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Original Research Article

Comparative Evaluation of Mannheim Peritonitis Index and APACHE II Scores in Hollow Viscus Perforation Peritonitis: A Single-Centre Retrospective Study

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ABSTRACT

Background: Hollow viscus perforation peritonitis remains a life-threatening surgical emergency with high morbidity and mortality. Objective scoring at the time of surgery is essential to guide decision-making and resource allocation. The Mannheim Peritonitis Index (MPI) and APACHE II are two widely used multi-parameter scoring systems; however, comparative data from the Indian subcontinent are limited.

Objectives: To evaluate and compare the performance of MPI and APACHE II scores in relation to in-hospital mortality and postoperative outcomes in surgically managed cases of hollow viscus perforation peritonitis.

Materials and Methods: A retrospective observational study of 45 consecutive patients of hollow viscus perforation peritonitis managed by emergency laparotomy at the Department of General Surgery, Sapthagiri Institute of Medical Sciences and Research Centre (SIMSRC), Bangalore, were analysed. MPI and APACHE II scores were computed from clinical, operative, and laboratory data. Statistical analysis was performed using IBM SPSS Statistics version 25.0.

Results: Of the 45 case records analysed (33 males, 12 females; mean age 46.4 ± 20.1 years), 7 (15.6%) had a fatal outcome. The mean MPI was 25.51 ± 8.81 and mean APACHE II was 11.16 ± 9.00. Both scores were significantly higher in non-survivors (MPI: 36.57 ± 3.69 vs. 23.47 ± 7.91, $p = 0.0005$; APACHE II: 24.14 ± 6.57 vs. 8.76 ± 7.19, $p = 0.0003$). All deaths occurred in MPI Category C ($p = 0.001$, Fisher's Exact Test). The AUROC was 0.919 (95% CI: 0.817–0.990) for MPI and 0.936 (95% CI: 0.842–1.000) for APACHE II, with no significant difference ($p = 0.755$). Both scores correlated significantly with ICU stay duration (MPI: $r = 0.703$, $p < 0.001$; APACHE II: $r = 0.556$, $p < 0.001$).

Conclusion: Both MPI and APACHE II demonstrated good discriminatory ability and comparable prognostic performance in predicting in-hospital mortality and morbidity in hollow viscus perforation peritonitis. MPI offers practical intraoperative applicability without requiring laboratory data. Larger prospective multicentre studies are required to validate these findings and establish generalisability.

Keywords: *Hollow viscus perforation, Peritonitis, Mannheim Peritonitis Index,* *APACHE II, Prognostic scoring, Mortality, ROC curve*

INTRODUCTION

Peritonitis from hollow viscus perforation is one of the most common life-threatening surgical emergencies in general surgical practice. The pathological spectrum includes perforated peptic ulcers, perforated appendicitis, typhoid ileal perforation, traumatic bowel injuries, and colonic perforations due to malignancy, diverticular disease, or volvulus. Despite modern advances in operative technique, anaesthetic management, critical care, and antimicrobial therapy, reported mortality rates continue to range from 10% to 40%, influenced by aetiology, duration of peritoneal contamination, patient demographics, and the extent of systemic organ dysfunction.[1,2]

Accurate and timely prognostic stratification is central to the management of these cases. Objective scoring systems allow quantification of disease severity, rational resource allocation, and informed communication with families. Among instruments designed specifically for peritonitis, the Mannheim Peritonitis Index (MPI), introduced by Linder et al. in 1987, has earned wide clinical acceptance.[3] Computed intraoperatively from eight clinical and operative parameters, it categorises cases into three strata of increasing predicted mortality without requiring laboratory data.[3,11]

The Acute Physiology and Chronic Health Evaluation II (APACHE II) score was developed by Knaus et al. in 1985 for critical care stratification and has since been applied to surgical peritonitis.[4] It assesses twelve physiological parameters, patient age, and chronic health status. Several studies have evaluated both indices in peritonitis with variable conclusions regarding relative superiority.[5,6,7,8,9] Comparative data from the Indian subcontinent, characterised by distinct epidemiology and variable resource availability, remain scarce.[10]

We conducted this study to compare the prognostic accuracy of MPI and APACHE II in case records of hollow viscus perforation peritonitis managed at a South Indian tertiary care teaching hospital, and to evaluate and compare the performance of both scoring systems in this clinical setting.

