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Predicting Mortality in Gastric Perforation: A Comparative Analysis of Boey Score and Mannheim Peritonitis Index Accuracy in an Indonesian Tertiary Hospital

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A B S T R A C T

Introduction: Peptic ulcer perforation (PUP), often leading to gastric perforation, represents a significant surgical emergency demanding rapid intervention. Effective risk stratification using prognostic scoring systems is crucial for optimizing patient management and improving outcomes. This study aimed to evaluate and compare the predictive performance of the Mannheim Peritonitis Index (MPI) and the Boey Score in estimating in-hospital mortality risk among patients presenting with gastric perforation at a tertiary hospital in Indonesia. **Methods:** A retrospective descriptive study employing an accuracy testing design was conducted. Data were collected from the medical records of 31 adult patients (≥18 years) who underwent exploratory laparotomy for non-traumatic gastric perforation at Dr. Mohammad Hoesin General Hospital Palembang, between January 2023 and December 2024. Patients with incomplete medical records were excluded. Boey Scores and MPI scores were calculated for each patient based on predefined criteria. The primary outcome measured was in-hospital mortality. Statistical analysis included descriptive statistics, calculation of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, and Receiver Operating Characteristic (ROC)[1] curve analysis to determine optimal cutoff values. **Results:** The median age was 62 years, with a male predominance (87.1%). Most patients presented late (>24 hours post-perforation, 90.3%) and had organ dysfunction (80.6%). Preoperative shock was present in 48.4%. The optimal cutoff for MPI predicting mortality was ≥22, yielding a sensitivity of 87.5% and specificity of 40.0%. The optimal Boey Score cutoff was ≥2, with a sensitivity of 75.0% and specificity of 53.3%. Comparing MPI (cutoff ≥22) against Boey Score (cutoff ≥2) as a reference, the MPI demonstrated an accuracy of 74.19%, sensitivity of 73.91%, specificity of 75.00%, PPV of 89.47%, and NPV of 50.00%. **Conclusion:** Both the Boey Score and MPI showed moderate predictive performance for in-hospital mortality in patients with gastric perforation in this cohort. MPI (cutoff ≥22) demonstrated higher sensitivity for identifying high-risk patients compared to the Boey Score (cutoff ≥2), although with lower specificity regarding mortality itself. MPI appears advantageous for identifying high-risk individuals, while the simpler Boey Score remains useful for rapid initial assessment.

1. Introduction

Gastric perforation, frequently a grave sequela of peptic ulcer disease (PUD), stands as one of the most commonly encountered acute abdominal emergencies in the realm of clinical practice. This condition arises from the development of a full-thickness defect within the gastric wall. Such a defect permits the leakage of gastric contents into the peritoneal cavity, a process that can precipitate chemical and subsequent bacterial peritonitis. While PUD affects millions on a global scale annually, the risk of perforation within an individual's lifetime spans from 2% to 14%. The

primary causative factors include *Helicobacter pylori* infection and the use of non-steroidal anti-inflammatory drugs (NSAIDs). However, other elements such as smoking and significant comorbidities also contribute to the development of this condition. The clinical presentation of gastric perforation is typically marked by the abrupt onset of severe epigastric pain. This pain often radiates to the shoulder and is accompanied by signs of peritonism, including abdominal rigidity and tenderness. Nevertheless, the clinical presentation can vary, particularly in elderly or immunocompromised patients. When coupled with delays in diagnosis, these variations can exacerbate the clinical course, leading to severe consequences such as diffuse peritonitis, sepsis, septic shock, multi-organ failure, and ultimately, death. Despite advancements in surgical techniques, resuscitation protocols, antimicrobial therapy, and critical care, gastric perforation continues to be associated with substantial morbidity, with rates ranging from 20% to 50%. The condition also carries a significant mortality rate, reported between 3% and 40%, and in some cases, as high as 30% within 30 days. Several factors contribute to these persistently elevated rates, including the increasing prevalence of an aging population with multiple comorbidities, the complexities associated with surgical infections, and the difficulties encountered in intensive care management.[1-3]

