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Comparison of APACHE II and Mannheim Peritonitis Index in Predicting Outcomes in Perforation Peritonitis - A Prospective Observational Study

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Abstract

Introduction: Perforation peritonitis is a common surgical emergency associated with significant morbidity and mortality. Accurate prognostic assessment is essential for early risk stratification and optimal management. This study compared the Mannheim Peritonitis Index (MPI) and Acute Physiology and Chronic Health Evaluation II (APACHE II) score in predicting outcomes in patients with perforation peritonitis.

Material and Methods: This prospective observational study was conducted over 18 months at a tertiary care teaching hospital and included 58 patients with perforation peritonitis undergoing emergency surgery. MPI and APACHE II scores were calculated for all patients. Postoperative outcomes assessed included wound infection, wound dehiscence, respiratory complications, ventilator requirement, anastomotic leak, and mortality. Statistical analysis was performed using Chi-square and Fisher's exact tests. Receiver operating characteristic (ROC) curve analysis was used to evaluate the predictive performance of both scoring systems.

Results: The mean MPI and APACHE II scores were 22.95 ± 8.03 and 19.46 ± 9.40, respectively. Wound infection (70.7%) was the most common postoperative complication, followed by respiratory complications (37.9%), wound dehiscence (36.2%), ventilator requirement (17.2%), and anastomotic leak (8.6%). Overall mortality was 12.1%. Increasing MPI scores were significantly associated with wound infection ($p = 0.011$), wound dehiscence ($p < 0.001$), respiratory complications ($p = 0.021$), ventilator requirement ($p < 0.001$), and mortality ($p < 0.001$). Higher APACHE II scores were

significantly associated with wound dehiscence (p = 0.002), respiratory complications (p = 0.048), ventilator requirement (p < 0.001), and mortality (p < 0.001). ROC analysis demonstrated that MPI (AUC = 0.91) had higher specificity (88.2%), whereas APACHE II (AUC = 0.89) showed greater sensitivity (85.7%) for mortality prediction.

Conclusions: Both MPI and APACHE II were reliable predictors of postoperative morbidity and mortality in patients with perforation peritonitis. MPI demonstrated better predictive accuracy for wound-related complications, including wound infection and wound dehiscence, while APACHE II showed superior performance in predicting postoperative respiratory complications. Both scoring systems were comparable and highly accurate in predicting the need for ventilatory support and overall mortality, whereas neither reliably predicted anastomotic leak.

Owing to its simplicity, rapid bedside applicability, and good predictive accuracy, MPI may be considered a practical tool for early risk stratification in patients with perforation peritonitis, particularly in emergency surgical and resource-constrained settings. APACHE II, despite requiring more extensive physiological and laboratory parameters, remains a valuable adjunct for comprehensive assessment of critically ill patients and for predicting respiratory complications and mortality. A combined application of both scoring systems may therefore provide a more complete picture of disease severity and help guide individualized management decisions.

Keywords: Peritonitis; Severity of Illness Index, Prognosis, Mortality, Acute Physiology and Chronic Health Evaluation II, Mannheim Peritonitis Index

Introduction

Perforation peritonitis is a life-threatening surgical emergency resulting from perforation of a hollow viscus and contamination of the peritoneal cavity. Despite advances in surgical techniques, antimicrobial therapy, and critical care, it continues to be associated with considerable morbidity and mortality, with reported mortality rates ranging from approximately 10% to 40% depending on patient characteristics, severity of sepsis, and timing of intervention[1,2]. Accurate prognostic assessment is essential for early risk stratification and optimal management. The Mannheim Peritonitis Index (MPI) and Acute Physiology and Chronic Health Evaluation II (APACHE II) are widely used scoring systems for predicting outcomes in patients with peritonitis[3,4]. However, studies comparing their prognostic performance have yielded variable results[1,5]. Therefore, the present study was undertaken to prospectively compare the predictive accuracy of MPI and APACHE II in assessing morbidity and mortality among patients with perforation peritonitis.

Materials and Methods

This prospective observational study was conducted in a tertiary care teaching hospital over an 18-month period after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants. A total of 58 patients with clinically and radiologically confirmed perforation peritonitis undergoing emergency surgery were included. Patients aged 12–65 years with traumatic, infective, or iatrogenic perforation peritonitis were considered, while those with primary, tertiary, or postoperative peritonitis and those unwilling to participate were excluded[2].

Clinical, laboratory, radiological, intraoperative, and postoperative data were recorded. The MPI (Table 1)[3] and APACHE II score (Table 2)[4]were calculated.