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective observational study conducted at the Department of General Surgery, Sapthagiri Institute of Medical Sciences and Research Centre (SIMSRC), Chikkabanavara, Bangalore – 560 090, Karnataka, India, from May 2024 to February 2026. Institutional ethics committee clearance was obtained prior to commencement of data collection.

Source of Data

Case records of all cases of hollow viscus perforation peritonitis managed by emergency laparotomy during the study period were retrieved from the Department of Medical Records. Data were extracted onto a pre-designed structured proforma covering demographic details, clinical presentation, operative findings, laboratory parameters, postoperative course, and final outcome.

Inclusion and Exclusion Criteria

Case records of patients aged ≥ 15 years in whom hollow viscus perforation peritonitis was confirmed intraoperatively and in whom complete clinical and operative data were available were included. Records with spontaneous bacterial peritonitis, primary peritonitis, non-operative management, or incomplete documentation were excluded.

Calculation of MPI Score

The MPI was calculated from intraoperative findings using the eight-parameter system of Linder et al.:[3] (1) age > 50 years (5 points); (2) female sex (5 points); (3) organ failure (7 points); (4) malignancy (7 points); (5) pre-operative peritonitis duration > 24 hours (4 points); (6) non-colonic origin (4 points); (7) diffuse generalised peritonitis (6 points); and (8) character of exudate - clear (0 points), cloudy or purulent (6 points), or faecal (12 points). For this retrospective analysis, organ failure was defined as any of the following at admission: systolic blood pressure <90 mmHg unresponsive to fluid resuscitation, serum creatinine >2.0 mg/dL, or requirement for immediate mechanical ventilatory support. Maximum possible score is 47. Cases were stratified as Category A (MPI <21), Category B (MPI 21–29), and Category C (MPI > 29).[3,11]

Calculation of APACHE II Score

The APACHE II score was computed from admission parameters as described by Knaus et al.[4] The Acute Physiology Score (APS) comprised twelve physiological variables: temperature, mean arterial pressure, heart rate, respiratory rate, oxygenation, arterial pH, serum sodium, serum potassium, serum creatinine, haematocrit, white cell count, and Glasgow Coma Scale. Age and chronic health points were added per the original protocol. The creatinine score was doubled in the presence of acute renal failure. Cases were classified as Low (< 10), Moderate (10–19), High (20–29), or Very High (≥ 30) risk.

Statistical Analysis

Data were entered in Microsoft Excel 2019 and analysed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables are expressed as frequency and percentage; continuous variables as mean ± standard deviation (SD). The Mann-Whitney U test was used to compare scores between survivor and non-survivor groups. For categorical comparisons involving contingency tables where more than 20% of expected cell counts were below 5, Fisher's Exact Test (Freeman-Halton extension for tables larger than 2 × 2) was applied in place of the chi-square test. Normally distributed continuous variables (age) were compared between outcome groups using the independent Student's t-test. Spearman's rank correlation was used to assess the relationship between the two scoring systems and to evaluate their correlation with ICU stay and total hospital stay as markers of morbidity. Receiver operating characteristic (ROC) curve analysis was performed to determine the area under the curve (AUROC) with 95% confidence intervals; the optimal diagnostic cutoff was identified by Youden's index (sensitivity + specificity − 1). A p-value < 0.05 was considered statistically significant.
Multivariable analysis was not performed owing to the limited sample size (n = 45) and the low number of mortality events (n = 7), which precluded robust logistic regression modelling. This study was accordingly designed and interpreted as an exploratory retrospective assessment of the comparative discriminatory performance of the two scoring systems, and its findings should not be construed as establishing their independent prognostic value.