The importance of timely surgical intervention cannot be overstated, as delays are known to significantly elevate the risk of mortality. In light of these high stakes, the necessity of accurate preoperative risk stratification becomes evident. Prognostic scoring systems are designed to categorize patients according to their likelihood of experiencing adverse outcomes. This categorization facilitates the optimization of treatment strategies, enables informed counseling of patients regarding their prognosis, aids in the allocation of resources such as ICU admission, and provides a valuable tool for surgical audit and quality assessment. Various scoring systems have been developed and utilized in the management of patients with PUP or peritonitis. These include the American Society of Anesthesiologists (ASA) physical status classification, the Boey Score, the Peptic Ulcer Perforation (PULP) Score, and the Mannheim Peritonitis Index (MPI). The Boey Score, introduced in 1982, has been widely adopted due to its simplicity. This scoring system incorporates three preoperative factors that are easily obtainable: the presence of significant medical comorbidity, preoperative shock (initially defined as systolic BP < 90 mmHg, but often modified to <100 mmHg in practice), and the duration of perforation exceeding 24 hours prior to intervention. The original study that introduced the Boey Score reported a striking stratification of mortality risk, ranging from 0% for a score of 0 to 100% for a score of 3. Subsequent validation studies have confirmed the utility of the Boey Score in predicting mortality. However, these studies also revealed some variability in mortality rates, underscoring the fact that the Boey Score, while useful, is not infallible. Criticisms of the Boey Score include its simplicity, which may lead to the overlooking of other relevant factors, its original derivation from a patient cohort that was younger than those typically seen today, and the evolving definition of shock.[4-6]

In contrast, the Mannheim Peritonitis Index (MPI), developed in 1983, provides a more comprehensive assessment. The MPI is based on a large cohort of patients with peritonitis and incorporates eight factors, each weighted according to its prognostic significance. These factors include age (greater than 50 years), female sex, the presence of organ failure at admission, the presence of malignancy, the duration of peritonitis (greater than 24 hours), the origin of perforation (colonic versus non-colonic), the extent of peritonitis (diffuse versus localized), and the character of peritoneal exudate (clear/serous versus purulent versus fecal). Typically, patients are stratified into low (<21), intermediate (21-29), and high (>29) risk groups based on their MPI scores. Numerous studies have demonstrated a strong correlation between increasing MPI scores and mortality. The strength of the MPI lies in its integration of both preoperative and

intraoperative findings, which allows for a more nuanced assessment of risk. Both the Boey Score and the MPI are widely employed in clinical practice. However, comparative studies specifically focused on evaluating their predictive accuracy in cases of gastric perforation have yielded inconsistent results. Some studies suggest that the MPI may offer superior predictive capability, particularly for complications. Conversely, other studies have found the Boey Score to be comparable or even superior in certain aspects, such as positive predictive value, although it may be less dynamic.[7-10] This study was designed to rigorously evaluate and directly compare the predictive accuracy of the Mannheim Peritonitis Index (MPI) and the Boey Score in forecasting in-hospital mortality. The study population consisted of patients undergoing emergency surgery for gastric perforation at Dr. Mohammad Hoesin General Hospital Palembang, a tertiary care center in Indonesia. By determining the sensitivity, specificity, and overall accuracy of each scoring system within this specific clinical setting, the researchers sought to identify the more effective prognostic tool. The ultimate goal was to provide clinicians with better tools to aid in early risk stratification, optimize patient management strategies, and improve outcomes for patients facing this high-risk surgical emergency.

2. Methods

This study adopted a retrospective, descriptive design, incorporating an accuracy test analysis to rigorously compare the diagnostic performance of the Mannheim Peritonitis Index (MPI) against the Boey Score. The primary focus was on evaluating and comparing the efficacy of these two scoring systems in predicting in-hospital mortality among patients who underwent surgical treatment for gastric perforation.

The research was meticulously conducted through the analysis of medical record data sourced from the Department of Surgery at Dr. Mohammad Hoesin General Hospital Palembang. This hospital serves as a tertiary referral center within Palembang, Indonesia. The data collection spanned the period from January 2023 to December 2024, encompassing patients who were admitted and subsequently underwent surgery during this timeframe. The study population consisted of all patients who received a diagnosis of gastric perforation and underwent exploratory laparotomy at the Department of Surgery of Dr. Mohammad Hoesin General Hospital Palembang, throughout the designated study period.

The study sample was carefully selected, including all patients from the broader population who specifically met the predefined inclusion and exclusion criteria. The inclusion criteria mandated that patients; Were diagnosed with gastric perforation and admitted to Dr. Mohammad Hoesin General Hospital Palembang; Underwent exploratory laparotomy for the gastric perforation at the same hospital; Were 18 years of age or older. Conversely, patients were excluded from the study if they met any of the following exclusion criteria; The gastric perforation was attributed to trauma; Their medical record data were incomplete, lacking essential information required for the calculation of the scoring systems or for the determination of the patient's outcome.

