

APACHE II Score as a Predictor of Outcomes in Patients with Perforation Peritonitis: A Prospective Observational Study

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Abstract

Background

Perforation peritonitis is a common surgical emergency associated with substantial morbidity and mortality, particularly where patients present late to care. Objective severity-scoring tools are needed for early risk stratification. This study evaluated the Acute Physiology and Chronic Health Evaluation II (APACHE II) score as a predictor of in hospital outcome in patients with perforation peritonitis.

Methods

In this prospective observational study conducted over nine months (April 2024–December 2025) in the Department of General Surgery at a tertiary-care teaching hospital in India, 66 consecutive adults (19–74 years) with perforation peritonitis were enrolled. The APACHE II score was calculated for each patient at admission. Associations with in hospital outcome were assessed using the Mann-Whitney U test and Fisher's exact/chi-square test, and discriminatory performance was assessed by receiver operating characteristic (ROC) curve analysis.

Results

The cohort had a male predominance (55/66, 83.3%) and mean age of 41.5 ± 14.6 years. Prepyloric perforation was the commonest cause (45.5%). Forty-nine patients (74.2%) were discharged and 17 (25.8%) died in hospital. The mean APACHE II score was significantly higher among patients who died (20.0 ± 12.2) than among survivors (9.4 ± 4.1 ; $p = 0.002$). Systemic complications were strongly associated with mortality (52.9% vs 2.0%; $p < 0.001$); local complications showed a similar but statistically non-significant trend (47.1% vs 20.4%; $p = 0.056$). APACHE II discriminated mortality with an area under the ROC curve (AUC) of 0.750 (95% CI 0.603–0.896); a cut-off of ≥ 20 yielded 47.1% sensitivity, 95.9% specificity, 80.0% positive and 83.9% negative predictive value, and 83.3% overall accuracy.

Conclusion

The APACHE II score at admission correlates strongly with in-hospital mortality in perforation peritonitis, and its high specificity makes it a useful bedside adjunct for identifying patients at low risk of death and for prioritising higher-risk patients for aggressive resuscitation and critical care, although its modest sensitivity means it should not be relied upon in isolation.

1. Introduction

Perforation peritonitis is one of the most common surgical emergencies encountered worldwide and remains an important cause of morbidity and mortality despite advances in diagnosis, critical care, and operative technique.¹ It results from perforation of a hollow viscus with peritoneal soiling by gastrointestinal contents and bacteria, triggering a systemic inflammatory response that can rapidly progress to sepsis and multi-organ dysfunction. Reported mortality ranges from 10% to 40% and is higher among elderly patients, those presenting late, and those with severe physiological derangement at admission.²

The etiological spectrum differs geographically: lower gastrointestinal perforation due to malignancy, diverticulitis, or ischaemia predominates in Western series,³ whereas upper gastrointestinal perforation related to peptic ulcer disease, enteric fever, and tuberculosis remains more common in South Asia.⁴ Delayed presentation, malnutrition, and limited access to emergency care further compound outcomes in these settings, underscoring the value of objective, reproducible tools for early risk stratification.⁵

Several severity scoring systems have been applied to peritonitis, including the Mannheim Peritonitis Index, the Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM), and the Acute Physiology and Chronic Health Evaluation (APACHE) score.⁶ Of these, APACHE II has gained the widest acceptance because it is derived entirely from readily available preoperative physiological, biochemical, and clinical variables temperature, mean arterial pressure, heart rate, respiratory rate, oxygenation, arterial pH, serum electrolytes, creatinine, haematocrit, leucocyte count, Glasgow Coma Scale score, age, and chronic health status producing a single score from 0 to 71 that correlates with predicted hospital mortality.⁷

Numerous single centre series have shown that APACHE II tracks closely with postoperative complications, intensive care requirement, length of stay, and death in patients with perforation peritonitis.^{8,9} However, most published validation of the score originates from tertiary centres, and its performance in a given population depends on local case-mix, time-to-presentation, and resource availability, supporting the need for setting-specific evaluation.¹⁰ We undertook this prospective observational study to evaluate the utility of the APACHE II score, calculated at presentation, in predicting in hospital outcome among patients undergoing emergency surgery for perforation peritonitis at a tertiary care teaching hospital in India.

