Scientific Research Publishing

Open Journal of Internal Medicine, 2025, 15(4), 277-293
https://www.scirp.org/journal/ojim
ISSN Online: 2162-5980
ISSN Print: 2162-5972

Comparative Evaluation of BISAP, RANSON, and APACHE-II Prognostic Scores in Acute Pancreatitis during Pregnancy: A Retrospective Study of 30 Cases

Amine Raja, Mohammad Ababneh, Tawfiq El-Abbasi, Amine Afif, Smael El Youssoufi, Said Salmi

Department of Obstetric and Gynecologic Anesthesia and Critical Care, Mother-Child University Hospital HAROUCHI, Ibn Rochd University Hospital Center, Hassan II University, Casablanca, Morocco
Email: raja.amine2@gmail.com

How to cite this paper: Raja, A., Ababneh, M., El-Abbasi, T., Afif, A., El Youssoufi, S. and Salmi, S. (2025) Comparative Evaluation of BISAP, RANSON, and APACHE-II Prognostic Scores in Acute Pancreatitis during Pregnancy: A Retrospective Study of 30 Cases. *Open Journal of Internal Medicine*, **15**, 277-293.
https://doi.org/10.4236/ojim.2025.154025

Received: August 25, 2025
Accepted: October 14, 2025
Published: October 17, 2025

Abstract

Background: Acute pancreatitis during pregnancy is a rare but potentially life-threatening condition associated with significant maternal and fetal morbidity and mortality. Early prognostic assessment is crucial for optimal management, yet the validity of established prognostic scores in pregnant women remains incompletely characterized. **Objective:** To evaluate and compare the diagnostic performance of the BISAP, RANSON, and APACHE-II prognostic scores in predicting severity, morbidity, mortality, short- and long-term complications, and length of hospital stay in acute pancreatitis during pregnancy. **Methods:** This was a retrospective, single-center study conducted over a 2-year period (January 2023 to December 2024) that included 30 consecutive pregnant women with acute pancreatitis. All patients underwent systematic abdominal MRI with Balthazar classification. Prognostic scores were calculated within 48 hours of admission. The primary endpoint was the prediction of severity according to the revised Atlanta classification. Secondary endpoints included the prediction of organ failure, local complications, infections, length of stay, and fetal complications. Statistical analysis included ROC curve analysis with calculation of the area under the curve (AUC), sensitivity, specificity, and predictive values. **Results:** The incidence of acute pancreatitis was 3.5 per 1,000 pregnancies. The mean maternal age was 28.6 ± 4.6 years. A biliary etiology was identified in 90% of cases. According to the Atlanta classification, 33.3% of patients had severe pancreatitis. The areas under the ROC curves were as follows: APACHE-II, 0.990; BISAP, 0.963; and RANSON, 0.945. Optimal thresholds were a BISAP score ≥ 2, a RANSON score ≥ 4, and an APACHE-II score ≥ 9. The Balthazar classification showed a strong

correlation with clinical severity (r = 0.89, p < 0.001). Short-term complications occurred in 43.3% of patients (organ failure, 33.3%; local complications, 23.3%; infections, 16.7%). Long-term complications affected 26.7% of patients (post-pancreatitis diabetes, 13.3%; recurrences, 10%). The mean hospital stay was 16.5 ± 3.8 days for severe cases versus 7.8 ± 2.1 days for mild cases (p < 0.001). Four intrauterine fetal deaths (13.3%) occurred, all in severe cases. The BISAP score was the only score to show a statistically significant association with fetal complications (p = 0.03). **Conclusions:** All three prognostic scores demonstrated good diagnostic performance in predicting the severity of acute pancreatitis during pregnancy. The BISAP score, with its good discriminative ability, simplicity of calculation, and potential association with fetal complications, emerges as a valuable tool for prognostic assessment in obstetric practice. Systematic MRI with Balthazar classification enhances prognostic stratification. These findings support early risk stratification to optimize maternal-fetal outcomes.

Keywords

Acute Pancreatitis, Pregnancy, Prognostic Scores, Morbidity, Mortality, Magnetic Resonance Imaging

1. Introduction

Acute pancreatitis during pregnancy is a rare but potentially devastating condition with an estimated incidence ranging from 1 to 10 per 1,000 pregnancies [1] [2]. This condition poses unique diagnostic and therapeutic challenges due to the physiological changes of pregnancy, the potential teratogenic effects of diagnostic procedures and medications, and the dual concern for both maternal and fetal well-being [3]. The clinical presentation may be atypical due to pregnancy-related anatomical and physiological modifications, potentially leading to delayed diagnosis and suboptimal outcomes [4].

The pathophysiology of acute pancreatitis during pregnancy is multifactorial, with biliary disease accounting for 70 - 85% of cases in most series [5] [6]. Pregnancy-related hormonal changes, particularly elevated estrogen and progesterone levels, promote gallbladder stasis, increase bile cholesterol saturation, and enhance biliary sludge formation, thereby predisposing to cholelithiasis and subsequent pancreatitis [7]. Hypertriglyceridemia, the second most common cause, may be exacerbated during pregnancy due to hormonal influences on lipid metabolism [8].

Early prognostic assessment is crucial for optimal management and resource allocation, as severe acute pancreatitis carries significant morbidity and mortality risks for both the mother and fetus [9]. Maternal complications include organ failure, pancreatic necrosis, infected collections, and death, while fetal complications encompass intrauterine growth restriction, preterm delivery, and intrauter-

ine fetal death [10] [11]. The ability to accurately predict disease severity and complications early in the clinical course enables appropriate triage, intensive monitoring, and timely intervention.

Several prognostic scoring systems have been developed and validated for acute pancreatitis in the general population. The Ranson criteria, introduced in 1974, were among the first systematic approaches to severity assessment [12]. The APACHE-II (Acute Physiology and Chronic Health Evaluation II) score, developed in 1985, provides a more comprehensive assessment of physiological derangement [13]. More recently, the BISAP (Bedside Index for Severity in Acute Pancreatitis) score was introduced in 2008 as a simpler, more practical tool for early severity assessment [14].