To ensure a comprehensive representation of eligible patients, a total sampling technique was employed. This approach involved the consecutive inclusion of all patients who satisfied the inclusion and exclusion criteria within the study period, continuing until the required sample size was attained. The determination of the minimum sample size was grounded in the formula used for sensitivity testing. The calculation aimed for a precision (d) of 0.10, a $Z\alpha$ value of 1.96 (corresponding to a 95% confidence level), an expected MPI sensitivity (sen) of 92%, and an estimated prevalence (P) of mortality predicted by the MPI of 99%. This calculation yielded a minimum sample size requirement of N=28.55. To account for a potential dropout rate or data incompleteness, estimated at 10%, the target sample size was increased to 31 patients.

The study involved the following key variables; Predictor Variables: Boey Score, Mannheim Peritonitis Index (MPI); Outcome Variable: In-hospital mortality,

categorized as either "Alive" or "Deceased"; Covariates/Demographics: A range of covariates and demographic factors were also considered, including age, gender, duration of perforation symptoms before admission, presence of preoperative shock, presence of comorbidities (specifically diabetes and hypertension), presence of malignancy, origin of peritonitis (classified as colonic or non-colonic), presence of organ dysfunction, and the type of peritoneal exudate.

Data collection was conducted retrospectively, utilizing patient medical records maintained by the Medical Records Installation of the hospital. To ensure consistency and standardization in data extraction, a structured data collection form was developed, aligned with the study variables. To maintain clarity and precision throughout the study, the following operational definitions were established; Gastric Perforation: This was defined as a confirmed perforation of the stomach, identified and documented during exploratory laparotomy, and recorded in the surgical report; Boey Score: The Boey Score was calculated based on three specific factors, with each factor contributing one point if present; Duration of perforation exceeding 24 hours before treatment; Preoperative shock, defined in this study as a systolic blood pressure (BP) of less than 100 mmHg (it is important to note that while the definition can vary, this threshold was consistently applied within this study); Presence of significant medical comorbidity, including cardiac, liver, or renal disease, or diabetes mellitus. The total Boey Score ranged from 0 to 3. For risk stratification, a cutoff of ≤1 was used to define the Low-Risk group, while a score of >1 was used to define the High-Risk group, consistent with the original Boey mortality thresholds; Mannheim Peritonitis Index (MPI): The MPI was calculated based on eight weighted factors, each assigned a specific number of points; Age >50 years (5 points); Female sex (5 points); Presence of organ failure (7 points); Presence of malignancy (4 points); Duration of peritonitis >24 hours (4 points); Non-colonic origin of perforation (4 points) – it is important to note that in this particular study, all perforations were of non-colonic origin; Diffuse peritonitis (6 points); Type of peritoneal exudate: Clear/Serous=0, Purulent=6, Fecal=12 points – in this study, all exudates were serous. Organ failure was defined based on specific thresholds for renal function (Creatinine >177 μmol/L or Urea >16.7 mmol/L or Oliguria <20 mL/hr), pulmonary function (PO_2 <50 mmHg or PCO_2 >50 mmHg), or the presence of shock (hypo- or hyper-dynamic state). MPI scores were used to stratify patients into risk groups: <21 (Low), 21-29 (Medium), and >29 (High). Mortality was defined as patient death occurring at any point during the hospital admission for the gastric perforation event. This was determined and recorded from the patient's medical record.

The collected data were analyzed using SPSS version 26. Descriptive statistics were employed to characterize the sample. Continuous variables, such as age, were reported using median and range or mean and standard deviation, depending on the data distribution. Categorical variables, including gender, presence of shock, comorbidities, Boey/MPI risk groups, and mortality, were presented as frequencies and percentages. To evaluate the diagnostic accuracy of the Boey Score and MPI in predicting mortality, Receiver Operating Characteristic (ROC) curves were generated. The Area Under the Curve (AUC) was calculated to quantify the overall predictive ability of each scoring system. Optimal cutoff points for each score were determined from the ROC curve coordinates, with the aim of maximizing the balance between sensitivity and specificity. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated for both the Boey Score and the MPI, using their respective optimal cutoff points, to assess their performance in predicting mortality. Furthermore, a comparison table (2x2) was constructed to facilitate a direct comparison of MPI against the Boey Score, utilizing the determined cutoff points. This comparison allowed for the calculation of relative accuracy, sensitivity, specificity, PPV, and NPV. Where appropriate, Fisher's exact test was used to compare

categorical characteristics between survival groups. In all statistical analyses, a p-value of less than 0.05 was considered to indicate statistical significance.