RESULTS

Demographic Profile

A total of 45 case records satisfying the inclusion criteria were analysed. Of these, 33 (73.3%) were male and 12 (26.7%) were female, with a male-to-female ratio of 2.75:1. Mean age was 46.4 ± 20.1 years (range 17–89 years). Seven case records (15.6%) had a fatal in-hospital outcome; 38 (84.4%) were discharged. The mean MPI was 25.51 ± 8.81 (range 10–43) and mean APACHE II was 11.16 ± 9.00 (range 0–35). Table 1 presents a summary of the demographic profile.

Table 1: Demographic and Clinical Profile of the Study Group (n = 45)

Parameter	n (%)	Mean ± SD
Total case records	45 (100%)	—
Age (years)	—	46.4 ± 20.1
≤ 30 years	14 (31.1%)	—
31–50 years	15 (33.3%)	—
> 50 years	16 (35.6%)	—
Sex	—	—
Male	33 (73.3%)	—

Female	12 (26.7%)	—
MPI Score	—	25.51 ± 8.81
APACHE II Score	—	11.16 ± 9.00
Outcome	—	—
Survived	38 (84.4%)	—
Death	7 (15.6%)	—

Site of Hollow Viscus Perforation

The appendix was the most common site of perforation (10 cases; 22.2%), followed by the pre-pyloric region (8 cases; 17.8%) and duodenum (7 cases; 15.6%). Ileal perforations were noted in 6 cases (13.3%), gallbladder in 4 (8.9%), and pylorus in 3 (6.7%). Colonic perforations (ascending, sigmoid, recto-sigmoid) accounted for 4 cases (8.8%), jejunum for 2 (4.4%), and stomach for 1 (2.2%). Distribution is detailed in Table 2.

Table 2: Distribution According to Site of Hollow Viscus Perforation

Site of Perforation	n	Percentage (%)
Appendix	10	22.2
Pre-pyloric region	8	17.8
Duodenum	7	15.6
Ileum	6	13.3
Gallbladder	4	8.9
Pylorus	3	6.7
Ascending colon	2	4.4
Jejunum	2	4.4
Stomach	1	2.2
Recto-sigmoid colon	1	2.2
Sigmoid colon	1	2.2
Total	**45**	**100.0**

Surgical Procedures Performed

Modified Graham's omental patch repair was the most frequent procedure (n = 15; 33.3%). Appendicectomy and resection with anastomosis were each performed in 7 cases (15.6%). Exploratory laparotomy with cholecystectomy was carried out in 4 cases (8.9%), primary repair in 4 cases (8.9%), and right hemicolectomy for ascending colon malignancy in 2 cases (4.4%). Appendicular lavage and drainage and Graham's patch repair were performed in 3 cases each (6.7%). Details are in Table 3.

Table 3: Distribution of Surgical Procedures Performed

Surgical Procedure	n	Percentage (%)
Modified Graham's omental patch repair	15	33.3
Appendicectomy	7	15.6
Resection and anastomosis	7	15.6
Exploratory laparotomy + cholecystectomy	4	8.9
Primary repair	4	8.9
Appendicular lavage and drainage	3	6.7
Graham's patch repair	3	6.7
Right hemicolectomy	2	4.4
Total	**45**	**100.0**

MPI Score Distribution and Outcome

Based on MPI stratification, 14 case records (31.1%) were in Category A (MPI < 21), 13 (28.9%) in Category B (MPI 21–29), and 18 (40.0%) in Category C (MPI > 29). All seven fatal outcomes occurred exclusively in Category C, yielding an intra-group mortality of 38.9% with no deaths in Categories A or B. Since 50% of expected cell counts fell below 5 in the 3 × 2 contingency table, Fisher's Exact Test was applied, confirming a statistically significant association between MPI category and outcome (p = 0.001). Results are shown in Table 4.

