ORIGINAL ARTICLE

Enhancing Acute Pancreatitis Prognosis: Combined Ultrasound and BISAP Score Approach

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Abstract

Background: Acute pancreatitis (AP) is a common gastrointestinal disorder with varying severity, ranging from mild, self-resolving cases to severe cases with systemic complications and high mortality rates. Early identification of patients at risk of developing severe AP is crucial for optimizing treatment and improving patient outcomes. **Methods:** This retrospective observational study aimed to assess the effectiveness of combining ultrasound (US) morphological staging with clinical severity scoring systems for early risk stratification in patients with AP. The study included 96 patients with AP who were admitted to two tertiary healthcare facilities in Bishkek, Kyrgyzstan, between December 2010 and November 2020. **Results:** Patients underwent US evaluation within 24 h of admission, and the findings were categorized using a modified Balthazar scoring system. Clinical severity was assessed using the Bedside Index of Severity in AP (BISAP), Ranson criteria, sequential organ failure assessment score, and Modified Marshall score. The results showed a significant correlation between higher Balthazar stages on US and moderate-to-severe AP. Among the clinical scoring systems, BISAP demonstrated the best balance between sensitivity (87.5%) and specificity (61.5%) in predicting severe disease. **Conclusion:** The integration of US morphological staging with BISAP scoring showed promise for enhancing early risk assessment in AP, particularly in resource-limited settings where computed tomography may not be readily available. Further prospective multicenter studies are needed to validate the effectiveness of this combined approach and explore the incorporation of advanced imaging techniques and molecular biomarkers for improved patient stratification and management of AP.

Keywords: Acute pancreatitis, acute physiology and chronic health evaluation II score, bedside index of severity in acute pancreatitis score, contrast-enhanced computed tomography, necrotizing pancreatitis, sequential organ failure assessment score

INTRODUCTION

Acute pancreatitis (AP) is a common gastrointestinal crisis characterized by pancreatic inflammation. AP ranges from mild, self-resolving cases to severe ones with systemic inflammatory response syndrome, multi-organ failure, and pancreatic tissue death, increasing mortality risks.[1,2] Prompt identification of severe cases is crucial for enhancing treatment and improving outcomes.

The incidence of AP is rising globally, with 30–34 cases/100,000 people annually, contributing significantly to gastrointestinal hospital admissions in the United States and Europe.[1,3] AP causes about 300,000 emergency department visits annually in the United States.[1] While 80% of patients experience

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mild disease resolving with supportive care, 20% develop moderate or severe AP with pancreatic necrosis and organ failure.[1,3,4] Severe AP (SAP) with necrosis or infection has mortality rates up to 30%, with increased morbidity from complications requiring intensive care.[3-5]

Necrotizing pancreatitis, characterized by pancreatic tissue death, is most severe due to infection risk and organ failure.[4,5] Patients need comprehensive care involving extended hospitalization and possible surgical interventions.[3,5] Treatment has shifted from early surgical necrosectomy to aggressive medical management, reducing mortality rates at specialized centers to below 20%.[3-5]

Early identification of patients at risk of severe AP is crucial because of its diverse nature. Clinical scoring systems like bedside index of SAP (BISAP) and acute physiology and chronic health evaluation II (APACHE II) help predict severity, but no single method fully captures AP's complexity, requiring combined clinical judgment and objective evaluations.[1] Biomarkers, including procalcitonin and interleukins, aid in early risk assessment within 48–72 h of onset, helping predict complications like infected necrosis and organ failure.[4,6] Contrast-enhanced computed tomography (CECT) after the 1st week identifies necrotizing pancreatitis and guides therapeutic decisions.[4,5]

Early intensive supportive care, including fluid resuscitation, enteral nutrition, and organ function monitoring, is essential for outcomes.[1,4] Research continues on the impact of analgesia timing and supportive interventions on disease progression.[7] Preventive measures for gallstone disease and alcohol consumption are vital to prevent recurrence.[1,8]

Current clinical methods for evaluating AP severity, including the Ranson criteria, BISAP score, sequential organ failure assessment (SOFA) score, and Marshall scoring system, have limitations that reduce their accuracy, particularly for early risk assessment.

