



Comparative Study of Modified Boey's Score and Mannheim Peritonitis Index in Predicting Outcome of Perforated Peptic Ulcer with Diffuse Peritonitis

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Abstract

Background: Perforated Peptic Ulcer (PPU) complicated with diffuse peritonitis despite all advances of diagnosis and surgical care. The timely and precise identification of prognosis is one of the most key issues to optimize peri-operative management. In this study, the Modified Boey's Score (MBS) and the Mannheim Peritonitis Index (MPI) were compared and assessed for their predictive capabilities in patients with PPU after surgery.

Methods: A prospective observational study was done in the Department of General Surgery from October 2025 to February 2026 with 50 patients with perforated peptic ulcer and diffuse peritonitis. Both MBS and MPI were calculated for each patient. Postoperative morbidity and mortality were tabulated and analyzed to test the predictive performance by using Chi-square test and Receiver Operating Characteristic (ROC) analysis.

Results: Mean age of the patients was 46.2 years and 88% were male. The overall morbidity was 62% and the mortality was 14%. Morbidity and mortality increased with rising MBS values: 4.35%, 31.25%, 88.89%, and 57.14% (morbidity) and 0%, 3.12%, 16.67%, and 100% (mortality) for scores 0-3, respectively. Based on the results of the ROC analysis, MBS had a higher AUC value (AUC=0.81) than MPI (AUC=0.68).

Conclusion: Modified Boey's Score was a more convenient, rapid and accurate means of predicting morbidity and mortality in patients with diffuse peritonitis and perforated peptic ulcer than Mannheim Peritonitis Index. It is also easily applied at the bedside, which is beneficial for early risk assessment and management planning.

Keywords: Modified Boey's Score; Mannheim Peritonitis Index; Perforated Peptic Ulcer; Morbidity; Mortality

Introduction

Although elective surgeries have come down significantly since the introduction of the effective proton pump inhibitors and Helicobacter pylori treatment in the modern era, Peptic Ulcer Disease (PUD) is still one of the most common gastrointestinal diseases seen in surgical practice. Others complications, however, like perforation and bleeding remain a significant contributor to morbidity and mortality, especially in areas with limited resources where delays in presentation are common [1, 2]. Perforated Peptic Ulcer (PPU) is a life-threatening surgical emergency that contributes to almost 2-10% of all ulcers, with the mortality rate of 5-30% and the morbidity being up to 80% depending on the age of the patient, associated morbidity and the time interval between perforation and surgery [3].

Although perioperative management has improved, PPU remains a difficult condition to manage because of the acute onset and rapid progression to generalized peritonitis and the increased risk of septic shock if not managed in a timely manner [4]. Perforation can be caused by any process that causes sudden breakdown in the integrity of the gastroduodenal mucosa, allowing the gastric contents to enter the peritoneal cavity and thus give rise to diffuse peritonitis [5]. Chronic use of NSAIDs, smoking, alcohol, and H. pylori are important factors in the damage to the mucosa and the development of ulcers; systemic factors (age, diabetes, renal failure, and immune deficiency) may be associated with poor prognosis [6].

These risks are further complicated by late presentation, poor nutritional status and the lack

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of access to healthcare facilities in developing countries such as India, hence early risk stratification and prognostic assessment is very important to achieve the best surgical outcomes. Reliable risk stratification tools help surgeons to place patients into prognostic groups, thus helping to appropriately allocate resources, time surgical interventions, and provide postoperative management. In this regard, there are some scores, which are applied in the clinical practice to predict the outcome of peritonitis and peptic ulcer perforation, among which two are prominent, Modified Boey's Score and the Mannheim Peritonitis Index (MPI) [7]. A new clinical assessment tool, the Modified Boey's Score, includes four simple and readily available pre-perforation parameters: perforation for more than 24 hours, age older than 50 years, presence of comorbid illnesses, and evidence of preoperative shock [8]. This score can be easily calculated at the bedside and thus early identify high-risk patients prior to surgery.

Mannheim Peritonitis Index (1983, Germany) is a more extensive scoring system that includes patient-related and intra-operative parameters such as age, sex, organ failure, malignancy, origin of sepsis and the extent of contamination of the peritoneum [9].