2. Materials and Methods

2.1 Study design and setting

This prospective observational study was conducted in the Department of General Surgery at Bangalore Medical College and Research Institute (BMCRI), Bengaluru, India, a tertiary-care university teaching hospital, over nine months (April 2024 to December 2025).

2.2 Participants

Consecutive adults presenting to the emergency and surgical departments with clinical features of perforation peritonitis were screened for eligibility. Patients older than 18 and younger than 75 years with clinically confirmed perforation peritonitis who provided informed consent were included. Patients who declined consent, pregnant women, and patients whose peritonitis was secondary to a ruptured liver or appendicular abscess were excluded.

2.3 Sample size

The sample size was calculated using the standard formula for estimation of a population proportion, $n = Z^2P(1 - P)/d^2$, assuming 80% power ($Z = 0.84$), an expected prevalence of the outcome of interest of 10%, and an effect size (d) of 0.98, which yielded a minimum requirement of 66 patients.

2.4 Data collection and APACHE II scoring

For each patient, demographic details, clinical history, examination findings (including guarding, rigidity, and obliteration of liver dullness), and standard admission investigations (haematocrit, total leucocyte count, blood urea, serum creatinine, serum sodium and potassium, arterial blood gas, and chest and erect abdominal radiographs) were recorded on a structured proforma. The APACHE II score was calculated for every patient at admission from the acute physiology score, age points, and chronic health points, as originally described by Knaus et al.⁷ All patients underwent emergency laparotomy; the operative procedure was selected by the operating surgeon according to perforation site, size, and degree of peritoneal contamination.

2.5 Outcome measures

The primary outcome was in-hospital status at discharge (discharged alive vs. death before discharge). Secondary outcomes included duration of hospital and intensive care unit (ICU) stay, and the occurrence of local (surgical-site or intra-abdominal) and systemic (extra-abdominal organ-system) postoperative complications.

2.6 Statistical analysis

Data were analysed using SPSS version 29.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro-Wilk test; age and APACHE II score were non-normally distributed and are reported as mean $\pm$ standard deviation for comparability with the existing literature, with between-group comparisons made using the Mann-Whitney U test. Categorical variables are reported as frequencies and percentages and were compared using the chi-square test, or Fisher's exact test where an expected cell count was below 5. Receiver operating characteristic (ROC) curve analysis was performed to assess the discriminatory ability of the APACHE II score for in-hospital mortality; the area under the curve (AUC) is reported with a 95% confidence interval, together with sensitivity, specificity, positive predictive value, negative predictive value, and accuracy at the cut-off used for risk stratification. A two-sided p -value < 0.05 was considered statistically significant.

3. Results

Sixty-six patients met the inclusion criteria and were enrolled over the study period.

Table 1
Baseline demographic and clinical characteristics of study patients

Variable	Value (N = 66)
Age (years), mean $\pm$ SD (range)	41.5 $\pm$ 14.6 (19–74)
Sex, n (%)	
Male	55 (83.3)
Female	11 (16.7)
Diabetes mellitus, n (%)	28 (42.4)
Hypertension, n (%)	31 (47.0)
Etiology of perforation, n (%)	
Prepyloric	30 (45.5)
Ileal	15 (22.7)
Gastric	10 (15.2)
Colonic	6 (9.1)
Duodenal	5 (7.6)

SD, standard deviation.

The mean age was 41.5 $\pm$ 14.6 years (range 19–74), with a marked male predominance (55/66, 83.3%). Diabetes mellitus was present in 28 patients (42.4%) and hypertension in 31 (47.0%). Prepyloric perforation was the commonest cause of perforation peritonitis (45.5%), followed by ileal (22.7%), gastric (15.2%), colonic (9.1%), and duodenal perforation (7.6%) (Table 1).

Table 2
Operative management, APACHE II score, and postoperative course

Variable	Value (N = 66)
Surgical procedure, n (%)	
Modified Graham's patch repair	45 (68.2)
Resection and anastomosis	8 (12.1)
Primary closure	7 (10.6)
Stoma formation	6 (9.1)
APACHE II score, mean $\pm$ SD (range)	12.1 $\pm$ 8.4 (5–35)
Hospital stay (days), mean $\pm$ SD (range)	10.7 $\pm$ 5.7 (1–40)
ICU stay (days), mean $\pm$ SD (range)	2.8 $\pm$ 3.2 (0–12)

SD, standard deviation; ICU, intensive care unit.