Table 4: Distribution According to MPI Category and Outcome

MPI Category	Total (n)	Survived (n)	Death (n)	Mortality (%)
A (< 21)	14	14	0	0.0
B (21–29)	13	13	0	0.0
C (> 29)	18	11	7	38.9
Total	**45**	**38**	**7**	**15.6**
Fisher's Exact Test (Freeman-Halton extension), p = 0.001				

APACHE II Score Distribution and Outcome

Twenty-three case records (51.1%) were in the Low-risk category, 15 (33.3%) in Moderate, 4 (8.9%) in High, and 3 (6.7%) in Very High risk. Mortality showed a clear stepwise increase: 0.0%, 13.3%, 75.0%, and 66.7% respectively. As 75% of expected cell counts in the 4 × 2 table were below 5, Fisher's Exact Test was applied; the stepwise increase in mortality across categories was statistically significant (p < 0.001). Table 5 presents this distribution.

Table 5: Distribution According to APACHE II Category and Outcome

APACHE II Category	Total (n)	Survived (n)	Death (n)	Mortality (%)
Low (< 10)	23	23	0	0.0
Moderate (10–19)	15	13	2	13.3
High (20–29)	4	1	3	75.0
Very High (≥ 30)	3	1	2	66.7
Total	**45**	**38**	**7**	**15.6**
Fisher's Exact Test (Freeman-Halton extension), p < 0.001				

Comparison of Scores Between Survivors and Non-survivors

The mean MPI in non-survivors was significantly higher than in survivors (36.57 ± 3.69 vs. 23.47 ± 7.91; U = 244.5; p = 0.0005). The mean APACHE II was similarly elevated in non-survivors (24.14 ± 6.57 vs. 8.76 ± 7.19; U = 249.0; p = 0.0003). These findings are presented in Table 6.

Table 6: Comparison of MPI and APACHE II Scores Between Survivors and Non-survivors

Scoring System	Survived (n = 38) Mean ± SD	Death (n = 7) Mean ± SD	p-value (Mann-Whitney U)
MPI Score	23.47 ± 7.91	36.57 ± 3.69	0.0005
APACHE II Score	8.76 ± 7.19	24.14 ± 6.57	0.0003

ROC Curve Analysis and Diagnostic Performance

The AUROC was 0.919 (95% CI: 0.817–0.990) for MPI and 0.936 (95% CI: 0.842–1.000) for APACHE II. At the optimal Youden index cutoff, MPI ≥ 32 yielded sensitivity 100.0%, specificity 71.1%, PPV 38.9%, NPV 100.0%, and accuracy 75.6%. APACHE II ≥ 14 yielded sensitivity 100.0%, specificity 76.3%, PPV 43.8%, NPV 100.0%, and accuracy 80.0%. APACHE II demonstrated a numerically higher AUROC compared to MPI; however, no statistically significant difference was observed between the two scoring systems (difference = −0.017; 95% CI: −0.133 to 0.085; p = 0.755). ROC curves for both scoring systems are illustrated in Figure 1. Detailed results are summarised in Table 7.