3. Results

Table 1 presents a comprehensive overview of the baseline sociodemographic and clinical characteristics of the 31 patients included in the study who underwent surgery for gastric perforation. The table is structured to allow for comparisons between the overall cohort, the patients who survived, and those who died, with a p-value provided to indicate the statistical significance of differences observed between the survival groups for each characteristic. The median age of the entire patient group was 62 years, with ages ranging from 36 to 84 years. A substantial portion of the patients (83.9%, n=26) were 50 years or older, highlighting that gastric perforation predominantly affects older individuals in this study population. When comparing survival groups, 80.0% of survivors and 87.5% of non-survivors were in the older age group (≥50 years). However, this difference in age distribution between the two groups was not statistically significant (p=0.654), suggesting that age, while generally high, was not a decisive factor in mortality within this cohort. The gender distribution revealed a strong male predominance in the study, with 87.1% (n=27) of the patients being male and only 12.9% (n=4) being female. Among the survivors, 93.3% were male and 6.7% were female, while in the deceased group, 81.2% were male and 18.8% were female. Despite the higher proportion of females in the non-survivor group, this difference was not statistically significant (p=0.600). A critical clinical characteristic is the duration of perforation before admission, which serves as a proxy for the time to intervention. The data indicates that a large majority of the patients (90.3%, n=28) experienced symptoms for more than 24 hours before being admitted to the hospital. Notably, all non-survivors (100%) had a perforation duration of over 24 hours, compared to 80.0% of the survivors. Although this trend suggests that delayed presentation is associated with higher mortality, the difference did not reach statistical significance (p=0.101). Preoperative shock, defined as a systolic blood pressure of less than 100 mmHg, was observed in 48.4% (n=15) of the entire cohort. This condition was significantly associated with mortality. A substantial 75.0% of non-survivors presented with shock, compared to only 20.0% of survivors (p=0.004). This statistically significant difference underscores the importance of preoperative hemodynamic status as a predictor of outcome in gastric perforation. The presence of comorbidities, specifically diabetes mellitus or hypertension, was assessed. In the overall cohort, 29.0% (n=9) of patients had at least one of these comorbidities. Comorbidities were present in 26.7% of survivors and 31.2% of non-survivors. However, the difference in comorbidity prevalence between the two groups was not statistically significant (p=1.000), indicating that, in this study, the presence of these specific comorbidities did not significantly influence mortality. Malignancy was a rare occurrence in this cohort, with only one patient (3.2%) having a malignancy. This patient was in the non-survivor group. Due to the extremely low prevalence, there was no significant association between malignancy and mortality (p=1.000). Organ dysfunction at admission was a common finding, observed in 80.6% (n=25) of the patients. A higher proportion of non-survivors (93.8%) exhibited organ dysfunction compared to survivors (66.7%). While this trend suggests that organ dysfunction is associated with increased mortality, the difference did not reach statistical significance (p=0.083). All patients in this study had non-colonic (gastric) origins of peritonitis. Similarly, the peritoneal exudate type was uniformly serous in all cases. Consequently, these variables did not contribute to the comparative analysis between survival and mortality.

Table 1. Baseline sociodemographic and clinical characteristics of patients with gastric perforation (N=31).

Characteristic	Category	Overall Cohort (N=31) n (%)	Survived (N=15) n (%)	Deceased (N=16) n (%)	p-value*
Age (years)	Median (Range)	62 (36-84)	-	-	
	< 50 years	5 (16.1%)	3 (20.0%)	2 (12.5%)	0.654
	≥ 50 years	26 (83.9%)	12 (80.0%)	14 (87.5%)	
Gender	Male	27 (87.1%)	14 (93.3%)	13 (81.2%)	0.600
	Female	4 (12.9%)	1 (6.7%)	3 (18.8%)	
Duration of perforation (Time to Admission)	≤ 24 hours	3 (9.7%)	3 (20.0%)	0 (0.0%)	0.101
	> 24 hours	28 (90.3%)	12 (80.0%)	16 (100.0%)	
Preoperative shock (Systolic BP < 100 mmHg)	No Shock	16 (51.6%)	12 (80.0%)	4 (25.0%)	**0.004**
	Shock Present	15 (48.4%)	3 (20.0%)	12 (75.0%)	
Comorbidities (Diabetes Mellitus/Hypertension)	No Comorbidities	22 (71.0%)	11 (73.3%)	11 (68.8%)	1.000
	Comorbidities Present	9 (29.0%)	4 (26.7%)	5 (31.2%)	
Malignancy	No Malignancy	30 (96.8%)	15 (100.0%)	15 (93.8%)	1.000
	Malignancy Present	1 (3.2%)	0 (0.0%)	1 (6.2%)	
Organ dysfunction (At Admission)	No Dysfunction	6 (19.4%)	5 (33.3%)	1 (6.2%)	0.083
	Dysfunction Present	25 (80.6%)	10 (66.7%)	15 (93.8%)	
Origin of peritonitis	Colonic	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.000
	Non-Colonic (Gastric)	31 (100.0%)	15 (100.0%)	16 (100.0%)	
Peritoneal exudate type (Intraoperative finding)	Serous	31 (100.0%)	15 (100.0%)	16 (100.0%)	-
	Purulent	0 (0.0%)	0 (0.0%)	0 (0.0%)	
	Fecal	0 (0.0%)	0 (0.0%)	0 (0.0%)	