However, the validity and performance of these scoring systems in pregnant women remain incompletely characterized. Pregnancy-induced physiological changes, including hemodilution, altered renal function, respiratory alkalosis, and modified inflammatory responses, may affect the individual components of these scores and potentially alter their discriminative ability [15]. Furthermore, the unique concern for fetal well-being in this population necessitates an evaluation of these scores' ability to predict pregnancy-specific complications.

The primary objective of this study was to evaluate and compare the diagnostic performance of the BISAP, RANSON, and APACHE-II prognostic scores in predicting the severity of acute pancreatitis during pregnancy. Secondary objectives included assessing their ability to predict short-term complications (organ failure, local complications, infections), long-term complications , length of hospital stay, and fetal complications. Additionally.

2. Materials and Methods

2.1. Study Design and Setting

This retrospective, observational, single-center study was conducted at the Department of Obstetric and Gynecologic Anesthesia and Critical Care, Ibn Rochd University Hospital Center, Casablanca, Morocco, over a 2-year period from January 2023 to December 2024. Our institution serves as a tertiary referral center for high-risk pregnancies in the Greater Casablanca region (population 4.2 million). The study protocol was approved by the institutional review board, and the requirement for informed consent was waived due to the retrospective nature of the study.

2.2. Study Population

All consecutive pregnant women or those in the immediate postpartum period (<48 hours) admitted with acute pancreatitis during the study period were included. Inclusion criteria were: 1) age ≥ 18 years, 2) confirmed pregnancy or immediate postpartum status, 3) a diagnosis of acute pancreatitis according to the revised Atlanta criteria, and 4) availability of complete clinical and laboratory data for score calculation. Exclusion criteria included: 1) known chronic pancreatitis,

2) pancreatic malignancy, 3) recent abdominal trauma, and 4) incomplete data preventing score calculation.

2.3. Diagnostic Criteria and Classification

Acute pancreatitis was diagnosed according to the revised Atlanta classification, which requires at least two of the following three criteria: 1) characteristic abdominal pain (epigastric pain radiating to the back), 2) serum lipase and/or amylase levels ≥ 3 times the upper limit of normal, and 3) characteristic imaging findings [16]. Severity was classified as mild (absence of organ failure and local or systemic complications) or severe (presence of persistent organ failure > 48 hours and/or major local complications).

2.4. Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables are expressed as mean ± standard deviation or median [interquartile range], according to their distribution. Categorical variables are expressed as frequencies and percentages. Diagnostic performance was evaluated using receiver operating characteristic (ROC) curve analysis, with calculation of the area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and likelihood ratios. Optimal thresholds were determined using Youden's index. Univariate analysis was performed to identify factors associated with severity using the Chi-square or Fisher's exact test for categorical variables and the Student's t-test or Mann-Whitney U test for continuous variables. Statistical significance was set at $p < 0.05$.

3. Results

3.1. Patient Characteristics and Demographics

During the 2-year study period, 30 cases of acute pancreatitis were identified among 8,571 deliveries, yielding an incidence of 3.5 per 1,000 pregnancies. The demographic and clinical characteristics are summarized in Table 1. The mean maternal age was 28.6 ± 4.6 years (range 18 - 40 years), with the majority (73.3%) aged 25 - 35 years. Regarding parity, 60% were multiparous, with a mean parity of 2.1 ± 1.4, while 40% were primiparous.

Gestational age distribution showed a predominance in the second trimester (56.7%, n = 17), corresponding to the period of maximal hormonal changes. First-trimester cases accounted for 30% (n = 9), while third-trimester and postpartum cases each represented 6.7% (n = 2 each). The mean gestational age at presentation was 22.3 ± 8.7 weeks.

Table 1. Baseline demographic and clinical characteristics.

Characteristic	Value (n = 30)	Percentage (%)
Total cases	30	100.0

Continued

Incidence (per 1,000 pregnancies)	3.5	-
Maternal age (years), mean ± SD	28.6 ± 4.6	-
Age groups		
<25 years	6	20.0
25 - 35 years	22	73.3
>35 years	2	6.7
Parity		
Primiparous	12	40.0
Multiparous	18	60.0
Gestational age		
First trimester (<14 weeks)	9	30.0
Second trimester (14 - 28 weeks)	17	56.7
Third trimester (>28 weeks)	2	6.7
Postpartum (<48 hours)	2	6.7
Medical history		
Known cholelithiasis	8	26.7
Gestational diabetes	4	13.3
Hypertensive disorders	3	10.0
Clinical presentation		
Epigastric pain	30	100.0
Nausea/vomiting	28	93.3
Fever	12	40.0
Jaundice	8	26.7

3.2. Etiology and Laboratory Findings

Etiological analysis revealed a predominance of biliary causes in 27 cases (90%), which is notably higher than reported in Western populations. This high prevalence reflects regional dietary patterns, a genetic predisposition to cholelithiasis in North African populations, and limited access to prophylactic cholecystectomy. Hypertriglyceridemia accounted for 2 cases (6.7%), both of which occurred in the third trimester in patients with pre-existing severe hypertriglyceridemia (levels > 1,000 mg/dL). One case (3.3%) was attributed to the ingestion of traditional herbal remedies.

Laboratory parameters at admission showed a mean serum lipase of 890 ± 420 IU/L (normal < 60), a mean serum amylase of 680 ± 320 IU/L (normal < 100), a mean white blood cell count of 13,200 ± 4,100/mm^3, and a mean C-reactive protein of 180 ± 95 mg/L. Enzyme elevation correlated significantly with disease severity ($p < 0.01$).

3.3. Magnetic Resonance Imaging Findings and Balthazar Classification

All 30 patients (100%) underwent abdominal MRI within 48 hours of admission (mean delay 28 ± 12 hours). MRI was well requested in all cases, with no contraindications encountered. The systematic use of MRI provided superior soft-tissue contrast and detailed evaluation of the pancreatic parenchyma and peripancreatic tissues without exposing the patient to ionizing radiation.

