = 0.78 and 0.75, respectively), supporting the reproducibility of these imaging-based assessment tools (Table 5).

Collectively, these findings highlight the clinical utility of both MCTSI and EPNV in predicting adverse outcomes in AP. Notably, EPNV ≥100 mL emerged as a highly sensitive predictor of infection and organ failure, with the added advantage of being assessable even on non-contrast CT scans, making it especially useful in patients with renal impairment.

DISCUSSION

This prospective observational study reinforces the prognostic significance of the Modified CT Severity Index (MCTSI) in acute pancreatitis (AP) and highlights the emerging utility of extrapancreatic necrosis volume (EPNV) as an adjunct radiological biomarker. The study findings demonstrate that MCTSI is significantly associated with important clinical outcomes, including duration of hospitalization, requirement for intensive care, occurrence of organ failure, and need for invasive interventions. These results are in agreement with Mortele et al., who originally proposed the MCTSI as an improved alternative to the original CTSI by incorporating extrapancreatic complications into the scoring system, thereby enhancing its predictive performance for morbidity and mortality(11). Similarly, Bollen et al. validated MCTSI's superiority over the traditional CTSI in correlating with patient outcomes such as infection and necrosis-related complications (9).

In our cohort, patients with severe AP (MCTSI score ≥8) had significantly prolonged hospital stays (r = 0.682, p<0.001) and were more likely to require ICU admission (52.9%) and experience organ failure (38.2%). These findings are consistent with the pathophysiological understanding of AP, where higher MCTSI scores reflect greater degrees of pancreatic and peripancreatic inflammation, necrosis, and systemic involvement. Furthermore, 29.4% of patients with severe AP required percutaneous drainage, supporting the utility of MCTSI in guiding early decisions about interventional radiology support. These findings align with prior evidence suggesting that radiologic severity scoring can stratify patients for timely management and resource allocation in high-volume centers(9,18).

Extrapancreatic complications were also notably associated with MCTSI severity categories. Pleural effusion (58.0%) and ascites (37.7%) occurred more frequently in severe AP cases, suggesting a more extensive inflammatory process. These findings mirror those of Sahu et al., who reported that pleural effusion and ascites significantly predicted poor outcomes in necrotizing pancreatitis, due to their association with increased vascular permeability and systemic inflammatory response syndrome (SIRS)(18). On the other hand, vascular complications such as venous thrombosis and pseudoaneurysm were less prevalent and not statistically significant, which may reflect sample size limitations or delayed onset not captured in early imaging.

A key strength of our study is the detailed volumetric assessment of EPNV using 3D Slicer software, which allowed for objective quantification of necrotic collections located in peripancreatic and retroperitoneal spaces. An EPNV threshold of ≥100 mL was associated with significantly worse outcomes, including infection, persistent organ failure, prolonged hospitalization, increased need for percutaneous drainage, and higher mortality. This high sensitivity (100%) and area under the curve (AUC = 0.80) for both infection and organ failure outcomes align with the work of Meyrignac et al., who showed that EPNV predicted adverse events more accurately than CTSI in early AP(19). The higher mean EPNV in our population (235 mL compared to 114 mL in Meyrignac's study) could be attributed to the higher prevalence of severe AP (49.3%) in our cohort, possibly reflecting referral bias in a tertiary care setting.

Importantly, EPNV demonstrated robust diagnostic performance even when derived from non-contrast CT scans—crucial in the context of renal impairment, which was present in approximately 11.6% of our participants. This is supported by findings from Çakar et al., who emphasized the clinical utility of non-contrast CT in initial triage, particularly in resource-limited settings where contrast studies may not be feasible(20). The applicability of EPNV to non-contrast CT enhances its relevance in community hospitals and rural health systems where contrast administration is often contraindicated or unavailable.

Interobserver reliability is a vital factor in radiological scoring, and our study demonstrated high agreement for EPNV (Cohen's kappa = 0.82), followed by MCTSI (κ = 0.78) and CTSI (κ = 0.75), indicating substantial to near-perfect reproducibility. This is consistent with earlier studies that found EPNV measurement to be less prone to subjectivity due to its volumetric nature compared to categorical grading systems like Balthazar or CTSI(9,21). While Balthazar grade E had the highest diagnostic accuracy (90.4%) for infection, EPNV's absolute sensitivity makes it a more reliable indicator in the early stages of the disease, when timely recognition is essential to prevent complications.

Clinically, the integration of MCTSI into routine CECT interpretation can aid in the early identification of patients requiring escalated care. The inclusion of extrapancreatic markers within MCTSI strengthens its ability to reflect systemic disease burden. However, EPNV provides an even more focused assessment of peripancreatic necrosis, which may precede pancreatic necrosis in some cases. Its use in non-contrast imaging also makes it highly applicable in low-resource environments. For instance, an EPNV ≥100 mL threshold could serve as a practical criterion for initiating early ICU referral or close monitoring, especially since all four deaths in our study occurred in this subgroup.

Nevertheless, several limitations merit discussion. This was a single-center study with a relatively small sample size, which may limit external validity. Imaging was performed early in the disease course, potentially missing delayed complications such as walled-off necrosis or vascular pseudoaneurysms. Additionally, the labor-intensive nature of EPNV quantification using 3D Slicer limits its integration into routine workflow. Broader adoption will likely depend on the development of automated segmentation tools integrated within PACS or radiology reporting software.