Modified Graham's omental patch repair was the most frequently performed procedure (68.2%), followed by resection and anastomosis (12.1%), primary closure (10.6%), and stoma formation (9.1%) (Table 2), consistent with the predominance of prepyloric and gastric perforations. The mean hospital stay was 10.7 ± 5.7 days and mean ICU stay was 2.8 ± 3.2 days. The mean APACHE II score at admission was 12.1 ± 8.4 (range 5–35).

Forty-nine patients (74.2%) were discharged and 17 (25.8%) died in hospital. Patients who died had a significantly higher mean admission APACHE II score (20.0 ± 12.2) than those discharged alive (9.4 ± 4.1 ; Mann-Whitney U test, $p = 0.002$) (Fig. 1, Table 3). Systemic complications were strongly associated with mortality, occurring in 9/17 patients (52.9%) who died compared with 1/49 (2.0%) who were discharged ($p < 0.001$). Local complications were more frequent among patients who died (8/17, 47.1%) than among survivors (10/49, 20.4%), but this difference did not reach statistical significance (Fisher's exact $p = 0.056$). Neither sex ($p = 0.264$) nor the type of surgical procedure performed ($p = 0.257$) was significantly associated with outcome (Table 3).

Table 3
Association between clinical variables and in-hospital outcome

Variable	Discharged (n = 49)	Expired (n = 17)	p-value
APACHE II score, mean $\pm$ SD	9.4 $\pm$ 4.1	20.0 $\pm$ 12.2	0.002*†
Sex, n (%)			0.264‡
Male	39 (79.6)	16 (94.1)	
Female	10 (20.4)	1 (5.9)	
Local complications, n (%)	10 (20.4)	8 (47.1)	0.056‡
Systemic complications, n (%)	1 (2.0)	9 (52.9)	< 0.001*‡
Surgical procedure, n (%)			0.257§
Modified Graham's patch repair	33 (67.3)	12 (70.6)	
Primary closure	4 (8.2)	3 (17.6)	
Resection and anastomosis	8 (16.3)	0 (0.0)	
Stoma formation	4 (8.2)	2 (11.8)	

*Statistically significant ($p < 0.05$). †Mann-Whitney U test. ‡Fisher's exact test (used where an expected cell count was < 5). §Chi-square test.

ROC curve analysis of APACHE II score for predicting in-hospital mortality yielded an area under the curve of 0.750 (95% CI 0.603–0.896) (Fig. 2). At a cut-off of ≥ 20 , the APACHE II score correctly classified 47 of 49 survivors and 8 of 17 non-survivors, corresponding to a sensitivity of 47.1%, specificity of 95.9%, positive predictive value of 80.0%, negative predictive value of 83.9%, and overall accuracy of 83.3% (Table 4).

Table 4
Diagnostic performance of APACHE II score (cut-off ≥ 20) for predicting in-hospital mortality

Measure	Value
Area under the ROC curve (95% CI)	0.750 (0.603–0.896)
Sensitivity	47.1%
Specificity	95.9%
Positive predictive value	80.0%
Negative predictive value	83.9%
Overall accuracy	83.3%

4. Discussion

In this prospective study of 66 patients with perforation peritonitis, the admission APACHE II score was significantly higher among patients who died in hospital than among those discharged alive (20.0 ± 12.2 vs 9.4 ± 4.1 ; $p = 0.002$), and it discriminated in hospital mortality with good accuracy (AUC 0.750, 95% CI 0.603–0.896). These findings support the use of a single, readily calculable bedside score for early risk stratification in a condition whose clinical course is otherwise difficult to predict at first presentation.

The discriminatory performance observed here is consistent with, though somewhat more modest than, other reports in perforation peritonitis. Delibegovic et al. found APACHE II to be superior to several competing scores, with an AUC of 0.86 on the first postoperative day.⁹ Subedi et al. reported an AUC of 0.915 for a single APACHE II measurement, rising to 0.919 when serial scores were combined with serum lactate.¹¹ Our wider confidence interval and lower point estimate most likely reflect the smaller number of deaths in our cohort (17 events) rather than a true difference in the score's underlying validity, and is consistent with a single baseline measurement rather than a serial one. Threshold-based analyses support a similar risk gradient to ours: Ahuja and Pal reported that all patients with an APACHE II score below 10 were discharged well, while three quarters of those scoring above 20 had an unfavourable outcome,¹² a pattern that closely mirrors the discharged and expired group means observed in the present cohort and that supports ≥ 20 as a clinically meaningful, literature concordant threshold for risk communication.