*Fisher exact test.

Table 2 presents a detailed analysis of the Boey Score's performance in predicting in-hospital mortality among the 31 patients who underwent surgery for gastric perforation. It includes descriptive statistics of the Boey Score, the results of the Receiver Operating Characteristic (ROC) curve analysis, and an evaluation of the score's predictive performance. The average Boey Score for the patient cohort was 1.68, with a standard deviation of 0.871. The scores ranged from 0 to 3, indicating the variability in the presence of the three risk factors assessed by the Boey Score (duration of perforation >24 hours, preoperative shock, and significant medical comorbidity) within this patient group. To determine the Boey Score's ability to discriminate between survivors and non-survivors, an ROC curve analysis was performed. This analysis identified an optimal cutoff score of ≥2 for predicting in-hospital mortality. At the optimal cutoff of ≥2, the Boey Score demonstrated a sensitivity of 75.0%. This means that the Boey Score correctly identified 75% of the patients who died (true positives). Specifically, it correctly identified 12 out of the 16 non-survivors. The specificity at this cutoff was 53.3%, indicating that the score correctly identified 53.3% of the patients who survived (true negatives). In other words, it correctly classified 8 out of the 15 survivors. However, this also implies a false positive rate of 46.7%, meaning that 46.7% of the patients predicted to die by the Boey Score actually survived. The overall accuracy of the Boey Score in predicting mortality at the chosen cutoff was 64.5%. The positive predictive value (PPV), which represents the proportion of patients with a positive test (Boey Score ≥2) who actually died, was 63.2%. The negative predictive value (NPV), the proportion of patients with a negative test (Boey Score <2) who actually survived, was 66.7%.

Table 2. Boey score analysis and performance in predicting in-hospital mortality (N=31).

Parameter	Detail	Value
Descriptive statistics	Mean Boey Score (± SD)	1.68 (± 0.871)
	Score Range	0 - 3
ROC curve analysis	Optimal Cutoff Score	≥ 2
	Sensitivity at Cutoff	75.0%
	Specificity at Cutoff	53.3%
Contingency table	**Mortality Outcome**	
Boey score category	**Deceased (n=16)**	**Survived (n=15)**
≥ 2 (High Risk)	12 (True Positives)	7 (False Positives)
< 2 (Low/Moderate Risk)	4 (False Negatives)	8 (True Negatives)
Total	16	15
Predictive performance (Based on Cutoff ≥ 2)	Accuracy	64.5%
	Positive Predictive Value (PPV)	63.2%
	Negative Predictive Value (NPV)	66.7%

Table 3 presents a detailed analysis of the Mannheim Peritonitis Index's (MPI) performance in predicting in-hospital mortality among the 31 patients who underwent surgery for gastric perforation. It includes descriptive statistics of the MPI scores, the distribution of patients across standard MPI risk categories, the results of the Receiver Operating Characteristic (ROC) curve analysis, and an evaluation of the score's predictive performance. The mean MPI score for the patient cohort was 20.61, with a standard deviation of 4.529. The scores ranged from 10 to 27, indicating a degree of variability in the severity of peritonitis among the patients as assessed by the MPI. The distribution of patients according to the standard MPI risk categories shows that the majority of patients (67.7%, n=21) fell into the medium-risk category (MPI score 21-29). 25.8% (n=8) were classified as low risk (MPI score <21), and only 6.5% (n=2) were classified as high risk (MPI score >29). To determine the MPI's ability to discriminate between survivors and non-survivors, an ROC curve analysis was performed. This analysis identified an optimal cutoff score of ≥22 for predicting in-hospital mortality in this specific study population. It's important to note that this cutoff may differ from the standard MPI risk categories. At the optimal cutoff of ≥22, the MPI demonstrated a sensitivity of 87.5%. This means that the MPI correctly identified 87.5% of the patients who died (true positives). Specifically, it correctly identified 14 out of the 16 non-survivors. The specificity at this cutoff was 40.0%, indicating that the score correctly identified 40.0% of the patients who survived (true negatives). In other words, it correctly classified 6 out of the 15 survivors. This also implies a false positive rate of 60.0%, meaning that 60.0% of the patients predicted to die by the MPI actually survived. The overall accuracy of the MPI in predicting mortality at the chosen cutoff of ≥22 was 64.5%. The positive predictive value (PPV), which represents the proportion of patients with a positive test (MPI score ≥22) who actually died, was 60.9%. The negative predictive value (NPV), the proportion of patients with a negative test (MPI score <22) who actually survived, was 75.0%.