MPI is useful to predict morbidity and mortality in patients with secondary peritonitis, but is being recognized as less clinically usable for bedside assessment in emergencies. It depends on the intraoperative findings which may cause a time lag in early risk estimation and triage of patients who need urgent surgical correction of PPU. Considering the various levels of complexity and application timing of both these scores it is crucial to compare the predictive performance and clinical significance of both scores in terms of outcomes after application. Both have been found to have different performance; some authors reporting higher predictive performance of Modified Boey's Score for death [10], whereas others have reported higher performance of MPI for comprehensive morbidity assessment [10].

Most of the earlier studies, however, have involved mixed populations of peritonitis and their conclusions have been limited to this group. Thus, the present study is designed to compare and assess the prognostic value of Modified Boey's Score and Mannheim Peritonitis Index in predicting the morbidity and mortality among patients with perforated peptic ulcer with diffuse peritonitis. The study aims at helping in the quest to improve outcome prediction and early risk stratification in surgical emergencies related to peptic ulcer perforation by defining which of the scoring systems is more reliable predictor and clinically applicable.

Materials and Methods

Study design

The present study was a prospective observational comparative study to assess and compare the predictive value of Modified Boey's Score and Mannheim Peritonitis Index (MPI) for morbidity and mortality in the patients of perforated peptic ulcer disease with diffuse peritonitis. The aim of this study was to identify the scoring system that was more reliable for predicting prognosis and more clinically useful in a tertiary care surgical intensive care unit. Each case was evaluated according to the standard clinical protocols and both scoring systems were used in each patient for comparison.

Study setting

The study was performed in the department of General Surgery of a tertiary care teaching hospital with a well-established surgical unit

and intensive care facilities.

Study duration

This study was conducted for 5 month (October 2025 to February 2026). This time frame enabled the recruitment of consecutive eligible patients, uniformity of data collection, and sufficient follow-up of the patients after surgery to evaluate their morbidity and mortality related to each scoring system.

Participants

All 50 patients with a clinical diagnosis of perforated peptic ulcer and diffuse peritonitis were studied. Preoperative, postoperative and follow-up evaluations were conducted in all participants.

Inclusion criteria:

1. Patients aged ≥ 18 years diagnosed with perforated gastric or duodenal ulcer confirmed by imaging or intraoperative findings.
2. Patients presenting with clinical and radiological evidence of peritonitis (free gas under diaphragm on X-ray or ultrasound findings).
3. Patients who provided written informed consent to participate in the study.

Exclusion criteria:

1. Patients aged < 12 years.
2. Perforations > 3 cm in diameter or associated with corrosive, malignant, or traumatic causes.
3. Patients with associated injury to other organs or previous gastric surgeries such as pyloroplasty or gastrectomy.
4. Patients with lack of postoperative follow-up or refusal to provide consent.

Study sampling

A consecutive sampling technique was used to include all eligible patients admitted with perforated peptic ulcer during the study period. Each case fulfilling the inclusion criteria was enrolled after obtaining informed consent. No randomization was done as this was an observational study.

Study sample size

A sample size of 50 patients was determined based on feasibility during the study period and when compared to other similar studies published. The number of cases was deemed large enough for statistical exploratory comparison of the two prognostic scoring systems and for preliminary clinical correlation.

Study groups

The enrolled patients were divided in subgroups according to the Modified Boey's Score (MBS) and Mannheim Peritonitis Index (MPI). For Modified Boey's Score, patients were grouped into four categories:

- Group 0: No risk factors (Score 0).
- Group 1: One risk factor (Score 1) 24 48 4.
- Group 2: Two risk factors (Score 2).
- Group 3: Three risk factors (Score 3).

For Mannheim Peritonitis Index, patients were classified according to the total score: o MPI ≤ 17 : Low-risk group MPI > 17 :

High-risk group.

Study parameters

The main parameters that were analyzed were morbidity and mortality associated with Modified Boey's Score and Mannheim Peritonitis Index. Post-operative complications like wound infection, dehiscence, respiratory infection, intraabdominal abscess, paralytic ileus, and renal failure were included as morbidity. Mortality was defined as death within 30 days of surgery.