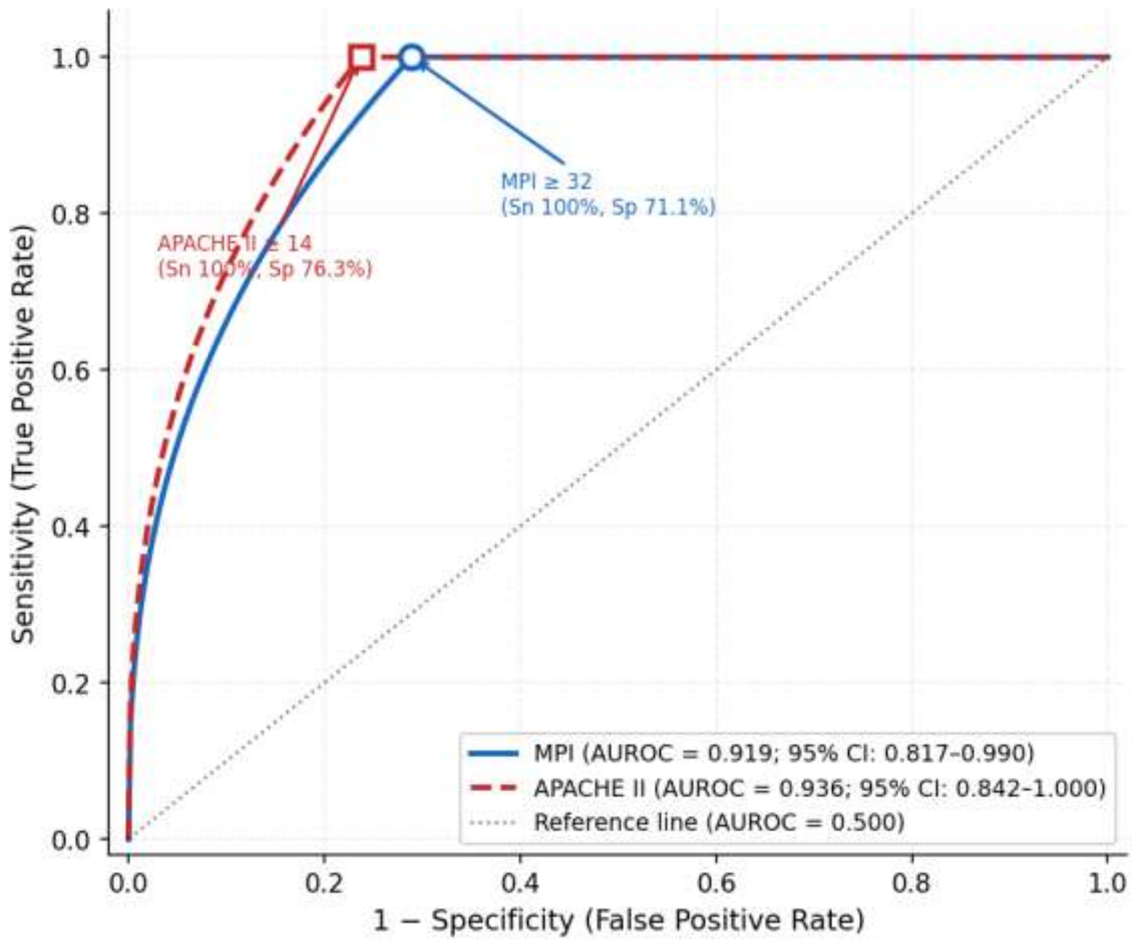

Figure 1. *Receiver Operating Characteristic (ROC) curves for MPI and APACHE II in predicting in-hospital mortality in hollow viscus perforation peritonitis. The open circle (○) marks the optimal cutoff for MPI (≥32; sensitivity 100%, specificity 71.1%) and the open square (□) for APACHE II (≥14; sensitivity 100%, specificity 76.3%). AUROC: area under the ROC curve; CI: confidence interval; Sn: sensitivity; Sp: specificity.*

Table 7: Receiver Operating Characteristic Curve Analysis for MPI and APACHE II

Score	AUROC (95% CI)	Optimal Cutoff	Sensitivity (%)	Specificity (%)	Accuracy (%)
MPI	0.919 (0.817–0.990)	≥ 32	100.0	71.1	75.6
APACHE II	0.936 (0.842–1.000)	≥ 14	100.0	76.3	80.0
AUC difference = −0.017 (95% CI: −0.133 to 0.085), p = 0.755; PPV: MPI = 38.9%, APACHE II = 43.8%; NPV: both = 100.0%					

Correlation Between MPI and APACHE II

A strong positive Spearman rank correlation was found between MPI and APACHE II scores ($r = 0.726$; $p < 0.001$), confirming that both instruments consistently reflect the same underlying disease severity.

Age and Outcome

Non-survivors tended to be older than survivors (59.9 ± 7.5 years vs. 44.0 ± 20.7 years). While this difference did not reach statistical significance on an independent Student's t-test ($t = 1.989$, $p = 0.053$), the trend aligns with the well-known impact of advancing age on surgical outcomes in peritonitis.