Future research should focus on multicenter validation of EPNV as a prognostic marker, particularly in combination with established

clinical scores such as BISAP or APACHE II. Given that existing clinical tools can misclassify up to 30–50% of AP cases in the early phase, radiologic enhancement of risk stratification offers a promising avenue for improving patient outcomes(8). Furthermore, studies assessing the real-world utility of EPNV in community hospitals are needed to determine its role in referral decision-making and mortality reduction in rural or resource-limited settings, where approximately 80% of global AP cases present(22).

CONCLUSION

This prospective study underscores the significant prognostic value of the Modified CT Severity Index (MCTSI) and extrapancreatic necrosis volume (EPNV) in the early assessment of disease severity in patients with AP. MCTSI showed strong correlations with critical clinical outcomes such as prolonged hospitalization, ICU admission, organ failure, and need for interventional procedures. The inclusion of extrapancreatic complications within the MCTSI framework enhances its utility in triaging patients in tertiary care settings.

Notably, EPNV ≥100 mL emerged as a robust independent predictor of infection, persistent organ failure, and mortality, with 100% sensitivity for both infection and organ failure, offering a valuable radiologic biomarker particularly in early-stage disease. Its compatibility with non-contrast CT scans further increases its applicability in patients with renal impairment and in low-resource settings, where contrast-enhanced imaging may not be feasible. High interobserver agreement for both MCTSI and EPNV reinforces their reliability and reproducibility across radiologists.

While the Balthazar and CTSI scoring systems remain useful, this study demonstrates that volumetric assessment of necrosis using EPNV provides added predictive accuracy, especially in scenarios where pancreatic necrosis is minimal but extrapancreatic involvement is substantial.

Despite limitations such as single-center design and moderate sample size, the findings advocate for integrating MCTSI and EPNV into routine radiological evaluation of AP. Future research should aim to automate EPNV quantification and validate its clinical utility in multicentric and community-based settings to optimize early risk stratification and improve patient outcomes globally.

Table 1: Patient Demographics and Clinical Characteristics

Characteristic	Value
Age (years)	45.3 ± 12.7
Sex (n, %)	
Male	42 (60.9%)
Female	27 (39.1%)
Etiology (n, %)	
Gallstones	26 (37.7%)
Alcohol	22 (31.9%)
Idiopathic	15 (21.7%)
Other	6 (8.7%)
Severity (n, %)	
Non-severe	35 (50.7%)
Severe	34 (49.3%)
Hospital Stay (days, median, IQR)	12 (7–18)
ICU Admission (n, %)	22 (31.9%)
Organ Failure (n, %)	17 (24.6%)
Transient	4 (5.8%)
Persistent	13 (18.8%)
Infection (n, %)	10 (14.5%)
Intervention (n, %)	15 (21.7%)
Mortality (n, %)	4 (5.8%)

Table 2: MCTSI Correlations with Clinical Outcomes

Outcome	Spearman's r	P-value	Severe AP (n=34)	Non-severe AP (n=35)	P-value (Chi-square)
Hospital Stay	0.682	<0.001	-	-	-
ICU Admission	-	-	18 (52.9%)	4 (11.4%)	0.002
Organ Failure	-	-	13 (38.2%)	4 (11.4%)	0.013
Infection	-	-	8 (23.5%)	2 (5.7%)	0.008
Percutaneous Drainage	-	-	10 (29.4%)	2 (5.7%)	<0.001

Table 3: Extrapancreatic Complications by AP Severity

Complication	Total (n=69)	Severe AP (n=34)	Non-severe AP (n=35)	P-value
Pleural Effusion	40 (58.0%)	30 (88.2%)	10 (28.6%)	<0.001
Ascites	26 (37.7%)	22 (64.7%)	4 (11.4%)	<0.001
Venous Thrombosis	10 (14.5%)	7 (20.6%)	3 (8.6%)	0.188
Pseudoaneurysm	2 (2.9%)	2 (5.9%)	0 (0%)	0.243
Bowel Edema	10 (14.5%)	8 (23.5%)	2 (5.7%)	0.021

Table 4: Diagnostic Performance for Infection and Organ Failure

Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	AUC (95% CI)	Outcome
Infection							
EPNV ≥100 mL	100	65.5	45.0	100	71.4	0.80 (0.63–0.97)	Infection
Balthazar	100	88.3	66.7	100	90.4	0.93 (0.73–0.99)	Infection
CTSI ≥7	100	75.9	52.6	100	80.2	0.85 (0.68–0.95)	Infection
Organ Failure							
EPNV ≥100 mL	100	66.0	41.5	100	73.9	0.80 (0.67–0.93)	Organ Failure
Balthazar	88.2	63.5	34.9	95.8	68.1	0.75 (0.60–0.87)	Organ Failure
CTSI ≥7	90.0	67.3	37.5	97.1	71.0	0.78 (0.64–0.89)	Organ Failure

Table 5: Interobserver Agreement for Scoring Systems

Scoring System	Cohen's Kappa	Interpretation
EPNV	0.82	Almost Perfect
MCTSI	0.78	Substantial
CTSI	0.75	Substantial

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