The Ranson criteria, developed in the 1970s, provide prognostic insights into SAP and mortality. A major drawback is the delayed scoring of 11 parameters over 48 h after admission, which impedes risk stratification during the crucial initial phase of care. This delay reduces its clinical value despite strong predictive ability (area under the receiver operating characteristic curve (AUC) ~0.69–0.82).[9,10]

The BISAP score was created for use within 24 h of the admission. It comprises five elements: Blood urea nitrogen, impaired mental status, systemic inflammatory response syndrome, age >60 years, and pleural effusion. While BISAP shows good specificity (~90–91%) for predicting SAP and mortality, its moderate sensitivity (~50–56%) indicates many patients who develop severe disease could be missed.[4,11] Meta-analyses show that while effective for confirming low-risk patients, BISAP lacks sensitivity for thorough early assessment.[4] Its predictive accuracy (AUC ~0.74 for severity) equals but does not exceed Ranson and APACHE-II scores.[9,11]

SOFA and Marshall scores evaluate organ dysfunction across systems, providing insights into multi-organ failure in SAP. These tools measure severity after organ failure occurs rather than predicting progression early.[12] While SOFA scoring correlates with outcomes and tracks treatment response, it cannot guide early management.[12] These scores lack sensitivity for early prognostication and cannot identify high-risk patients before organ failure develops.

Imaging techniques, particularly CECT, effectively diagnose pancreatic issues like necrosis and fluid accumulation and remain preferred for morphological evaluation after the 1st week.[1,12] However, CECT is not useful during the initial acute phase (first 48–72 h) as necrosis indicators appear later than clinical symptoms.[1] CECT is limited by equipment availability, high costs, and moving unstable patients.[1,12] Iodinated contrast agents can cause kidney damage in patients with renal issues or hemodynamic instability, common in SAP cases.[12] Radiation exposure concerns with multiple imaging sessions make CECT less viable as an early prognostic tool.

Ultrasound (US) is crucial for the initial assessment of AP, as it is cost-effective and readily available after admission. These features make it an excellent first-choice technique, especially for a quick bedside evaluation or when computed tomography (CT) access is limited.

Transabdominal US identifies early morphological changes, including pancreatic swelling and peripancreatic fluid collections, which indicate disease severity.[13] It detects biliary tract abnormalities, a frequent pancreatitis cause. Despite visualization challenges due to bowel gas, US remains preferred for initial evaluation.[14]

Contrast-enhanced US techniques have expanded the diagnostic capabilities beyond traditional B-mode scanning. These methods show strong correlation with CT severity indices and clinical indicators.[15] Echo-enhanced US offers improved detection of pancreatic necrosis within 72 h of admission, avoiding radiation and contrast risks.[15]

Endoscopic US (EUS) enhances the diagnosis of AP with unclear origins. EUS provides high-resolution images of the pancreas and biliary system, detecting abnormalities like microlithiasis, tumors, and chronic pancreatitis changes.[16,17] EUS aids diagnosis and treatment planning, reducing endoscopic retrograde cholangiopancreatography (ERCP) need.[16,17] EUS-guided tissue sampling helps distinguish between autoimmune and neoplastic conditions.[18]

EUS shows accuracy comparable to ERCP in identifying small bile duct stones or biliary sludge during AP, serving as a safer initial diagnostic tool.[19] In specialized facilities,

integrating EUS with ERCP and pancreatic endotherapy improves management of complex pancreatitis.[20]

Recognizing the limitations of current clinical scoring systems and imaging methods in predicting the early severity of AP, this study assessed whether US-based morphological indicators combined with clinical severity scores, such as BISAP, Ranson, SOFA, and Marshall, could improve early risk assessment. The goal was to establish a reliable, accessible, and non-invasive method for predicting disease progression by combining sonographic findings with clinical and laboratory parameters. This approach aims to enhance triage decisions, inform therapeutic strategies, and decrease the morbidity and mortality associated with moderate-to-severe AP.