Other factors like age, sex, comorbidities, length of perforation, shock on admission, and peritoneal contamination were also noted.

Study procedure

The initial management of all those with a diagnosis of acute abdomen and features of peritonitis was to get the patient stabilised with intravenous fluids, nasogastric decompression and broad-spectrum antibiotics. The X-ray of abdomen and ultrasound abdomen were performed after clinical assessment for confirmation of pneumoperitoneum. After making the diagnosis of perforated peptic ulcer, patients underwent emergency exploratory laparotomy. The surgical procedure consisted of locating the perforation, closing with an omental (Graham's) patch, peritoneal lavage with warm saline and a pelvic drain was placed. The size and location of the perforation, contamination and the extent of the organ involvement were documented during the pre-operative phase. Intravenous fluids, antibiotics, analgesics, proton pump inhibitors were given after the surgery. They were closely monitored for signs of wound infection, leakage or sepsis. Pre- and intraoperative Modified Boey's Score and Mannheim Peritonitis Index were both computed for each patient. Scores were noted and correlated with outcomes after surgery.

Study data collection

A structured proforma which involved demographic data, clinical presentation, lab and imaging data, intra-operative observations, and complications in the post-operative period was used to collect the data. The data were manually recorded and then input into a computer database for statistical analysis. Data validity and completeness have been checked on a regular basis.

Data analysis

All statistical analysis were conducted using SPSS, version 21.0 (IBM Corp., Armonk, NY, USA). Data of quantitative variables like age, duration of perforation was shown as mean $\pm$ SD and categorical variables like morbidity and mortality were presented as percentage. Chi square test was used to examine the correlation between the Modified Boey's score and MPI and morbidity and mortality. The predictive ability of both scoring systems was tested by plotting Receiver Operating Characteristic (ROC) curves and determining the Area Under the Curve (AUC). A p value of < 0.05 was deemed statistically significant.

Ethical considerations

The protocol of the study was reviewed and approved by the Institutional Ethics Committee before it was started. Written informed consent was obtained from all participants or legal guardians, who were informed about the purpose, procedures, potential risks and benefits of the study.

Results

The number of patients who were diagnosed with perforated peptic ulcer complicated by diffuse peritonitis were 50. All patients have

Table 1: Sex distribution of study population.

Gender	Parent age	Percentage
Male	4	8
Female	6	1
Total	10	9

Table 2: Risk factors and comorbid conditions.

Risk/Comorbidity	No. of Patients	Percentage (%)
Regular NSAID use	6	12
Smoking	15	30
Alcoholuse	11	22
Diabetes Mellitus	5	10
Hypertension	4	8
CKD/IHD	3	6

Table 3: Duration of perforation before surgery.

Duration of Symptoms	No. of Patients	Percentage (%)
≤ 24 hours	27	54
>24 hours	23	46

Table 4: Site and size of perforation.

Site of perforation	No. of Patients	Percentage (%)	Mean Size (cm)
Duodenal	30	60	0.9
Prepyloric	10	20	0.7
Pyloric	6	12	0.8
Gastric (Body/Antrum)	4	8	1.1

had an exploratory laparotomy and patch repair of the momentum and lavage of the peritoneum. The following sections show the demographic distribution, clinical characteristics and the outcome as a function of Modified Boey's Score and Mannheim Peritonitis Index. The majority of patients (26%) were 41-50 years old, followed by 31-40 years. The mean $\pm$ SD age was 46.2 $\pm$ 13.5 years, which is similar to the epidemiology reported previously that is characterized by a male predominance in middle age. The male/female ratio was around 7:1, which is due to the greater incidence of ulcer perforation in the male, which may be associated with lifestyle factors including alcohol intake, smoking, and use of NSAIDs (Table 1).

Common modifiable risk factors included smoking (30%) and drinking alcohol (22%). The most important comorbidities associated with adverse postoperative outcomes were diabetes and hypertension (Table 2).

In a sub-analysis, almost half (46%) of patients presented after 24 hours of perforation, with this group having increased morbidity and mortality as a result of delayed resuscitation and prolonged peritoneal contamination (Table 3).