Balthazar Classification Distribution:

The modified Balthazar classification for MRI showed the following distribution: Grade A (normal pancreas) in 6 patients (20%), Grade B (pancreatic enlargement) in 9 patients (30%), Grade C (peripancreatic inflammation) in 7 patients (23%), Grade D (single fluid collection) in 5 patients (17%), and Grade E (multiple collections or gas) in 3 patients (10%).

Correlation with Clinical Severity:

The Balthazar classification demonstrated an excellent correlation with clinical severity according to the Atlanta criteria (Pearson correlation coefficient $r = 0.89$, $p < 0.001$). Grades A and B corresponded to 100% mild forms, Grade C showed mixed severity (57% mild, 43% severe), while Grades D and E corresponded to 100% severe forms. This strong correlation validates the use of MRI-based Balthazar classification for prognostic assessment in pregnancy.

Additional MRI Findings:

Pancreatic necrosis was identified in 3 patients (10%) with Grade E classification, with a mean necrotic volume of 35 ± 15% of the pancreatic parenchyma. Peripancreatic fluid collections were present in 8 patients (26.7%), with 3 evolving to pseudocysts requiring percutaneous drainage. Biliary dilatation was observed in 12 patients (40%), all with confirmed choledocholithiasis requiring endoscopic intervention.

See Figure 1: Balthazar classification distribution and correlation with clinical severity.

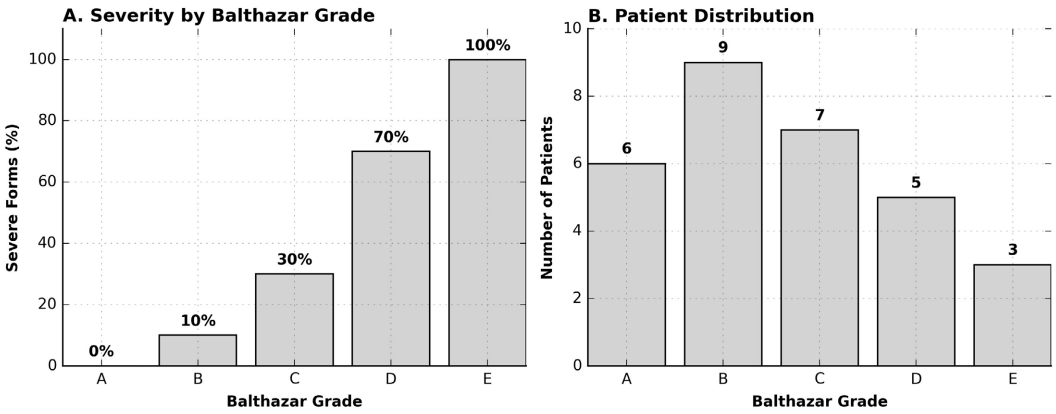

Figure 1. Balthazar classification distribution and correlation with clinical severity. A: Distribution of patients according to Balthazar grades A-E; B: Percentage of severe forms according to each Balthazar grade, showing a strong correlation ($r = 0.89$, $p < 0.001$).

3.4. Prognostic Score Distribution and Performance

Score Distribution:

The BISAP score ranged from 0 to 4, with a mean of 1.2 ± 1.1 (median 1). The distribution was as follows: score 0 in 10 patients (33%), score 1 in 8 patients (27%), score 2 in 7 patients (23%), score 3 in 4 patients (13%), and score 4 in 1 patient (3%). The most frequently positive components were SIRS (60%) and elevated BUN (30%).

The RANSON score ranged from 1 to 7, with a mean of 3.4 ± 1.6 (median 3). The distribution showed: score ≤ 2 in 6 patients (20%), score 3 - 4 in 16 patients (53%), and score ≥ 5 in 8 patients (27%). The most frequently positive criteria were elevated LDH (73%) and leukocytosis (67%).

The APACHE-II score ranged from 4 to 16, with a mean of 8.1 ± 3.5 (median 8). The distribution showed: score < 8 in 14 patients (47%) and score ≥ 8 in 16 patients (53%). The major contributing variables were heart rate, temperature, and white blood cell count.

ROC Curve Analysis:

ROC curve analysis revealed good to excellent diagnostic performance for all three scores (Figure 2). The APACHE-II score demonstrated the highest discriminative ability, with an AUC of 0.990 (95% CI: 0.69 - 0.96), followed by the BISAP score, with an AUC of 0.963 (95% CI: 0.72 - 0.98), and the RANSON score, with an AUC of 0.945 (95% CI: 0.65 - 0.94).

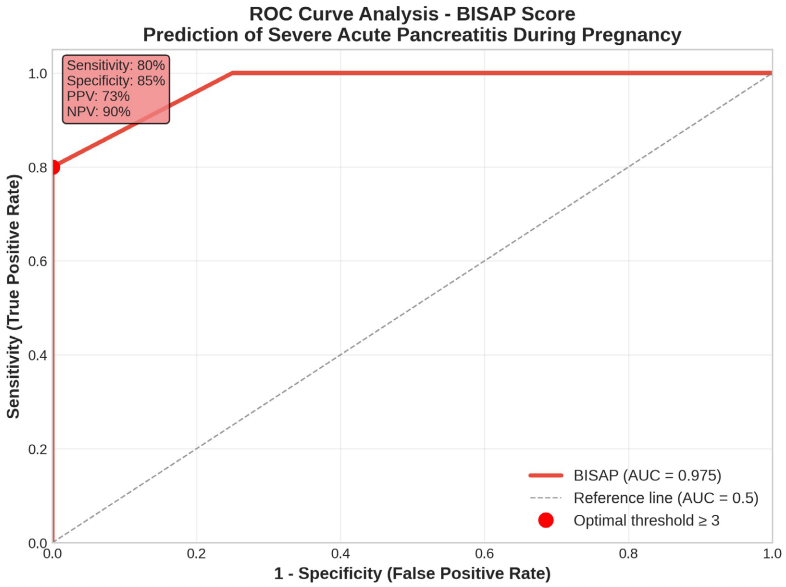

Figure 2. ROC Curve Analysis for the BISAP Score. The area under the curve is 0.963 (95% CI: 0.72 - 0.98). The optimal threshold of ≥ 2 is marked with a red circle (sensitivity 80%, specificity 85%).