METHODS

This retrospective observational study was conducted at two tertiary healthcare facilities in Bishkek, Kyrgyzstan: City Clinical Hospital No. 1 and the National Surgical Center under the Ministry of Health. It included patients admitted with AP between December 2010 and November 2020. The Bioethics Committee of I.K. Akhunbaev Kyrgyz State Medical Academy approved this study (Protocol No. 56, dated February 12, 2016). Informed consent for surgery and study participation was obtained from all patients or their legal guardians.

This study included 96 patients with AP. For inclusion, participants had to be at least 18 years old and have AP confirmed by at least two indicators: (1) Sudden onset of upper abdominal pain, (2) serum amylase and/or lipase levels at least 3 times above the normal limit, or (3) imaging results (US or CT) typical of AP. Patients were excluded if they had chronic pancreatitis, a history of pancreatic surgery, had cancer, or had incomplete laboratory or imaging records during hospitalization.

The 2012 revised Atlanta classification categorizes AP severity into three categories: Mild AP, with no organ failure or complications; Moderate AP, with temporary organ failure (<48 h) and/or local complications; and SAP, with ongoing organ failure (>48 h) affecting one or more organs. Organ failure assessment used clinical criteria supported by the SOFA and Marshall scoring systems.

All patients underwent transabdominal US within 24 h of admission, following standardized procedures. Sonographic assessments were performed using high-resolution US equipment with convex and linear probes (3.5–7.5 MHz) and interpreted by senior radiologists who were blinded to the clinical severity scores. Pancreatic evaluation included size, echogenicity, peripancreatic fluid collections, retroperitoneal alterations, ascites, and abnormalities in the spleen or pleura. The results were categorized using a modified Balthazar scoring system for US: Stages A–C indicated no or minor changes, such as pancreatic edema or indistinct margins, whereas stages D–E denoted significant changes, including fluid accumulation in the omental or retroperitoneal areas or widespread tissue necrosis. If the pancreas was not visible due to aerocolia, this was recorded, and follow-up imaging was performed using CT or repeat US.

Patients were assessed using four prognostic scoring systems: BISAP, Ranson's Criteria, SOFA Score, and Modified Marshall Score. Scores were determined within 24–48 h after admission, following specific protocols. Patients were classified as having a severe disease risk based on established cut-offs, such as BISAP ≥3 and SOFA ≥2.

CECT was selectively performed in 26 patients when US results were inconclusive or necrotizing pancreatitis was suspected, following a standardized pancreatic protocol. CT findings were compared with the initial US evaluations to validate the staging.

Data analysis was performed using Statistical Package for the Social Sciences version 25.0 (IBM Corp., Armonk, NY). Categorical variables are presented as frequencies and percentages, and continuous variables as means ± standard deviation. The Chi-square (χ^2) test was used to evaluate the relationships between the imaging stages and severity. Odds ratios (OR) and 95% confidence intervals (CI) were computed to determine the risk. Spearman's correlation coefficient explored connections between organ dysfunction scores and imaging stages. Receiver operating characteristic curves were created for clinical scores to assess diagnostic accuracy. Multivariate logistic regression analysis was used to identify independent predictors of moderate-to-severe AP, and AUC values were used to evaluate the discriminative ability of the model.

RESULTS

This study included 96 patients diagnosed with AP, with a mean age of 47.3 ± 15.6 years. According to the revised Atlanta classification, 26 (27.1%), 36 (37.5%), and 34 (35.4%) patients had mild, moderate, and SAP, respectively. Males were more prevalent, with a male-to-female ratio of 1.4:1.