Morbidity Analysis: Score Correlation with ICU and Hospital Stay

To address the morbidity objective, Spearman rank correlation was performed between each scoring system and two continuous markers of postoperative morbidity. Both MPI and APACHE II showed a statistically significant positive correlation with duration of ICU stay (MPI: r = 0.703, p < 0.001; APACHE II: r = 0.556, p < 0.001), indicating that higher scores were associated with longer ICU admission and greater critical care burden. Neither score showed a significant correlation with total hospital stay duration (MPI: r = 0.133, p = 0.383; APACHE II: r = 0.022, p = 0.889). Table 8 presents these correlations.

Table 8: Spearman Rank Correlation of MPI and APACHE II Scores with Morbidity Markers

Scoring System	ICU Stay Spearman r	ICU Stay p-value	Hospital Stay Spearman r	Hospital Stay p-value	Sig.
MPI Score	0.703	< 0.001	0.133	0.383	*
APACHE II Score	0.556	< 0.001	0.022	0.889	*

** Significant correlation with ICU stay duration. No significant correlation with total hospital stay. Spearman rank correlation.*

Postoperative Complications

Intra-abdominal collection (53.3%) and wound infection (51.1%) were the most frequently recorded complications. Mechanical ventilation was required in 18 cases (40.0%), altered sensorium in 11 (24.4%), wound dehiscence in 8 (17.8%), anastomotic leak and haemodialysis requirement each in 7 (15.6%), and reoperation in 5 (11.1%). ICU admission was required in 36 cases (80.0%), with a mean ICU stay of 3.0 ± 2.6 days and mean hospital stay of 10.3 ± 5.8 days. Complication data are presented in Table 9.

Table 9: Postoperative Complications and Hospital Course (n = 45)

Complication / Parameter	n	Percentage (%)
Intra-abdominal collection	24	53.3
Wound infection	23	51.1
Mechanical ventilation required	18	40.0
Altered sensorium	11	24.4
Wound dehiscence	8	17.8
Anastomotic leak	7	15.6
Haemodialysis required	7	15.6
Reoperation	5	11.1
ICU admission	36	80.0
Mean ICU stay (days)	3.0 ± 2.6	—
Mean hospital stay (days)	10.3 ± 5.8	—

DISCUSSION

The present retrospective study analysed 45 case records of surgically managed hollow viscus perforation peritonitis and compared the prognostic utility of MPI and APACHE II. Both instruments demonstrated good and statistically comparable discriminatory ability for in-hospital mortality, with AUROCs of 0.919 and 0.936 respectively and no significant difference (p = 0.755). Beyond mortality, both scores correlated significantly with ICU stay duration, suggesting an association with broader postoperative morbidity outcomes.

The overall case fatality rate of 15.6% is consistent with data from comparable Indian tertiary care settings, where rates between 10% and 30% are reported.[10,11] The male predominance (73.3%) reflects the well-recognised higher incidence of peptic ulcer disease and enteric perforation in male patients in South Asia. The most common perforation site was the appendix (22.2%), followed by the pre-pyloric region (17.8%) and duodenum (15.6%), consistent with contemporary regional epidemiology.[12]

The high rates of intra-abdominal collection (53.3%) and wound infection (51.1%)

recorded in this series reflect the severity of the case mix. The majority of case records in Category C (MPI > 29) had a pre-operative peritonitis duration exceeding 24 hours and faecal or purulent exudate intraoperatively — conditions well established as risk factors for surgical site infection and intraperitoneal abscess. The high rate of resection and anastomosis (15.6%) and right hemicolectomy (4.4%) further contributed to anastomotic complications. These morbidity figures should be interpreted in this context rather than as isolated metrics.