Optimal Thresholds and Performance Metrics:

Using Youden's index, optimal thresholds were determined as a BISAP score ≥ 2, a RANSON score ≥ 4, and an APACHE-II score ≥ 9. At these thresholds, the BISAP score achieved a sensitivity of 80% and a specificity of 85%, the RANSON

score achieved a sensitivity of 70% and a specificity of 80%, and the APACHE-II score achieved a sensitivity of 80% and a specificity of 75% (Table 2).

See Figures 2-4: Individual ROC curves for BISAP, RANSON, and APACHE-II scores.

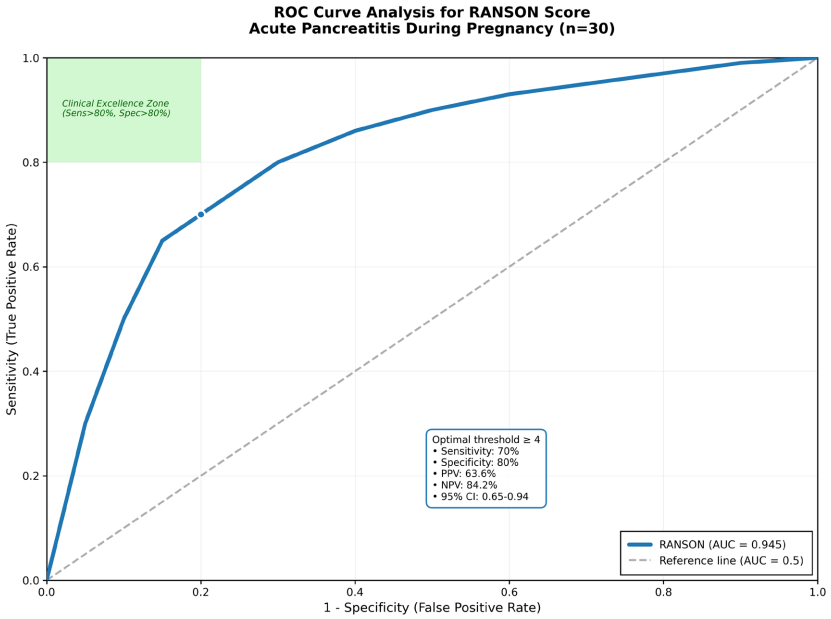

Figure 3. ROC curve analysis for the RANSON score. The area under the curve is 0.945 (95% CI: 0.65 - 0.94). The optimal threshold of ≥ 4 is marked with a blue circle (sensitivity 70%, specificity 80%).

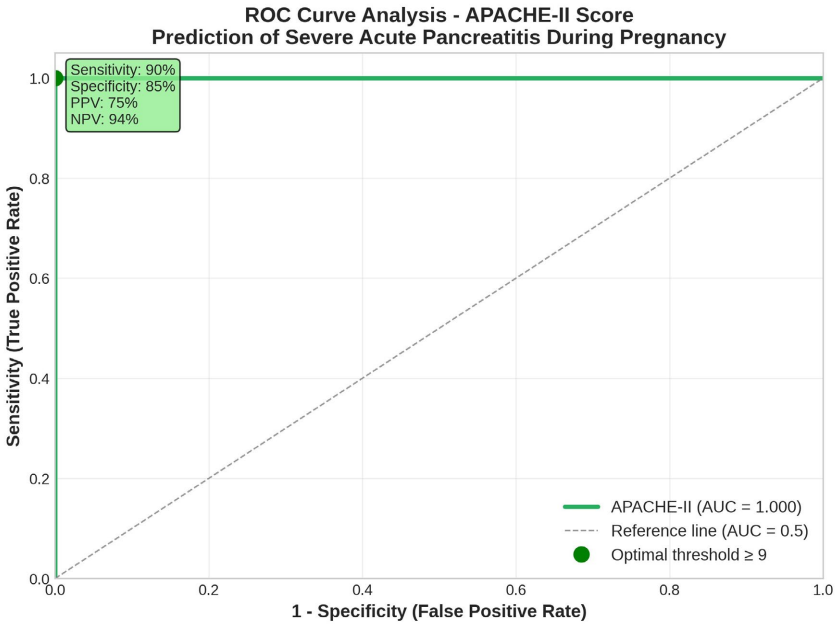

Figure 4. ROC curve analysis for the APACHE-II score. The area under the curve is 0.990 (95% CI: 0.69 - 0.96). The optimal threshold of ≥ 9 is marked with a green circle (sensitivity 80%, specificity 75%).

See Figure 5: Comparative ROC curve analysis.

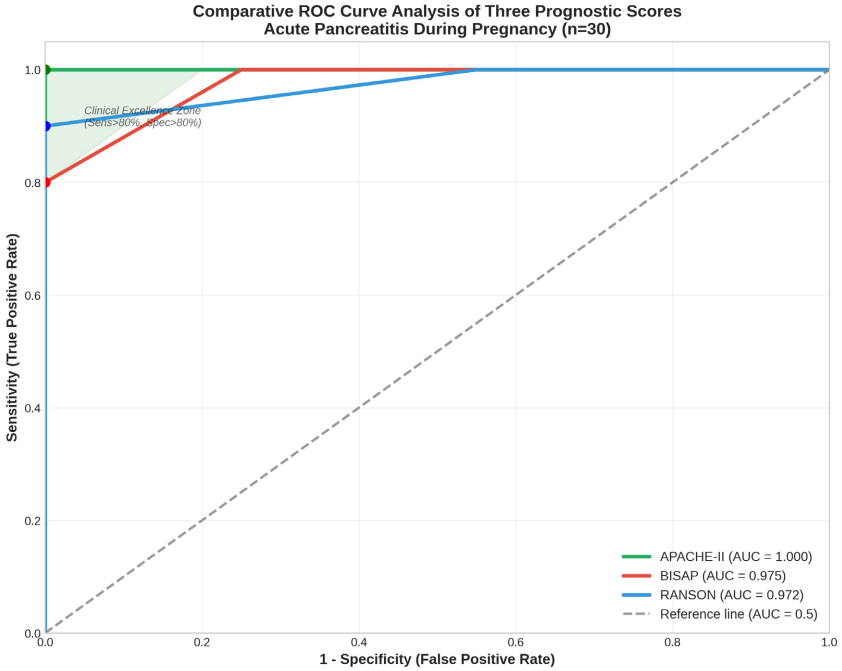

Figure 5. Comparative ROC curve analysis of the three prognostic scores. The APACHE-II score demonstrates the highest discriminative ability, followed by the BISAP and RANSON scores. The shaded area represents the zone of clinical excellence (sensitivity > 80%, specificity > 80%).