Table 3. Mannheim Peritonitis Index (MPI) analysis and performance in predicting in-hospital mortality (N=31).

Parameter	Detail	Value
Descriptive statistics	Mean MPI Score (± SD)	20.61 (± 4.529)
	Score Range	10 - 27
Distribution by standard MPI risk categories	< 21 (Low Risk)	8 (25.8%)
	21 - 29 (Medium Risk)	21 (67.7%)
	> 29 (High Risk)	2 (6.5%)
ROC curve analysis (for Mortality)	Optimal Cutoff Score	≥ 22
	Sensitivity at Cutoff	87.5%
	Specificity at Cutoff	40.0%
Contingency table (using study cutoff ≥ 22)	**Mortality Outcome**	
MPI score category	**Deceased (n=16)**	**Survived (n=15)**
≥ 22 (Positive)	14 (True Positives)	9 (False Positives)
< 22 (Negative)	2 (False Negatives)	6 (True Negatives)
Total	16	15
Predictive performance (Based on Cutoff ≥ 22 for Mortality)	Accuracy	64.5%
	Positive Predictive Value (PPV)	60.9%
	Negative Predictive Value (NPV)	75.0%

Table 4 presents a comparative analysis of the Mannheim Peritonitis Index (MPI) and the Boey Score in their ability to classify patients into risk categories. This comparison helps to understand how well the MPI aligns with the Boey Score in identifying patients at high or low risk. The analysis was structured by first establishing cutoff points for each scoring system. A specific cutoff was used for the MPI, and a separate cutoff was used for the Boey Score, which served as the reference point for the comparison. A contingency table was created to illustrate the agreement and disagreement between the two scoring systems. This table shows how many patients were classified as high risk by both MPI and Boey, how many were classified as low risk by both, and how many were classified differently by the two systems. Based on this comparison, several performance metrics were calculated to evaluate how well the MPI predicts the Boey Score classification. The overall agreement between the MPI and Boey Score classifications was measured, indicating the proportion of patients for whom both scores assigned them to the same risk category. The ability of the MPI to correctly identify patients classified as high risk by the Boey Score was assessed. This metric indicates how sensitive the MPI is in detecting patients that the Boey Score identifies as being at higher risk. The ability of the MPI to correctly identify patients classified as low risk by the Boey Score was also evaluated. This metric indicates the specificity of the MPI in detecting patients that the Boey Score identifies as being at lower risk. Furthermore, the analysis determined the proportion of patients classified as high risk by the MPI who were also classified as high risk by the Boey Score. This is a measure of how likely it is that a patient identified as high risk by the MPI is truly high risk according to the Boey Score. Finally, the proportion of patients classified as low risk by the MPI who were also classified as low risk by the Boey Score was calculated. This indicates how likely it is that a patient identified as low risk by the MPI is truly low risk according to the Boey Score.

Table 4. Comparative performance of Mannheim Peritonitis Index (MPI) vs. Boey score for risk stratification (N=31).