The MPI demonstrated clear risk stratification, with all deaths confined to Category C, yielding an intra-group mortality of 38.9% and no deaths in Categories A or B. Fisher's Exact Test confirmed the significance of this association ($p = 0.001$). This aligns with the original validation by Linder et al.,[3] and the large-scale study by Billing et al. involving a cohort of 2,003 patients, which confirmed stepwise mortality escalation across MPI categories.[11]

APACHE II demonstrated equally robust stratification, with mortality rising from 0% (Low risk) to 75.0% (High risk) and 66.7% (Very High risk). Fisher's Exact Test confirmed the statistical significance of this trend ($p < 0.001$). The mean APACHE II in non-survivors (24.14 ± 6.57) was significantly higher than in survivors (8.76 ± 7.19; $p = 0.0003$), consistent with findings by Malik et al.[6] and Demmel et al.[5]

APACHE II demonstrated a numerically higher AUROC (0.936 vs. 0.919) and specificity (76.3% vs. 71.1%) and accuracy (80.0% vs. 75.6%) compared to MPI, though these differences were not statistically significant. Both achieved 100% sensitivity and NPV at their optimal cutoffs — APACHE II ≥ 14 and MPI ≥ 32 — meaning no case below either threshold had a fatal outcome. Bootstrapped comparison confirmed no statistically significant difference between the two scoring systems ($p = 0.755$), consistent with Malik et al.[6] and Notash et al.[7]

Both scoring systems demonstrated a significant positive correlation with ICU stay duration (MPI: $r = 0.703$; APACHE II: $r = 0.556$; both $p < 0.001$). This confirms their utility as predictors of postoperative morbidity and critical care burden, not merely mortality. The absence of correlation with total hospital stay duration likely reflects the confounding influence of social, logistical, and surgical factors that prolong ward stay independently of disease severity.

In practice, the MPI holds a significant operational advantage — it is computed entirely from clinical history and intraoperative findings, without requiring laboratory investigations, suggesting particular utility in resource-limited and peripheral surgical settings.[13] APACHE II, while more demanding in terms of data requirements, provides a comprehensive physiological assessment and demonstrated numerically higher specificity and AUROC in this cohort, though these differences were not statistically significant.[4,8]

This study has several important limitations that should be considered when interpreting its findings. First, the retrospective single-centre design limits the generalisability of results and introduces the potential for selection and information bias inherent in data extracted from case records. Second, the modest sample size of 45 patients and the low number of mortality events (n = 7) precluded robust multivariable logistic regression analysis; consequently, the independent contributions of MPI and APACHE II to mortality risk could not be established, and the study should be interpreted as exploratory. Third, potential confounders — including nutritional status, pre-operative resuscitation adequacy, and timing of surgical intervention — were not systematically captured or adjusted for. Fourth, APACHE II estimation in a retrospective setting relied on values extracted from clinical notes and available laboratory results, which may introduce inconsistencies compared to prospective real-time data collection. Fifth, subgroup analysis by causative pathology (gastroduodenal, small bowel, or colonic perforation) was not performed owing to small cell sizes. These limitations reinforce the exploratory nature of the present study. Larger prospective multicentre studies with adequate statistical power are required to validate and extend these preliminary findings.

CONCLUSION

Both MPI and APACHE II demonstrated good discriminatory ability and statistically comparable prognostic performance for predicting in-hospital mortality in hollow viscus perforation peritonitis, with AUROCs of 0.919 and 0.936 respectively and no statistically significant difference between them. Both scores were also significantly associated with ICU stay duration, suggesting their potential utility in predicting postoperative morbidity burden. MPI, by virtue of its intraoperative applicability and independence from laboratory parameters, may be particularly suited to resource-limited surgical settings, while APACHE II demonstrated numerically higher specificity and AUROC in this cohort. Given the exploratory nature and inherent limitations of this single-centre retrospective study, larger prospective multicentre studies with adequate statistical power are required to validate these findings and establish definitive prognostic recommendations.

Declaration by Authors

Ethical Approval: Approved by the Institutional Ethics Committee of SIMSRC, Bangalore.

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