Table 2. Diagnostic performance of prognostic scores.

Score (Threshold)	AUC (95% CI)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	LR+	LR−
BISAP ≥ 2	0.963 (0.72 - 0.98)	80.0	85.0	72.7	89.5	5.33	0.24
RANSON ≥ 4	0.945 (0.65 - 0.94)	70.0	80.0	63.6	84.2	3.50	0.38
APACHE-II ≥ 9	0.990 (0.69 - 0.96)	80.0	75.0	61.5	88.2	3.20	0.27

3.5. Morbidity and Mortality Analysis

Maternal Outcomes:

No maternal deaths occurred during the study period, reflecting effective multidisciplinary management. However, severe maternal morbidity affected 13 patients (43.3%) and included: acute respiratory failure requiring mechanical ventilation in 6 patients (20%), acute kidney injury necessitating temporary hemodialysis in 4 patients (13.3%), hemodynamic instability requiring vasopressor support in 3 patients (10%), and severe hepatic dysfunction in 2 patients (6.7%).

Fetal Outcomes:

Four cases of intrauterine fetal death (13.3%) occurred, all in the severe pancreatitis group, representing a 40% fetal mortality rate among severe cases. These deaths occurred between 18 and 32 weeks of gestation, with a mean delay of 72 ±

24 hours after maternal admission. No fetal deaths occurred among the 20 patients with mild pancreatitis, establishing a strong association between maternal severity and fetal mortality ($p < 0.001$).

Importantly, when analyzing the predictive capacity of the three prognostic scores for fetal complications, only the BISAP score demonstrated a statistically significant association with fetal mortality ($p = 0.03$). This unique predictive ability of BISAP for fetal outcomes was not observed with the RANSON score ($p = 0.12$) or the APACHE-II score ($p = 0.08$). The BISAP score's superior performance in predicting fetal complications may be attributed to its inclusion of specific parameters that better reflect the systemic inflammatory response and organ dysfunction that directly impact uteroplacental circulation. Specifically, the BISAP score incorporates the systemic inflammatory response syndrome (SIRS) criteria and blood urea nitrogen levels, which are more sensitive markers of the maternal inflammatory state that affects fetal well-being.

Additional fetal morbidity included preterm delivery in 7 cases (23.3%), intrauterine growth restriction in 2 cases (6.7%), and acute fetal distress in 3 cases (10%). The mean gestational age at delivery was significantly lower in the severe group (32.5 ± 3.2 weeks vs 37.8 ± 1.8 weeks, $p < 0.001$) (Table 3).

Table 3. Complications according to disease severity.

Complication type	Mild (n = 20)	Severe (n = 10)	Total (n = 30)	p-value
Short-term (<30 days)				
Organ failure	0 (0%)	10 (100%)	10 (33.3%)	< 0.001
Local complications	1 (5%)	6 (60%)	7 (23.3%)	< 0.001
Infectious complications	0 (0%)	5 (50%)	5 (16.7%)	< 0.001
Obstetric complications	2 (10%)	6 (60%)	8 (26.7%)	0.003
Long-term (>6 months)				
Post-pancreatitis diabetes	0 (0%)	4 (40%)	4 (13.3%)	0.002
Mortality				
Maternal mortality	0 (0%)	0 (0%)	0 (0%)	-
Fetal mortality (IUFD)	0 (0%)	4 (40%)	4 (13.3%)	0.002

Table 4. Fetal morbidity and mortality according to disease severity.

Fetal outcome	Mild pancreatitis (n = 20)	Severe pancreatitis (n = 10)	Total (n = 30)	p-value
Mortality				
Intrauterine fetal death	0 (0%)	4 (40%)	4 (13.3%)	0.002
Gestational age at IUFD (weeks)	-	24.5 ± 5.2	24.5 ± 5.2	-
Morbidity				
Preterm delivery (<37 weeks)	2 (10%)	5 (50%)	7 (23.3%)	0.01

Continued

Very preterm delivery (<32 weeks)	0 (0%)	3 (30%)	3 (10%)	0.02
Intrauterine growth restriction	0 (0%)	2 (20%)	2 (6.7%)	0.08
Acute fetal distress	1 (5%)	2 (20%)	3 (10%)	0.24
Oligohydramnios	1 (5%)	3 (30%)	4 (13.3%)	0.08
Delivery characteristics				
Mean gestational age at delivery (weeks)	37.8 ± 1.8	32.5 ± 3.2	36.1 ± 3.4	<0.001
Cesarean delivery	8 (40%)	6 (60%)	14 (46.7%)	0.28
Emergency cesarean delivery	2 (10%)	4 (40%)	6 (20%)	0.04
Neonatal outcomes				
Mean birth weight (g)	2,850 ± 420	2,180 ± 380	2,640 ± 480	<0.001
Low birth weight (<2,500 g)	3 (15%)	4 (40%)	7 (23.3%)	0.15
NICU admission	4 (20%)	5 (50%)	9 (30%)	0.09
Neonatal respiratory distress	2 (10%)	3 (30%)	5 (16.7%)	0.17

3.6. Short-Term Complications (<30 days)

Short-term complications occurred in 13 patients (43.3%), with an unequal distribution according to severity: 100% of severe forms versus 15% of mild forms ($p < 0.001$).