Table 1: Mannheim Peritonitis Index (MPI) Scoring System

Risk Factor	Score
Age >50 years	5
Female sex	5
Organ failure*	7
Malignancy	4

Duration of peritonitis >24 hours before surgery	4
Origin of sepsis not colonic	4
Diffuse generalized peritonitis	6
Exudate: Clear / Cloudy-Purulent / Fecal	0 / 6 / 12

*Organ failure is defined by the presence of any one of the following: renal failure (serum creatinine >2 mg/dL, urea >167 mmol/L, or oliguria <20 mL/hour), pulmonary failure (PaO_2 <50 mmHg or $PaCO_2$ >50 mmHg), shock (systolic blood pressure <90 mmHg), or intestinal obstruction (paralytic ileus >24 hours or complete mechanical obstruction).

Table 2: APACHE II Scoring System

Variable		+4	+3	+2	+1	0	+1	+2	+3	+4
Temp (°C)		≥41	39–40.9	NA	38.5–38.9	36–38.4	34–35.9	32–33.9	30–31.9	≤29.9
MAP (mmHg)		≥160	130–159	110–129	NA	70–109	NA	50–69	NA	≤49
HR (/min)		≥180	140–179	110–139	NA	70–109	55–69	40–54	NA	≤39
RR (/min)		≥50	35–49	NA	25–34	12–24	10–11	6–9	NA	≤5
Oxygenation*	A–a Gradient	>500	350–499	200–349	NA	<200	NA	NA	NA	NA
	PaO_2	NA	NA	NA	NA	>70;	61–70	NA	55–60	<55
Arterial pH		≥7.70	7.60–7.69	NA	7.50–7.59	7.33–7.49	NA	7.25–7.32	7.15–7.24	<7.15
S. Na (mmol/L		≥180	160–179	155–159	150–154	130–149	NA	120–129	111–119	≤110
S. K (mmol/L		≥7.0	6.0–6.9	NA	5.5–5.9	3.5–5.4	3.0–3.4	2.5–2.9	NA	<2.5
S. Creat (mg/dL)		≥3.5*	2.0–3.4	1.5–1.9	NA	0.6–1.4	<0.6	NA	NA	NA
Hct (%)		≥60	NA	50–59.9	46–49.9	30–45.9	NA	20–29.9	NA	<20
WBC (×10⁹/L)		≥40	NA	20–39.9	15–19.9	3–14.9	NA	1–2.9	NA	<1
GCS		Points = 15 − Actual GCS								

B. Age point	
Age (years)	Points
≤44	0
45-54	2
55-64	3
65-74	5
≥75	6
C. Additional Chronic Health Points	
Chronic Health	Points
Elective postoperative patient with severe chronic disease	2
Emergency postoperative or non-operative or patient with chronic disease**	5
Total APACHE II Score = A+B+C	

*If (FiO_2 <50% use PaO_2 (mmHg) otherwise use A–a Gradient (mmHg)

** cirrhosis with portal hypertension, class IV angina, chronic hypoxia, polycythemia, chronic dialysis, immunocompromised

Temp: Temperature; NA: Not applicable; MAP: Mean Arterial Pressure; HR: Heart Rate; RR: Respiratory Rate; FiO_2: Fraction of Inspired Oxygen; PaO_2: Partial Pressure of Arterial Oxygen; A–a Gradient: Alveolar–Arterial Oxygen Gradient; S. Na: Serum Sodium; S. K: Serum Potassium; S. Creat: Serum Creatinine; Hct: Hematocrit; WBC: White Blood Cell Count; GCS: Glasgow Coma Scale: APACHE II: Acute Physiology and Chronic Health Evaluation II.

The outcome was studied in terms of postoperative wound infection, wound dehiscence, anastomotic leak, respiratory complication, need for ventilator support, and mortality[6].

Statistical analysis was performed using IBM SPSS Statistics version 26.0. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Receiver operating characteristic (ROC) curve analysis was used to evaluate the predictive performance of MPI and APACHE II scores. A p-value of <0.05 was considered statistically significant.

Results

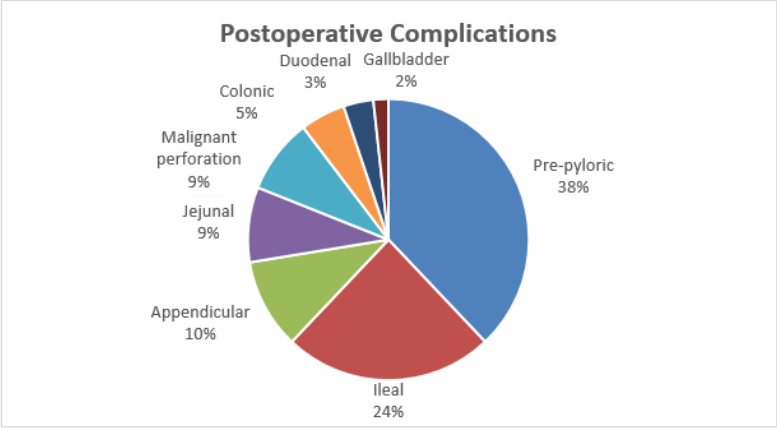
A total of 58 patients were included in the study, comprising 28 males (48%) and 30 females (52%). The highest number of cases was observed in the 41–50 years age group (n = 18), followed closely by the 51–65 years age group (n = 17). The 12–30 years age group accounted for 14 cases, while the 31–40 years age group had the lowest number of cases (n = 9). Overall, the majority of cases were concentrated in the fourth and fifth decades of life.