Using the modified Balthazar classification, US evaluation showed a significant link between morphological characteristics and clinical severity. In mild AP, stage B was the most common at 57.7% of patients, with stages A and C each at 15.4%. No patients showed US results for stages D or E. In moderate AP, patients showed more advanced imaging stages: 30.6% at stage D, 22.2% at stage B, and 11.1% at stage C. Notably, 25.0% of moderate cases had pancreases that were not visible due to intestinal gas (aerocolia), which correlated with disease progression. In patients with SAP, stages D and E were predominant, each in 26.5% of cases,

whereas stages A and B were uncommon. The inability to visualize the pancreas occurred in 8.8% of the patients, corresponding with later confirmation of necrotizing or exudative changes [Table 1].

Statistical analysis showed a significant correlation between the US findings severity (Balthazar stage) and clinical severity category ($\chi^2 = 52.4$, $P < 0.001$). Patients with Balthazar D or E findings were 6.2 times more likely to develop moderate-to-severe disease than those with stage A–C findings (OR = 6.23; 95% CI: 3.01–12.87; $P < 0.001$).

Clinical scoring systems were assessed for diagnostic effectiveness, and they showed varying performance levels. A BISAP score of ≥3 demonstrated strong prediction, with 87.5% sensitivity and 61.5% specificity. Ranson and Marshall scores achieved 100% sensitivity but lower specificities of 38.5% and 15.4%, leading to severity overestimation in milder cases. A SOFA score of ≥2 showed 67.0% sensitivity and 64.3% specificity. Receiver Operating Characteristic curve analysis revealed AUCs of 0.782 for BISAP, 0.776 for Ranson, 0.723 for SOFA, and 0.711 for Marshall scores. The BISAP score provided the best balance between sensitivity and specificity for early risk assessment in this study [Table 2].

Table 1: Distribution of US-based Balthazar stages according to AP severity

Balthazar Stage	Mild AP (%)	Moderate AP (%)	Severe AP (%)
A	4 (15.4)	3 (8.3)	2 (5.9)
B	15 (57.7)	8 (22.2)	1 (2.9)
C	4 (15.4)	4 (11.1)	1 (2.9)
D	0 (0.0)	11 (30.6)	9 (26.5)
E	0 (0.0)	1 (2.8)	9 (26.5)
Not visualized	3 (11.5)	9 (25.0)	3 (8.8)
Total	26 (100)	36 (100)	34 (100)

Data presented as *n* (%), *n*=No. of patients. Balthazar ultrasound staging indicates morphological severity progression: Stage A: Normal pancreas, Stage B: Focal or diffuse enlargement, Stage C: Peripancreatic inflammation, Stage D: Single fluid collection, Stage E: Multiple fluid collections or gas within the pancreas, and Not visualized: Inability to assess pancreas due to bowel gas. AP: Acute pancreatitis

The integration of US morphological staging with clinical scoring systems shows significant promise for early risk assessment in AP. The results indicate that higher Balthazar stages on US correlate strongly with clinical severity, particularly in patients developing moderate to severe disease. Among the clinical tools, BISAP offered the most reliable balance of sensitivity and specificity for predicting negative outcomes, whereas Ranson and Marshall scores often overestimated the severity in milder cases. These findings highlight the complementary role of US and clinical scoring in enhancing diagnostic precision and informing timely management decisions for patients with AP.