The diagnostic profile we observed high specificity (95.9%) with more modest sensitivity (47.1%) has a specific clinical interpretation: a high APACHE II score reliably flags patients at genuine risk, and a low score is a reasonably trustworthy indication that a patient is likely to survive, but a substantial minority of eventual deaths were not identified by the admission score alone. This is unsurprising for a tool applied at a single time point in a disease whose severity evolves over the first 24–72 hours of treatment, and it echoes the rationale behind Subedi and colleagues' serial-scoring approach.¹¹ It suggests that admission APACHE II is best used to identify patients who can be safely stepped down from intensive monitoring rather than as a stand-alone rule for excluding risk in patients with a lower initial score.

The demographic and etiological profile of our cohort marked male predominance (83.3%), a mean age in the fifth decade, and prepyloric perforation as the leading cause closely resembles other South Asian series. Kamble et al. reported 88% male patients with a mean age of 36.8 years and gastroduodenal perforation as the dominant etiology (61% of cases), a regional pattern also reflected in a large Pakistani series.^{4,1} This contrasts with Western cohorts, where lower gastrointestinal perforation secondary to diverticular disease or malignancy predominates in an older population;³ Nakamura et al., for example, reported a mean age of 73 years in a cohort of colonic perforation.¹³ These regional differences in etiology and age structure likely explain much of the variation in reported mortality and operative

strategy across published series and reinforce the value of setting-specific validation of severity scores such as APACHE II.

Systemic complications were strongly associated with mortality in our cohort (52.9% vs 2.0%; $p < 0.001$), whereas local, surgical-site-related complications showed only a non-significant trend (47.1% vs 20.4%; $p = 0.056$). This pattern is consistent with previous work: Agrawal et al. found that APACHE II predicted postoperative respiratory complications, ventilatory requirement, and mortality, but not wound infection, dehiscence, or anastomotic leak,⁸ and Yelamanchi et al. similarly reported that APACHE II correlated with respiratory complications, intensive care requirement, and death but not with wound-related complications.⁶ Taken together, these findings suggest that the prognostic value of APACHE II operates chiefly through its capture of systemic physiological derangement and organ dysfunction rather than through prediction of local surgical morbidity, and that the non-significant association with local complications in our cohort may reflect this same biological pattern as much as the limited number of events available for that comparison.

Neither sex ($p = 0.264$) nor the type of surgical procedure performed ($p = 0.257$) was associated with outcome, echoing previous reports that survival in perforation peritonitis is determined chiefly by physiological severity and complication trajectory rather than by demographic factors or the specific operative technique chosen.^{8,6} Practically, this supports applying APACHE II-based risk stratification uniformly across patients rather than adjusting expectations by sex or anticipated procedure, and directing perioperative resources early critical care review, aggressive resuscitation, vigilant monitoring for organ dysfunction according to admission severity.

This study has several strengths, including its prospective design with consecutive enrolment, standardized data collection, and the combined reporting of discrimination (AUC with 95% CI) alongside classification performance (sensitivity, specificity, and predictive values) at a pre-specified, literature-concordant cut-off. Several limitations should also be acknowledged. This was a single-centre study with a modest sample size and only 17 deaths, which limits statistical power for secondary comparisons including the local-complications analysis discussed above and widens the confidence interval around the AUC; multivariable adjustment for potential confounders such as time to surgery and degree of peritoneal contamination was not performed. APACHE II was assessed only at admission, so we could not evaluate whether serial scoring, shown elsewhere to improve prediction,¹¹ would have captured the deaths missed by a single baseline measurement. Finally, outcome was limited to in-hospital status; longer-term outcomes such as 30-day mortality were not assessed. Larger, multicentre, prospective studies incorporating serial APACHE II assessment and longer follow-up are needed to refine these findings.

5. Conclusion

In patients undergoing emergency surgery for perforation peritonitis, the admission APACHE II score correlated strongly with in-hospital mortality and discriminated survivors from non-survivors with good

accuracy. Its high specificity makes it particularly useful for identifying patients at low risk of death who may be managed without escalation to intensive care, while its more modest sensitivity means it should inform, rather than replace, ongoing clinical judgement and vigilant monitoring for evolving systemic complications. Routine calculation of APACHE II at admission is a simple, low-cost adjunct to early risk stratification, ICU triage, and resource planning in this common surgical emergency, and warrants validation in larger, multicentre cohorts with serial scoring.