Intra-operatively, the pre-pyloric region was the most common site of perforation, accounting for 22 (37.9%) cases, followed by ileal perforation in 14 (24.1%) patients. Appendicular perforation was observed in 6 (10.3%) cases, while jejunal and malignant perforations each accounted for 5 (8.6%) cases. Colonic, duodenal, and gallbladder perforations were noted in 3 (5.2%), 2 (3.4%), and 1 (1.7%) patients, respectively (Table 3) (Figure 1).

Table 3: Source/Pathology of Perforation

Site Of Perforation	Number (n)	Percentage (%)
Pre-pyloric	22	37.9
Ileal	14	24.1
Appendicular	6	10.3
Jejunal	5	8.6
Malignant perforation	5	8.6
Colonic	3	5.2
Duodenal	2	3.4
Gallbladder	1	1.7

Figure 1: Intraoperative site of perforation



The choice of surgical procedure was based on the site of perforation, degree of contamination, bowel viability, and patient condition. Pre-pyloric and selected jejunal perforations underwent primary repair, whereas ileal, complicated appendicular, colonic, and delayed jejunal perforations were managed with diversion stoma. Appendicectomy was performed for localized appendicular perforations, and cholecystectomy was performed for gallbladder perforation. Diversion procedures were undertaken in malignant perforations. All patients received standard postoperative care and were followed until discharge or death.

MPI scores ranged from 6 to 42, with a mean score of 22.95 ± 8.03, while APACHE II scores ranged from 3 to 41, with a mean score of 19.46 ± 9.40 (Table 4).

Table 4: Frequency Distribution of MPI and APACHE II Scores

MPI Score	n (%)	APACHE II Score	n (%)
≤20	30 (51.7)	≤10	8 (13.8)
21–29	19 (32.8)	11–20	29 (50.0)
≥30	9 (15.5)	≥21	21 (36.2)

MPI: Mannheim Peritonitis Index;

APACHE II: Acute Physiology and Chronic Health Evaluation II.

Regarding clinical outcomes, 7 patients (12%) died while 51 patients (88%) were discharged. Mortality did not show a statistically significant association with gender (p = 0.7596). Mortality was observed to increase with advancing age, with the highest mortality seen in the 51–65 years age group. The association was statistically significant (p = 0.0349) (Table 5).

Table 5: Association of age group with clinical outcome in perforation peritonitis

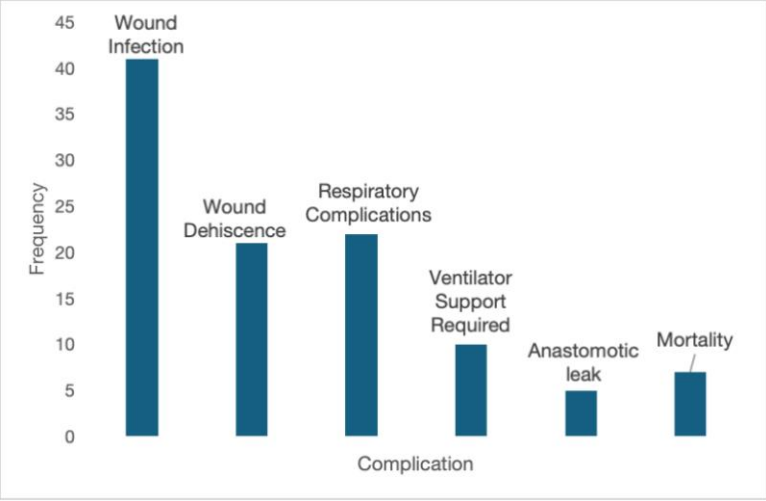
Age Group (years)	Death (n)	Discharge (n)
12–30	0	14
31–40	0	9
41–50	1	17
51–65	6	11

Postoperative complications were common. Wound infection was the most frequent complication, occurring in 41 patients (70.7%), followed by respiratory complications in 22 (37.9%), wound dehiscence in 21 (36.2%), and requirement of ventilator support in 10 (17.2%) patients. Anastomotic leak was observed in 5 patients (8.6%), while the overall mortality rate was 12.1% (7/58). (Table 6) (Figure 2).