Parameter	Detail	Value
Comparison setup	MPI Classification Cutoff	≥ 22
	Boey Score Classification Cutoff (Reference)	≥ 2
Contingency table (MPI vs. Boey Score)	**Boey Score Classification**	
MPI classification (Cutoff ≥ 22)	**Positive (Boey ≥ 2)**	**Negative (Boey < 2)**
Positive (MPI ≥ 22)	17 (a)	6 (b)
Negative (MPI < 22)	2 (c)	6 (d)
Total	19	12
Calculated performance metrics MPI predicting Boey Score Classification	**Accuracy**	**74.19%**
	Sensitivity	**89.47%**
	Specificity	**50.00%**
	Positive Predictive Value (PPV)	**73.91%**
	Negative Predictive Value (NPV)	**75.00%**

4. Discussion

The cohort of 31 patients analyzed in this study demonstrated several key demographic and clinical characteristics that are pertinent to the interpretation of the scoring system performance. The median age of the patients was 62 years, with a significant proportion (83.9%) being 50 years or older. This older age profile is frequently observed in patients with gastric perforation and often reflects the underlying pathophysiology of peptic ulcer disease and the impact of age-related comorbidities. Advanced age is independently associated with poorer outcomes in surgical emergencies, including gastric perforation, due to factors such as diminished physiological reserve and an increased prevalence of concomitant medical conditions. Therefore, the age distribution within this study population is an important contextual factor. Furthermore, the study revealed a marked male predominance, with 87.1% of the patients being male. While the epidemiology of peptic ulcer disease can vary across populations, a higher incidence in males has been reported in numerous studies. Hormonal influences, lifestyle factors, and occupational exposures have all been implicated as potential contributors to this gender disparity. However, it is crucial to acknowledge that recent trends suggest an increasing incidence of peptic ulcer disease and its complications in elderly females, particularly those with a history of non-steroidal anti-inflammatory drug (NSAID) use. A particularly noteworthy finding was the high proportion of patients (90.3%) presenting with a perforation duration exceeding 24 hours prior to hospital admission. Delayed presentation is a significant risk factor in gastric perforation, as it increases the likelihood of bacterial peritonitis, sepsis, and associated complications. The progression from chemical peritonitis to bacterial peritonitis, as gastric contents leak into the peritoneal cavity, leads to a cascade of inflammatory and infectious processes that can overwhelm the patient's physiological defenses. Factors contributing to delayed presentation can include patient-related issues such as delayed recognition of symptoms or reluctance to seek medical care, as well as system-related issues such as delays in transportation or access to healthcare facilities. In this study, the high prevalence of delayed presentation underscores the need for public health initiatives aimed at improving awareness of the signs and symptoms of gastric perforation and promoting timely access to medical care. Preoperative shock, defined in this study as a systolic blood pressure of less than 100 mmHg, was present in 48.4% of the patients. Shock is a critical indicator of hemodynamic instability and

reflects the systemic effects of peritonitis and sepsis. The presence of shock significantly increases the risk of mortality in patients with gastric perforation, as it is associated with end-organ dysfunction and a higher likelihood of requiring intensive care support. The fact that nearly half of the patients in this study presented with preoperative shock highlights the severity of their condition and the urgency of the required medical and surgical intervention. Furthermore, 29.0% of the patients had significant medical comorbidities, such as diabetes mellitus or hypertension. Comorbidities are known to negatively impact surgical outcomes, as they can impair the patient's ability to tolerate the physiological stress of surgery and increase the risk of postoperative complications. Diabetes mellitus, for example, can impair wound healing and increase the risk of surgical site infections, while hypertension can contribute to cardiovascular complications. The presence of comorbidities in this patient population adds to the complexity of their management and contributes to the overall risk profile. A substantial proportion of patients (80.6%) exhibited organ dysfunction upon admission. Organ dysfunction is a manifestation of severe sepsis and reflects a failure of the body's homeostatic mechanisms. The presence of organ dysfunction is a strong predictor of mortality in patients with peritonitis and underscores the severity of the systemic inflammatory response. The high prevalence of organ dysfunction in this study population indicates that many patients presented with advanced stages of peritonitis, further emphasizing the need for timely and aggressive intervention. Finally, the overall in-hospital mortality rate in this study was 51.6%. This mortality rate is notably higher than those reported in many contemporary studies, which often range from 3% to 40%. Several factors may contribute to this elevated mortality rate, including the high prevalence of delayed presentation, the significant proportion of patients presenting with preoperative shock and organ dysfunction, and potential variations in local healthcare practices and resources. The high mortality rate observed in this study underscores the seriousness of gastric perforation as a surgical emergency and the need for ongoing efforts to improve patient outcomes.[11-15]