Declarations

Ethics approval and consent to participate: This study was approved by the Institutional Ethics Committee of Bangalore Medical College and Research Institute and was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment.

Availability of data and materials: The dataset analysed for the current study is available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: N.S. and M.M. conceived and designed the study. N.S. collected the data, performed the statistical analysis and drafted the manuscript. M.M. supervised the study and critically revised the manuscript for important intellectual content. Both authors read and approved the final manuscript.

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Figures

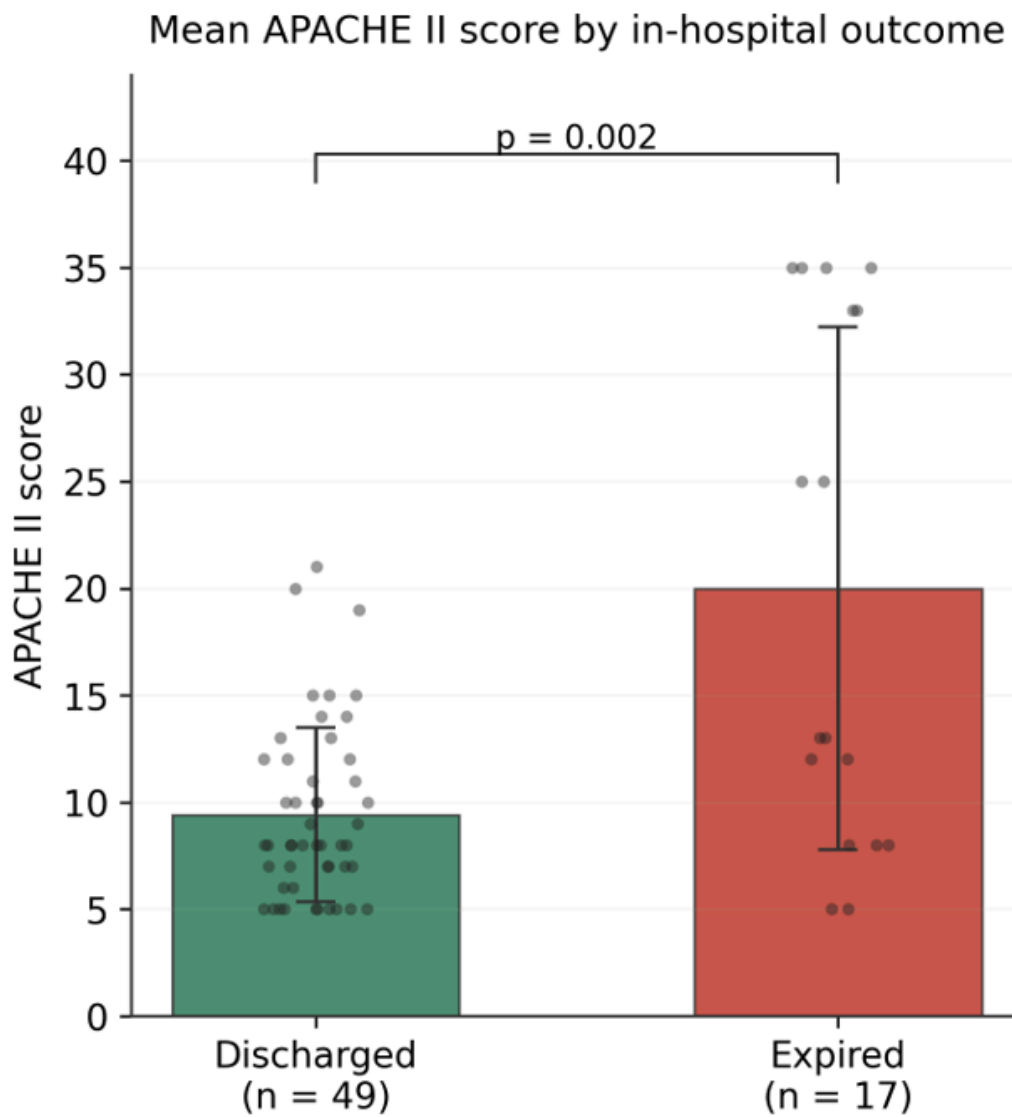


Figure 1

Mean APACHE II score (bars, $\pm$ SD) by in-hospital outcome. Individual patient values are overlaid as jittered points. p-value from the Mann-Whitney U test.