Table 6: Postoperative Complications

Complication	Number (n)	Percentage (%)
Wound Infection	41	70.7
Wound Dehiscence	21	36.2
Respiratory Complications	22	37.9
Ventilator Support Required	10	17.2
Anastomotic leak	5	8.6
Mortality	7	12

Figure 2: Distribution of postoperative complications among patients with perforation peritonitis



Postoperative complications increased significantly with increasing MPI score. Wound infection (53.3%, 89.5%, and 88.9%; p = 0.011), wound dehiscence (3.3%, 57.9%, and 100%; p < 0.001), respiratory complications (26.6%, 36.8%, and 77.8%; p = 0.021), and requirement for ventilator support (3.3%, 15.8%, and 66.7%; p < 0.001) were significantly more frequent with increasing MPI score. Anastomotic leak did not differ significantly among MPI groups (p = 0.282). Mortality also increased significantly, from 0% in the low-risk group to 10% and 62.5% in the intermediate- and high-risk groups, respectively (p < 0.001). ROC curve analysis demonstrated good to excellent predictive performance of MPI for these complications and mortality (Table 7) (Figures 3–7).

Table 7: Association of Postoperative Complications with MPI Score

Complication	MPI ≤20 (n=30)	MPI 21–29 (n=19)	MPI ≥30 (n=9)	p-value
Wound Infection	16 (53.3%)	17 (89.5%)	8 (88.9%)	0.011
Wound Dehiscence	1 (3.3%)	11 (57.9%)	9 (100%)	<0.001
Respiratory Complications	8 (26.6%)	7 (36.8%)	7 (77.8%)	0.021
Ventilator Support Required	1 (3.3%)	3 (15.8%)	6 (66.7%)	<0.001
Anastomotic leak	2 (6.6%)	1 (5%)	2 (22.2%)	0.282
Mortality	0 (0%)	2 (10%)	5 (62.5%)	<0.001

MPI: Mannheim Peritonitis Index.

Figure 3: Receiver operating characteristic (ROC) curve of MPI for predicting wound infection. The area under the curve (AUC) was 0.856, indicating good discriminatory ability. The optimal cut-off value was MPI ≥16, with 97.5% sensitivity and 61.1% specificity.

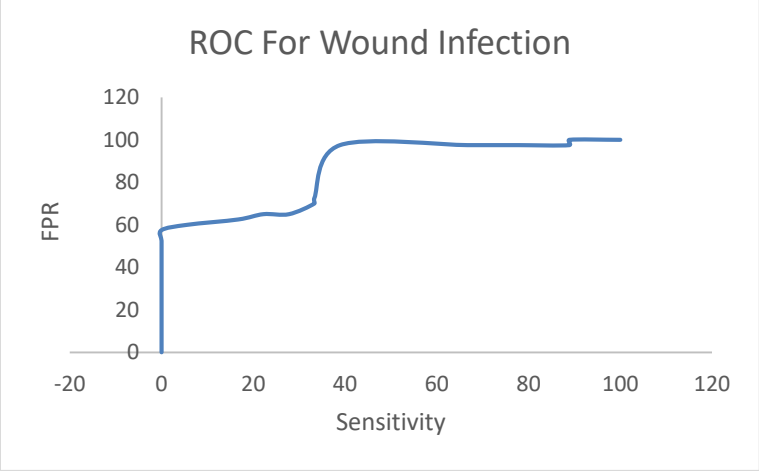


Figure 4: ROC curve of MPI for predicting wound dehiscence. The AUC was 0.942, indicating excellent predictive performance. The optimal cut-off was MPI ≥23 (sensitivity 90.5%, specificity 89.2%).

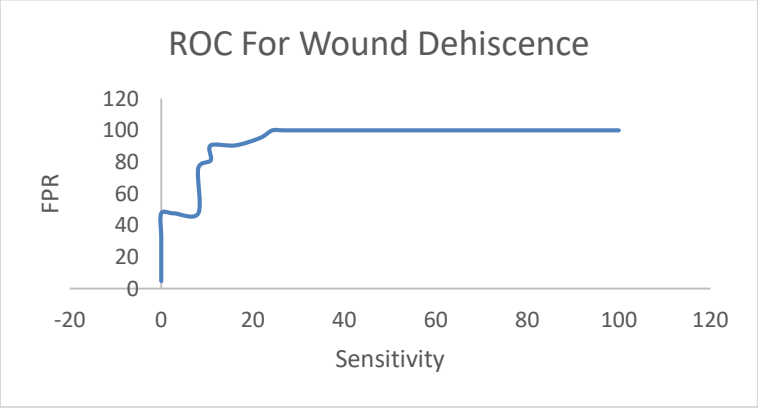


Figure 5: ROC curve of MPI for predicting respiratory complications. The AUC was 0.683, indicating fair predictive ability. The optimal cut-off was MPI ≥25 (sensitivity 52.2%, specificity 80.0%).