The Boey Score, a simple and widely used prognostic tool, was evaluated for its ability to predict in-hospital mortality in patients with gastric perforation. The mean Boey Score in this study population was 1.68, with scores ranging from 0 to 3. The Boey Score assigns one point for each of the following risk factors: duration of perforation greater than 24 hours, preoperative shock, and significant medical comorbidity. Thus, the range of scores reflects the varying number of these risk factors present in individual patients. Receiver Operating Characteristic (ROC) curve analysis was employed to determine the optimal cutoff point for the Boey Score in predicting mortality within this specific cohort. The analysis identified a cutoff score of ≥2 as the optimal threshold. This means that patients with a Boey Score of 2 or 3 were classified as high risk, while those with a score of 0 or 1 were classified as low risk. At this optimal cutoff, the Boey Score demonstrated a sensitivity of 75.0%. Sensitivity refers to the ability of the test to correctly identify patients who will experience the outcome of interest, in this case, mortality. A sensitivity of 75.0% indicates that the Boey Score correctly identified 75% of the patients who died. In other words, out of the 16 patients who died, the Boey Score classified 12 of them as high risk. The specificity of the Boey Score at the optimal cutoff was 53.3%. Specificity refers to the ability of the test to correctly identify patients who will *not* experience the outcome of interest. A specificity of 53.3% indicates that the Boey Score correctly identified 53.3% of the patients who survived. Out of the 15 patients who survived, the Boey Score classified 8 of them as low risk. The accuracy of the Boey Score in predicting mortality was 64.5%. Accuracy represents the overall proportion of patients who were correctly classified by the test, considering both true positives and true negatives. In this study, the Boey Score correctly classified 64.5% of the patients with respect to their survival status. The positive predictive value (PPV) of the Boey Score was 63.2%. PPV is the

probability that a patient with a positive test result (high-risk Boey Score) will actually experience the outcome (mortality). In this case, if a patient was classified as high risk by the Boey Score (≥2), there was a 63.2% chance that they would die. The negative predictive value (NPV) of the Boey Score was 66.7%. NPV is the probability that a patient with a negative test result (low-risk Boey Score) will *not* experience the outcome (mortality). If a patient was classified as low risk by the Boey Score (<2), there was a 66.7% chance that they would survive. In interpreting these results, it is important to consider both the strengths and limitations of the Boey Score. Its simplicity and ease of use are undeniable advantages, making it a practical tool for rapid bedside assessment. The three factors included in the score – duration of perforation, preoperative shock, and comorbidity – are clinically relevant and readily available. However, the Boey Score's simplicity also implies that it may not capture the full complexity of the patient's condition. It does not incorporate intraoperative findings, which can provide valuable prognostic information. Additionally, the definition of shock can vary in clinical practice, which may affect the score's reproducibility. In this study, the Boey Score demonstrated moderate sensitivity and specificity for predicting mortality. The sensitivity of 75.0% suggests that the score is reasonably good at identifying patients who are likely to die. However, the specificity of 53.3% indicates that the score has a relatively high false positive rate, meaning that it may classify some patients as high risk who will actually survive. The accuracy of 64.5% reflects the overall ability of the score to correctly classify patients, while the PPV and NPV provide information about the probability of mortality in high-risk and low-risk groups, respectively. These findings are generally consistent with previous studies that have evaluated the performance of the Boey Score. While the Boey Score has been shown to be a useful prognostic tool, its accuracy can vary across different patient populations and clinical settings. The results of this study contribute to the body of evidence on the Boey Score's performance and highlight the need for careful interpretation of the score in the context of individual patient characteristics.[16-20]

5. Conclusion

In conclusion, this study provides a comparative analysis of the Boey Score and the Mannheim Peritonitis Index (MPI) in predicting in-hospital mortality among patients undergoing surgery for gastric perforation. Both scoring systems demonstrated moderate predictive performance within this cohort. The Boey Score, with its simplicity and ease of use, offers a practical tool for rapid initial assessment, particularly in identifying patients with a higher likelihood of mortality. However, its moderate specificity suggests a potential for overestimating risk in some patients. Conversely, the MPI, while more complex, showed higher sensitivity in detecting high-risk patients. This indicates that the MPI is more effective in identifying patients who are truly at risk of mortality. However, this higher sensitivity comes at the cost of lower specificity, implying that the MPI may also over-predict mortality in some cases. The findings suggest that the choice between the Boey Score and MPI should be guided by the specific clinical context and the relative importance of sensitivity versus specificity. For situations requiring rapid triage and initial risk stratification, the Boey Score may be adequate. In contrast, the MPI may be more suitable when a more thorough risk assessment is needed, especially in identifying patients who warrant more aggressive intervention and intensive monitoring. Further research with larger sample sizes and diverse populations is warranted to validate these findings and refine the application of these scoring systems in predicting outcomes for gastric perforation.

6. References

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