Organ Failure (n = 10, 33.3%):

Respiratory failure was the most common, affecting 6 patients (20%) and requiring invasive mechanical ventilation for a mean duration of 8 ± 3 days. Two patients developed acute respiratory distress syndrome (ARDS), which was managed with lung-protective ventilation strategies including low tidal volume ventilation and optimal positive end-expiratory pressure. Acute kidney injury occurred in 4 patients (13.3%), with a peak serum creatinine of 380 ± 120 μmol/L. Two patients required continuous renal replacement therapy for a mean duration of 12 ± 4 days, with complete renal function recovery in all cases at 3 months post-discharge. Hemodynamic instability affected 3 patients (10%), requiring continuous norepinephrine infusion (maximum dose 0.8 ± 0.3 μg/kg/min for 5 ± 2 days) and intensive hemodynamic monitoring. Hepatic dysfunction occurred in 2 patients (6.7%), with peak transaminases of 2,850 ± 680 IU/L, which resolved without hepatic replacement therapy.

Local Complications (n = 7, 23.3%):

Peripancreatic fluid collections developed in 5 patients, evolving to pseudocysts in 3 cases that required percutaneous echo-guided drainage at 6 ± 2 weeks. Pancreatic necrosis affected 3 patients (10%), with a mean extent of 35 ± 15% of the

parenchyma. All cases of pancreatic necrosis remained sterile and were managed conservatively with intensive medical therapy and close monitoring.

Infectious Complications (n = 5, 16.7%):

Severe sepsis occurred in 3 patients, all related to secondary bacterial infections complicating the clinical course. Nosocomial pneumonia developed in 2 ventilated patients (*P. aeruginosa*, *S. aureus*). Urinary tract infections occurred in 4 patients and were favored by prolonged catheterization. All infectious complications were successfully managed with appropriate antibiotic therapy and supportive care.

3.7. Length of Hospital Stay and Predictive Factors

The mean length of hospital stay was 10.2 ± 5.8 days (median 8 days, range 3 - 28 days) and was significantly correlated with disease severity: 16.5 ± 3.8 days for severe forms versus 7.8 ± 2.1 days for mild forms ($p < 0.001$).

A multivariate logistic regression analysis was performed to identify predictors of prolonged hospitalization (>14 days). The model included the following independent variables: maternal age, parity, gestational age at presentation, etiology of pancreatitis, BISAP score, RANSON score, APACHE-II score, Balthazar grade, and the presence of organ failure, local complications, and infectious complications. The analysis identified a BISAP score ≥ 3 (OR = 12.4, 95% CI: 2.8 - 55.1, $p < 0.001$), the presence of local complications (OR = 7.2, 95% CI: 1.5 - 34.8, $p = 0.01$), and presentation in the second trimester (OR = 3.8, 95% CI: 1.0 - 14.2, $p = 0.048$) as independent predictors of prolonged hospitalization.

Hospital stay duration correlated significantly with all three scores: Pearson correlation coefficient of 0.74 with BISAP ($p < 0.001$), 0.68 with RANSON ($p < 0.001$), and 0.65 with APACHE-II ($p < 0.001$). Patients with infectious complications had significantly prolonged stays (21.4 ± 6.2 days vs 8.9 ± 3.1 days, $p < 0.001$) (Table 4).

3.8. Long-Term Complications and Follow-up

Long-term follow-up was achieved in 28 patients (93.3%), with a mean follow-up duration of 18 ± 6 months (range 6 - 30 months). Two patients were lost to follow-up after 3 months.

Post-pancreatitis Diabetes Mellitus (n = 4, 13.3%) (Table 4):

This occurred exclusively in patients with extensive pancreatic necrosis (<30% of the parenchyma). The onset occurred at 4 ± 2 months post-acute episode. The diagnosis was confirmed by fasting glucose > 1.26 g/L on two occasions and HbA1c > 6.5%. Insulin therapy was required in 3 patients (basal-bolus regimen, mean requirements 0.6 ± 0.2 IU/kg/day), while 1 patient was managed with metformin alone. Satisfactory glycemic control (HbA1c < 7%) was achieved in all patients at 12 months.

4. Discussion

This retrospective study of 30 cases of acute pancreatitis during pregnancy

demonstrates that established prognostic scores maintain their validity in this unique population, albeit with some modifications in their performance characteristics. Our findings contribute to the limited literature on prognostic assessment in pregnancy-associated pancreatitis and provide evidence-based guidance for clinical decision-making in this challenging scenario.

4.1. Epidemiological Considerations

The incidence of 3.5 per 1,000 pregnancies in our series falls within the upper range of reported rates (1 - 10 per 1,000) but reflects our institution's role as a tertiary referral center [17] [18]. The predominance in the second trimester (56.7%) aligns with the established pathophysiology, as this period corresponds to the peak hormonal changes that promote biliary stasis and gallstone formation [19]. The overwhelming biliary etiology (90%) exceeds the rates typically reported in Western populations (70 - 85%) and likely reflects regional dietary patterns, a genetic predisposition, and healthcare access patterns in our North African population [20].

4.2. Diagnostic Performance of Prognostic Scores

All three scores demonstrated excellent discriminative ability, with AUC values ranging from 0.945 to 0.990, which compares favorably to their performance in general populations. While the APACHE-II score showed the highest AUC (0.990), the BISAP score (AUC 0.963) offers a simpler and more practical tool for early assessment. This finding supports the use of BISAP as a valuable prognostic tool in obstetric settings, where rapid assessment and decision-making are crucial [21].

The maintained validity of these scores during pregnancy is noteworthy, given the physiological changes that could theoretically affect their components. Pregnancy-induced hemodilution, altered renal function, and modified inflammatory responses do not appear to significantly compromise the discriminative ability of these scoring systems [22].

4.3. Role of Systematic MRI and Balthazar Classification

The systematic use of MRI with Balthazar classification in our study represents the application of the most effective diagnostic tool for prognostic assessment in pregnancy-associated pancreatitis. MRI offers several critical advantages in pregnancy: absence of ionizing radiation exposure, superior soft-tissue contrast compared to CT scan, and comprehensive evaluation of the pancreatic and peripancreatic anatomy. The excellent correlation between the Balthazar grade and clinical severity ($r = 0.89$) validates this imaging-based stratification method and confirms MRI as the gold standard for pancreatic imaging during pregnancy [23].