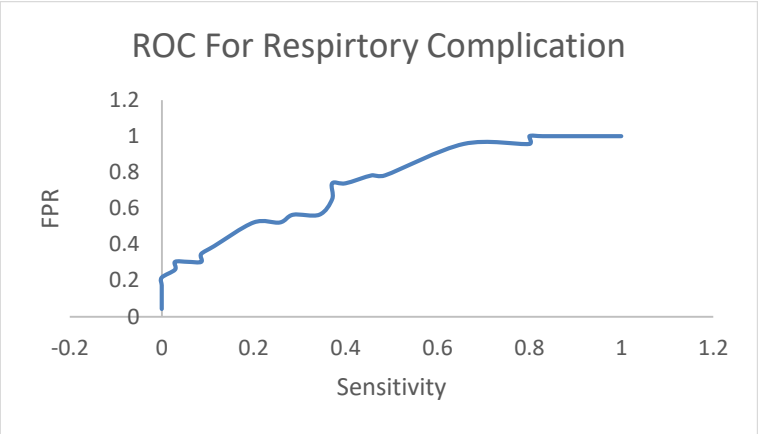


Figure 6: ROC curve of MPI for predicting requirement for ventilator support. The AUC was 0.882, indicating good predictive accuracy. The optimal cut-off was MPI ≥26 (sensitivity 80.0%, specificity 89.6%).

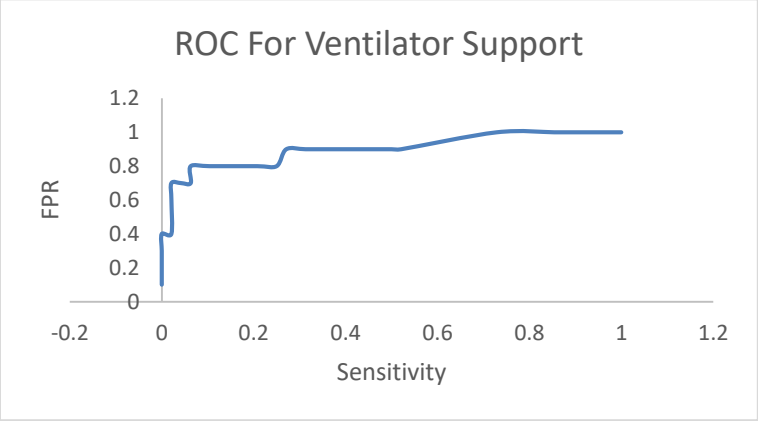
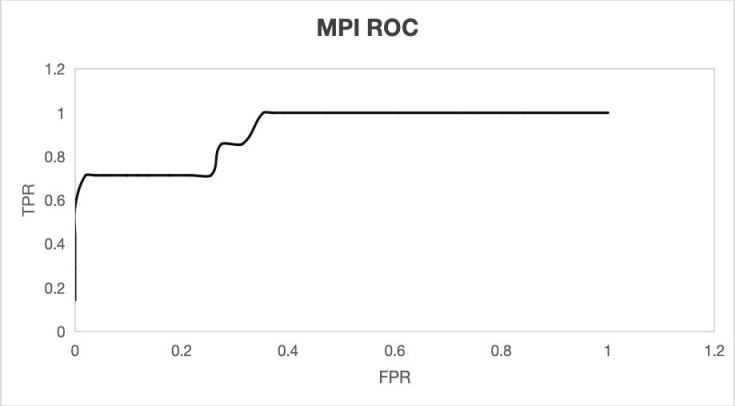


Figure 7: ROC curve of MPI for predicting mortality. The AUC was 0.910, demonstrating excellent prognostic performance. The optimal cut-off was MPI ≥29 (sensitivity 71.4%, specificity 88.2%).



Postoperative complications were analyzed according to APACHE II score categories. Wound infection was observed in 62.5%, 62.1%, and 85.7% of patients with APACHE II scores ≤10, 11–20, and ≥21, respectively, although the association was not statistically significant (p = 0.127). Wound dehiscence (12.5%, 20.7%, and 66.7%; p = 0.002), respiratory complications (25.0%, 37.9%, and 57.1%; p = 0.048), and the requirement for ventilator support (0%, 6.9%, and 42.9%; p < 0.001) increased significantly with higher

APACHE II scores. Anastomotic leak was not significantly associated with APACHE II score (p = 0.862). Mortality also increased significantly with increasing APACHE II score, with no deaths in patients scoring ≤10, one death (3.4%) in those scoring 11–20, and six deaths (28.6%) in patients scoring ≥21 (p < 0.001). ROC curve analysis demonstrated good predictive performance of APACHE II for postoperative complications and mortality (Table 8) (Figures 8–12).