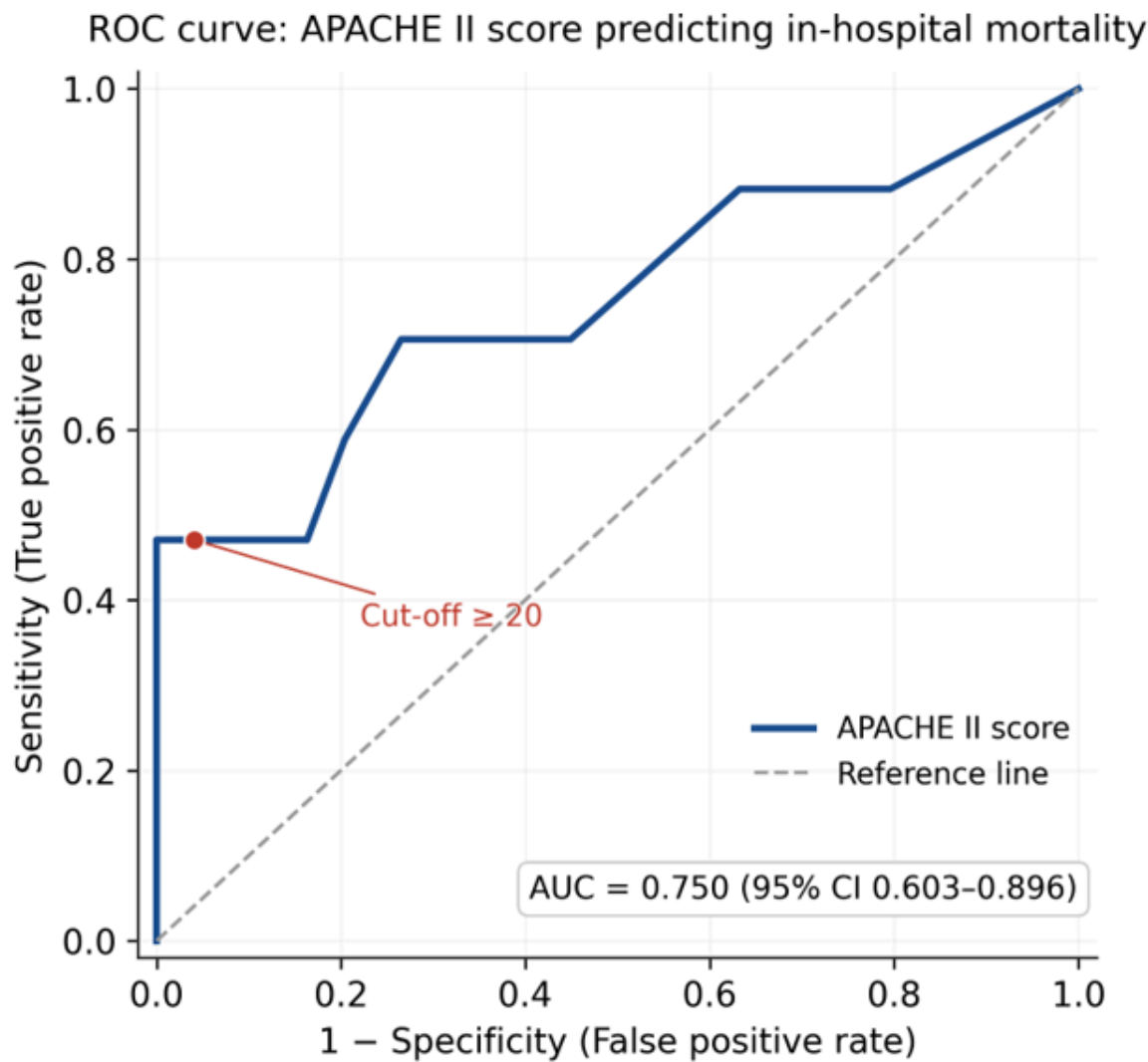


Figure 2

Receiver operating characteristic (ROC) curve for APACHE II score in predicting in-hospital mortality among patients with perforation peritonitis. AUC, area under the curve; CI, confidence interval.