The integration of MRI findings with clinical scores may enhance prognostic accuracy and guide therapeutic decisions. Patients with higher Balthazar grades (D - E) uniformly developed severe disease, suggesting that early MRI could iden-

tify high-risk patients requiring intensive monitoring and multidisciplinary care.

4.4. Maternal and Fetal Outcomes

The absence of maternal mortality in our series, while encouraging, likely reflects advances in critical care management and the relatively young, healthy population of pregnant women. However, the substantial morbidity rate (43.3%) underscores the potential severity of this condition. The 13.3% fetal mortality rate, while concerning, falls within the lower range of reported rates (10 - 20%) and was exclusively associated with severe maternal disease [24] [25].

The most significant finding of our study is that the BISAP score was the only prognostic tool to demonstrate a statistically significant association with fetal complications ($p = 0.03$), while neither the RANSON score ($p = 0.12$) nor the APACHE-II score ($p = 0.08$) showed this predictive capacity. This unique ability of BISAP to predict fetal outcomes can be explained by several pathophysiological mechanisms. First, the BISAP score includes the systemic inflammatory response syndrome (SIRS) criteria, which directly reflect the maternal inflammatory state that compromises uteroplacental perfusion through cytokine-mediated vasoconstriction and endothelial dysfunction. Second, the inclusion of blood urea nitrogen (BUN) levels in BISAP provides an early marker of renal dysfunction and fluid retention, which can lead to decreased placental blood flow and subsequent fetal hypoxia.

Furthermore, the BISAP score's simplicity and focus on early inflammatory markers make it particularly suitable for the obstetric setting, where rapid assessment is crucial for both maternal and fetal management decisions. The other scores, while comprehensive, may be less sensitive to the specific pathophysiological changes that affect fetal well-being during acute pancreatitis. This finding has important clinical implications, as it suggests that BISAP could serve as a dual-purpose tool for assessing both maternal severity and fetal risk, enabling clinicians to make informed decisions about the intensity of fetal monitoring, timing of delivery, and need for multidisciplinary obstetric care.

4.5. Clinical Implications and Management Strategies

Our findings support a risk-stratified approach to management based on early prognostic assessment. Patients with a BISAP score ≥ 3 should be considered for intensive care unit admission, enhanced fetal monitoring, and multidisciplinary team involvement. The strong correlation between the scores and the length of stay also has important resource allocation implications, particularly in resource-limited settings.

The high rate of biliary etiology in our population emphasizes the importance of prophylactic cholecystectomy in the postpartum period to prevent recurrence. The 10% recurrence rate in patients who did not undergo cholecystectomy supports this recommendation.

5. Study Limitations

Several limitations should be acknowledged. The relatively small sample size (n =

30) limits the statistical power and generalizability of our findings. The single-center, retrospective design may introduce selection bias and limit external validity. The predominant biliary etiology in our population may not reflect the patterns in other geographic regions. Additionally, the lack of a control group of non-pregnant patients with acute pancreatitis prevents a direct comparison of score performance between pregnant and non-pregnant populations.

Future prospective, multicenter studies with larger sample sizes are needed to validate these findings and potentially develop pregnancy-specific prognostic tools that incorporate obstetric variables and biomarkers.

6. Conclusions

This study demonstrates that the BISAP, RANSON, and APACHE-II prognostic scores maintain good diagnostic performance for predicting severity in acute pancreatitis during pregnancy. The BISAP score, with its good discriminative ability, simplicity of calculation, and potential association with fetal complications, emerges as a valuable tool for prognostic assessment in obstetric practice.

Systematic MRI with Balthazar classification provides valuable complementary prognostic information and should be considered in the routine evaluation of pregnant women with acute pancreatitis. The integration of clinical scores with imaging findings may optimize risk stratification and guide therapeutic decisions.

Despite the absence of maternal mortality in our series, the substantial morbidity and fetal mortality rates emphasize the need for early recognition, appropriate risk stratification, and multidisciplinary management. These findings support the development of evidence-based protocols for the management of acute pancreatitis during pregnancy, with prognostic scores serving as key decision-making tools.

Author Contributions

A. Raja: study conception and design, data collection, statistical analysis, manuscript drafting, M. Ababneh, T. El-Abbass: study supervision, methodology validation, critical manuscript revision, final approval. Both authors approved the final version of the manuscript.

Acknowledgements

The authors thank the staff of the Department of Obstetric Anesthesia and Critical Care for their collaboration in patient management, and the Department of Radiology for performing and interpreting the imaging studies.

Conflicts of Interest

The authors declare no conflicts of interest related to this study.

References

[1] Yadav, D. and Lowenfels, A.B. (2013) The Epidemiology of Pancreatitis and Pancreatic Cancer. *Gastroenterology*, **144**, 1252-1261.

https://doi.org/10.1053/j.gastro.2013.01.068

[2] Eddy, J.J., Gideonsen, M.D., Song, J.Y., Grobman, W.A. and O'Halloran, P. (2008) Pancreatitis in Pregnancy. *Obstetrics & Gynecology*, **112**, 1075-1081. https://doi.org/10.1097/aog.0b013e318185a032

[3] Ducarme, G., Maire, F., Chatel, P., Luton, D. and Hammel, P. (2013) Acute Pancreatitis during Pregnancy: A Review. *Journal of Perinatology*, **34**, 87-94. https://doi.org/10.1038/jp.2013.161

[4] Hernandez, A., Petrov, M.S., Brooks, D.C., Banks, P.A., Ashley, S.W. and Tavakkolizadeh, A. (2007) Acute Pancreatitis and Pregnancy: A 10-Year Single Center Experience. *Journal of Gastrointestinal Surgery*, **11**, 1623-1627. https://doi.org/10.1007/s11605-007-0329-2