Table 8: Association of Postoperative Complications with APACHE II Score

Complication	APACHE II ≤10 (n=8)	APACHE II 11–20 (n=29)	APACHE II ≥21 (n=21)	p-value
Wound Infection	5 (62.5%)	18 (62.1%)	18 (85.7%)	0.127
Wound Dehiscence	1 (12.5%)	6 (20.7%)	14 (66.7%)	0.002
Respiratory Complications	2 (25%)	8 (27.6%)	12 (57.1%)	0.048
Ventilator Support Required	0 (0%)	1 (3.4%)	9 (42.9%)	<0.001
Anastomotic leak	1 (12.5%)	2 (6.9%)	2 (9.5%)	0.862
Mortality	0 (0%)	1 (3.44%)	6 (28.7%)	<0.001

APACHE II: Acute Physiology and Chronic Health Evaluation II.

Figure 8: Receiver operating characteristic (ROC) curve of APACHE II score for predicting wound infection. The area under the curve (AUC) was 0.682, indicating fair discriminatory ability. The optimal cut-off value was APACHE II ≥18, with a sensitivity of 87.5% and a specificity of 38.9%.

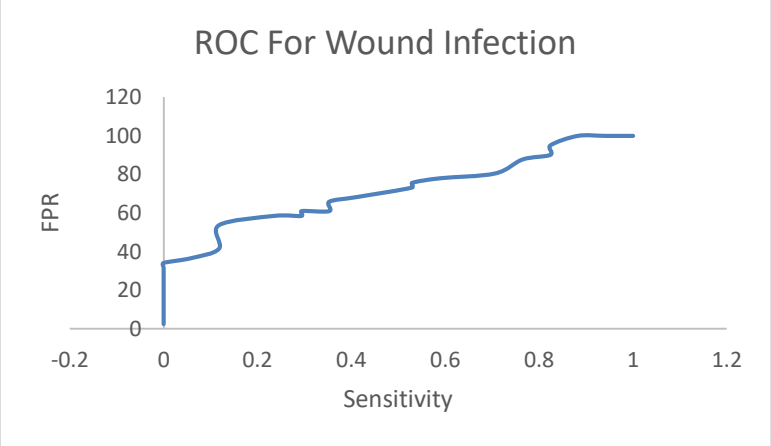


Figure 9: Receiver operating characteristic (ROC) curve of APACHE II score for predicting wound dehiscence. The AUC was 0.823, indicating good predictive performance. The optimal cut-off value was APACHE II ≥23, with a sensitivity of 70.0% and specificity of 86.8%.

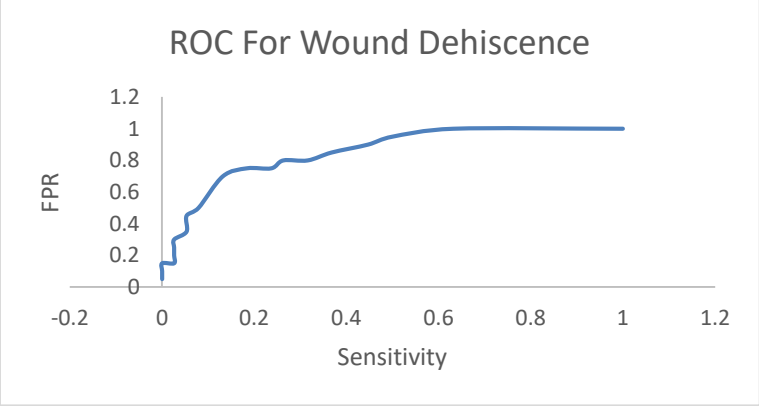


Figure 10: Receiver operating characteristic (ROC) curve of APACHE II score for predicting respiratory complications. The AUC was 0.784, indicating good discriminatory ability. The optimal cut-off value was APACHE II ≥23, with a sensitivity of 61.9% and specificity of 89.2%.