DISCUSSION

This study demonstrates the value of integrating US morphological staging with severity-scoring systems to predict AP outcomes. Results showed that higher Balthazar stages on US are linked to moderate-to-severe cases, particularly stages D and E, which showed a significant association with necrotizing pancreatitis and systemic complications. These findings align with studies highlighting the prognostic importance of peripancreatic fluid collections, necrosis, and ascites in forecasting adverse outcomes.[21,22]

This study showed that US evaluation within 24 h of admission provided significant prognostic information, despite challenges such as aerocolia. US is especially beneficial in resource-limited settings, serving as a safe, accessible, and repeatable method that avoids ionizing radiation or nephrotoxic contrast agents. Earlier studies demonstrated that echo-enhanced US achieves accuracy similar to CT in identifying necrosis and aligns with clinical severity indices, indicating its potential as a supplementary tool to clinical scoring in early AP.[23,24]

The BISAP stands out among clinical scoring systems for effectively balancing sensitivity and specificity, making it practical for bedside risk assessment. Multiple meta-analyses confirm BISAP as a strong early indicator of mortality and severe illness, particularly within 24 h of admission.[11,25] Conversely, Ranson and Marshall scores show high sensitivity but very low specificity, overestimating the severity in less severe cases. While these systems have

Table 2: Effectiveness of clinical severity scoring systems in predicting moderate-to-severe acute pancreatitis

Score	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)	AUC (95% CI)
BISAP ≥3	87.5	61.5	68.3	83.9	0.782 (0.701–0.862)
Ranson ≥3	100	38.5	61.8	100	0.776 (0.689–0.847)
SOFA ≥2	67.0	64.3	66.1	65.2	0.723 (0.635–0.811)
Marshall ≥2	100	15.4	56.2	100	0.711 (0.621–0.801)

Data presented as *n* (%). BISAP: Bedside index of severity in acute pancreatitis, SOFA: Sequential organ failure assessment, AUC: Area under the receiver operating characteristic curve, CI: 95% Confidence intervals

historical and prognostic value, their reliance on delayed parameters (Ranson) or post-organ dysfunction evaluations (Marshall, SOFA) limits their utility for prompt triage.[26]

Combining US morphological evaluation with BISAP scoring could enhance early prognosis. Our results align with evidence that multimodal strategies integrating imaging biomarkers with clinical and laboratory measures improve predictive accuracy beyond single-method tools. Procalcitonin, C-reactive protein, and interleukin-6 are validated supplementary biomarkers, yet imaging remains essential for confirming necrosis or complications.[27,28] Therefore, incorporating sonographic findings with BISAP might help clinicians identify high-risk patients sooner, make better ICU admission decisions, and minimize overtreatment in mild cases of AP.

While there are strengths, certain limitations must be recognized. US can be operator-dependent and face visualization difficulties in obese patients or those with excessive bowel gas, potentially underestimating the severity of the condition. Although CECT is preferred for identifying necrosis, its application is often delayed due to timing requirements and patient instability. The retrospective nature of the study and the small sample size limit its broader applicability. Nonetheless, these findings hold clinical significance, especially in settings where CT scans may not be readily accessible.

Future studies should prospectively confirm the effectiveness of combining US and BISAP assessments in larger multicenter groups. Creating standardized severity indices based on US and incorporating artificial intelligence-assisted imaging interpretation could minimize inter-observer variability and enhance reproducibility. Furthermore, merging morphological characteristics with new molecular and metabolomic biomarkers may lead to more accurate risk stratification models.

CONCLUSION

This study shows that combining US morphological staging with clinical severity scoring systems improves the early evaluation of AP. Higher Balthazar stages on the US were linked to moderate-to-severe cases, highlighting the importance of morphological assessment in forecasting negative outcomes. Among the scoring systems, BISAP offered the most effective balance of sensitivity and specificity, while Ranson and Marshall scores, though highly sensitive, often overestimated the severity in milder cases.

The combined use of US and BISAP scoring indicates that this integrated method can enhance triage decisions, allocate intensive care resources, and enable timely interventions. This approach benefits settings with limited resources, where CT access is constrained. Broader multicenter studies, standardization of US severity indices, and incorporation of advanced imaging techniques or molecular biomarkers are required to validate this method. Merging morphological and clinical parameters may decrease morbidity and mortality in moderate-to-severe AP and improve the precision of patient care.

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