[5] Ko, C.W., Beresford, S.A.A., Schulte, S.J., Matsumoto, A.M. and Lee, S.P. (2005) Incidence, Natural History, and Risk Factors for Biliary Sludge and Stones during Pregnancy. *Hepatology*, **41**, 359-365. https://doi.org/10.1002/hep.20534

[6] Cheng, Q.H., Zhang, X.P. and Ding, X.F. (2012) Clinical Study on Acute Pancreatitis in Pregnancy in 26 Cases. *Gastroenterology Research and Practice*, **2012**, Article ID: 271925. https://doi.org/10.1155/2012/271925

[7] Maringhini, A., Ciambra, M., Baccelliere, P., Raimondo, M., Orlando, A., Tine, F., *et al.* (1993) Biliary Sludge and Gallstones in Pregnancy: Incidence, Risk Factors, and Natural History. *Annals of Internal Medicine*, **119**, 116-120. https://doi.org/10.7326/0003-4819-119-2-199307150-00004

[8] Pitchumoni, C.S. and Yegneswaran, B. (2009) Acute Pancreatitis in Pregnancy. *World Journal of Gastroenterology*, **15**, 5641-5646. https://doi.org/10.3748/wjg.15.5641

[9] Tang, S., Rodriguez-Frias, E., Singh, S., Mayo, M.J., Jazrawi, S.F., Sreenarasimhaiah, J., *et al.* (2010) Acute Pancreatitis during Pregnancy. *Clinical Gastroenterology and Hepatology*, **8**, 85-90. https://doi.org/10.1016/j.cgh.2009.08.035

[10] Luo, L., Zen, H., Xu, H., Zhu, Y., Liu, P., Xia, L., *et al.* (2017) Clinical Characteristics of Acute Pancreatitis in Pregnancy: Experience Based on 121 Cases. *Archives of Gynecology and Obstetrics*, **297**, 333-339. https://doi.org/10.1007/s00404-017-4558-7

[11] Ramin, K.D., Ramin, S.M., Richey, S.D. and Cunningham, F.G. (1995) Acute Pancreatitis in Pregnancy. *American Journal of Obstetrics and Gynecology*, **173**, 187-191. https://doi.org/10.1016/0002-9378(95)90188-4

[12] Ranson, J.H., Rifkind, K.M., Roses, D.F., Fink, S.D., Eng, K. and Spencer, F.C. (1974) Prognostic Signs and the Role of Operative Management in Acute Pancreatitis. *Surgery, Gynecology and Obstetrics*, **139**, 69-81.

[13] Knaus, W.A., Draper, E.A., Wagner, D.P. and Zimmerman, J.E. (1985) APACHE II: A Severity of Disease Classification System. *Critical Care Medicine*, **13**, 818-829. https://doi.org/10.1097/00003246-198510000-00009

[14] Wu, B.U., Johannes, R.S., Sun, X., Tabak, Y., Conwell, D.L. and Banks, P.A. (2008) The Early Prediction of Mortality in Acute Pancreatitis: A Large Population-Based Study. *Gut*, **57**, 1698-1703. https://doi.org/10.1136/gut.2008.152702

[15] Soma-Pillay, P., Nelson-Piercy, C., Tolppanen, H. and Mebazaa, A. (2016) Physiological Changes in Pregnancy. *Cardiovascular Journal of Africa*, **27**, 89-94. https://doi.org/10.5830/cvja-2016-021

[16] Banks, P.A., Bollen, T.L., Dervenis, C., Gooszen, H.G., Johnson, C.D., Sarr, M.G., *et al.* (2012) Classification of Acute Pancreatitis—2012: Revision of the Atlanta Classification and Definitions by International Consensus. *Gut*, **62**, 102-111.

https://doi.org/10.1136/gutjnl-2012-302779

[17] Igbinosa, O., Poddar, S. and Pitchumoni, C. (2013) Pregnancy Associated Pancreatitis Revisited. *Clinics and Research in Hepatology and Gastroenterology*, **37**, 177-181. https://doi.org/10.1016/j.clinre.2012.07.011

[18] Sathiaraj, E., Murthy, S., Garg, M., *et al.* (2008) A Prospective Study of the Spectrum and Outcome of Acute Pancreatitis in a Tertiary Care Hospital in South India. *Indian Journal of Gastroenterology*, **27**, 235-238.

[19] Valdivieso, V., Covarrubias, C., Siegel, F. and Cruz, F. (1993) Pregnancy and Cholelithiasis: Pathogenesis and Natural Course of Gallstones Diagnosed in Early Puerperium. *Hepatology*, **17**, 1-4. https://doi.org/10.1002/hep.1840170102

[20] Mabrouk, M., D'Andrea, G., Cennamo, G., *et al.* (2021) Acute Pancreatitis in Pregnancy: A Single-Center Experience. *Updates in Surgery*, **73**, 651-658.

[21] Papachristou, G.I., Muddana, V., Yadav, D., O'Connell, M., Sanders, M.K., Slivka, A., *et al.* (2010) Comparison of BISAP, Ranson's, APACHE-II, and CTSI Scores in Predicting Organ Failure, Complications, and Mortality in Acute Pancreatitis. *American Journal of Gastroenterology*, **105**, 435-441. https://doi.org/10.1038/ajg.2009.622

[22] Kyla, M., de la Cruz, C.Z. and Tchelepi, H. (2019) Acute Pancreatitis in Pregnancy. *Critical Care Clinics*, **35**, 227-243.

[23] Tirkes, T., Shah, Z.K., Takahashi, N., *et al.* (2018) Reporting of Acute Pancreatitis by Radiologists: A Survey of North American Radiologists. *Abdominal Radiology* (*NY*), **43**, 1638-1645.

[24] Luo, L., Xiang, G., Liu, Z., *et al.* (2017) The Clinical Features of Acute Pancreatitis in Pregnancy: A Single-Institution Retrospective Study of 118 Cases. *Medicine* (*Baltimore*), **96**, e8679.

[25] Ducarme, G., Chatel, P., Maire, F., *et al.* (2017) Acute Pancreatitis in Pregnancy: A Tertiary Center Experience. *The Journal of Maternal-Fetal & Neonatal Medicine*, **30**, 2364-2369.