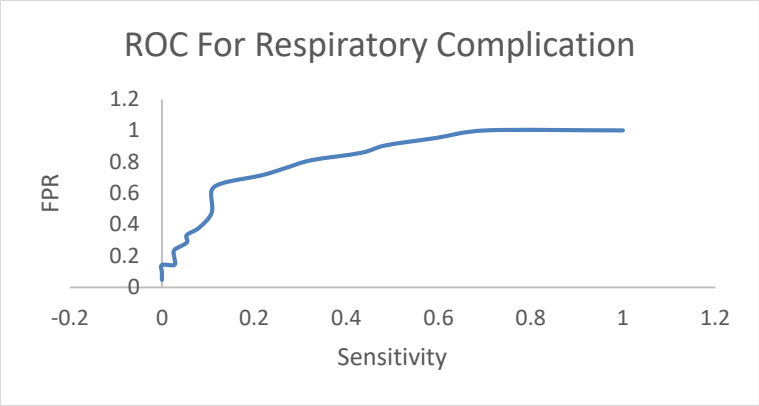


Figure 11: Receiver operating characteristic (ROC) curve of APACHE II score for predicting requirement for ventilator support. The AUC was 0.869, indicating good predictive performance. The optimal cut-off value was APACHE II ≥25, with a sensitivity of 81.8% and specificity of 85.1%.

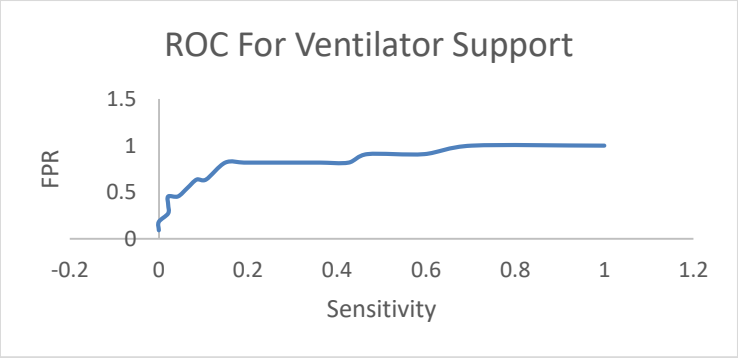
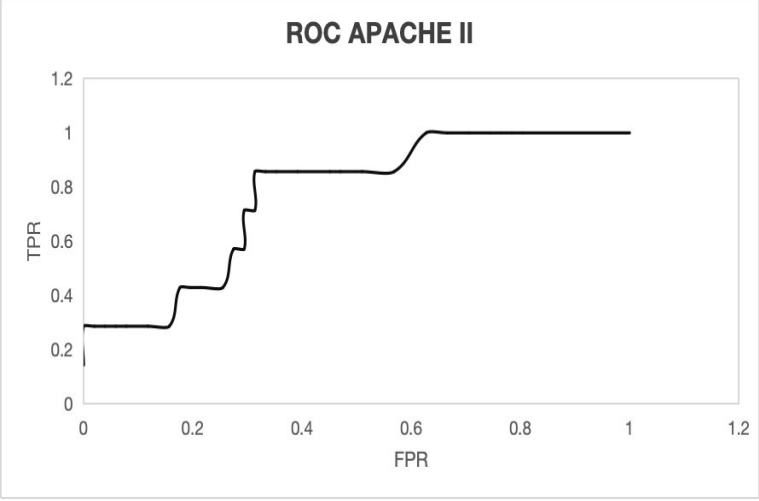


Figure 12: Receiver operating characteristic (ROC) curve of APACHE II score for predicting mortality. The AUC was 0.890, indicating good prognostic accuracy. The optimal cut-off value was APACHE II ≥25, with a sensitivity of 85.7% and specificity of 76.5%.



MPI showed slightly higher specificity and overall predictive accuracy, whereas APACHE II demonstrated greater sensitivity.

Discussion

Perforation peritonitis remains associated with high mortality, particularly in elderly patients and those presenting with sepsis. Early prognostic stratification is important for identifying patients who may require aggressive management and intensive care. In the present study, the pre-pyloric region was the most common site of perforation, followed by the ileum, consistent with the findings of Jhobta et al.[7], who reported duodenal perforations as the predominant site (57%) followed by ileal (15%) and appendicular (12%) perforations in a large Indian series. The predominance of pre-pyloric perforations may be related to widespread NSAID use, alcohol consumption, and delayed healthcare-seeking behavior in the study population, similar to the risk factors reported by Murmu et al.[8], who found alcohol use in 42.7% and lower socioeconomic status in 41.5% of patients with peptic ulcer perforation. The relatively high incidence of ileal and appendicular perforations may reflect the lower socioeconomic background of many patients attending our institution, which is associated with poor sanitation, a higher burden of gastrointestinal infections, and delayed presentation to healthcare facilities[8].

The overall mortality rate in the present study was 12%. Mortality increased significantly with advancing age, consistent with the findings of Bylapudi et al.[9], who also reported higher mortality among older patients with perforation peritonitis. This may be attributable to reduced physiological reserve and the higher burden of comorbidities in elderly patients.

Wound infection showed a significant association with increasing MPI score ($p = 0.011$), whereas no significant association was observed with APACHE II score ($p = 0.127$). Furthermore, MPI demonstrated good predictive accuracy for wound infection (AUC = 0.856). A similarly stronger relationship between MPI and wound-related complications, compared to APACHE II, was reported by Maran et al.[2].

Wound dehiscence showed a significant association with both MPI ($p < 0.001$) and APACHE II ($p = 0.002$) scores. ROC analysis demonstrated excellent predictive performance of MPI (AUC = 0.942) and good predictive performance of APACHE II (AUC = 0.823), suggesting that MPI may be a more accurate predictor of wound-related postoperative complications, in agreement with Sharma et al.[5].

Respiratory complications were significantly associated with both MPI ($p = 0.021$) and APACHE II scores ($p = 0.048$). MPI showed fair predictive ability (AUC = 0.683), whereas APACHE II demonstrated good predictive performance (AUC = 0.784), indicating that APACHE II may better identify patients at risk of postoperative respiratory complications. This is consistent with Gupta et al.[6], who reported that APACHE II was superior to MPI in predicting postoperative respiratory complications and the need for ventilatory support.

The requirement for ventilatory support demonstrated a highly significant association with both MPI and APACHE II scores ($p < 0.001$ for both). Both scoring systems showed good predictive performance, with MPI (AUC = 0.882) and APACHE II (AUC = 0.869) demonstrating comparable accuracy in identifying patients requiring postoperative ventilatory support, similar to the observations of Gupta et al.[6].

Anastomotic leak did not show a significant association with either MPI ($p = 0.282$) or APACHE II score ($p = 0.862$), suggesting limited predictive value of both scoring systems for this complication, in agreement with Gupta et al. [6], who similarly found that neither APACHE II nor MPI could reliably predict postoperative anastomotic leak. This may be because anastomotic leak is influenced primarily by local and technical factors, such as tissue perfusion, anastomotic tension, and surgical technique, rather than the overall severity of peritonitis or physiological derangement.

Mortality showed a highly significant association with both MPI and APACHE II scores ($p < 0.001$ for both). ROC analysis demonstrated excellent predictive accuracy for mortality with both MPI (AUC = 0.91) and APACHE II (AUC = 0.89), with MPI showing slightly better overall discriminatory ability. Similar findings were reported by Mishra et al.[1], who found that both scoring systems were reliable predictors of mortality, with APACHE II

demonstrating slightly higher sensitivity and MPI showing comparable specificity.

These findings indicate that patients with more severe peritonitis and greater physiological derangement are at a substantially higher risk of adverse postoperative outcomes, which can be explained by delayed presentation and associated comorbidities. Notably, 33 patients presented more than 24 hours after symptom onset, and all 7 deaths occurred in this group, whereas no mortality was observed among patients presenting within 24 hours. Delayed presentation likely resulted in advanced peritoneal contamination, sepsis, and physiological deterioration, thereby contributing to poorer outcomes, consistent with Singh et al.[10], who identified delay in surgical intervention as an independent predictor of mortality in patients with perforation peritonitis.

The MPI offers several practical advantages over APACHE II, as also highlighted by Maran et al.[2]. It is simple, rapid, disease-dependent, and cost-effective, can be calculated intraoperatively, and requires fewer clinical variables, making it suitable for early bedside risk assessment. In contrast, although APACHE II is a well-established and reliable prognostic tool, it requires multiple physiological and laboratory parameters, making it relatively more complex and time-consuming to calculate, and it is disease independent.

The present study has certain limitations, including a relatively small sample size and its single-center design, which may limit the generalizability of the findings. Furthermore, operative complexity and procedure-specific outcomes were not analyzed separately.

Conclusion

Both MPI and APACHE II were reliable predictors of postoperative morbidity and mortality in patients with perforation peritonitis. MPI demonstrated better predictive accuracy for wound-related complications, including wound infection and wound dehiscence, while APACHE II showed superior performance in predicting postoperative respiratory complications. Both scoring systems were comparable and highly accurate in predicting the need for ventilatory support and overall mortality, whereas neither reliably predicted anastomotic leak.

Owing to its simplicity, rapid bedside applicability, and good predictive accuracy, MPI may be considered a practical tool for early risk stratification in patients with perforation peritonitis, particularly in emergency surgical and resource-constrained settings. APACHE II, despite requiring more extensive physiological and laboratory parameters, remains a valuable adjunct for comprehensive assessment of critically ill patients and for predicting respiratory complications and mortality. A combined application of both scoring systems may therefore provide a more complete picture of disease severity and help guide individualized management decisions.

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