Duodenal perforation was the most common (60%) which was similar to the regional pattern of ulcer distribution. Postoperative complications were increased with size of the perforations (> 1cm) (Table 4).

Pre-operative shock was documented in 28% of the cases and this was significantly associated with the postoperative morbidity ($p < 0.05$) (Table 5).

The overall morbidity was 62%, with wound infection as the most

Table 5: Pre-operative clinical parameters.

Parameter	No. of Patients	Percentage (%)
Shock (SBP<100mmHg)	14	28
Fever>38°C	12	24
Tachycardia>100bpm	35	70
Anemia (Hb<10g/dL)	8	16

Table 6: Post-operative complications (morbidity profile).

Complication	No. of Patients	Percentage (%)
Wound infection	12	24
Wound dehiscence	7	14
Respiratory infection/failure	3	6
Intra-abdominal abscess	4	8
Paralyticileus	3	6
Renal failure	1	2
Sutureleak	1	2
Total patients with ≥ 1 complication	31	62

Table 7: Modified Boey's score in relation to morbidity and mortality.

Modified form	No of patients	Morbidity (%)	Mortality (%)
0	7	4.35	0
1	16	31.25	3.12
2	9	88.89	16.67
3	7	57.14	100

Table 8: Mannheim Peritonitis Index (MPI) and outcome.

MPI Range	No. of Patients	Morbidity (%)	Mortality (%)
≤17(Lowrisk)	38	39.47	10.52
>17(Highrisk)	12	83.33	33.33

common postoperative complication, followed by wound dehiscence (Table 6).

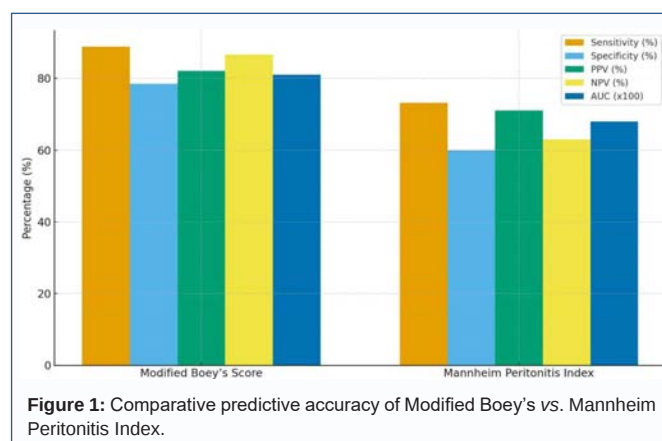
As the Modified Boey's Score got higher, so did the complications increase. There was good correlation between MBS and the postoperative result ($p<0.001$), with mortality at 100% for those with score 3 (Table 7).

There were a significantly high morbidity (83.3%) and mortality (33.3%) in high risk MPI (>17) group. However, its predictive accuracy was relatively lower when compared to Modified Boey's Score (Table 8).

Receiver Operating Characteristic (ROC) analysis revealed that the Modified Boey's Score had the best discriminatory power (AUC=0.81) over the MPI (AUC=0.68) and thus had a better predictive reliability for both morbidity and mortality (Figure 1).

Discussion

Despite advancement in critical care and operative skills, Perforated Peptic Ulcer (PPU) remains one of the most difficult abdominal emergencies for surgeons all over the world, accounting for a high rate of morbidity and mortality. To compare and test the predictive value of Modified Boey's Score and the Mannheim Peritonitis Index (MPI) in predicting postoperative morbidity and mortality in patients who had presented with perforated peptic ulcer and diffuse peritonitis, was the aim of the present prospective study of



50 patients. The age of presentation was 46.2 ± 13.5 years with highest incidence in 41-50-year age group (26%), which is comparable with the mean age of 48.8 ± 13.2 years in their study of 50 patients with ED at a tertiary care center in Bahawalpur, India. There was a significant male predominance with 88% of the patients in our series, as also noted by Shah *et al.*, [11] in their 50-patient study. This is consistent with the epidemiology of PPU as reported by Dani *et al.*, (2015) who reported peritonitis as one of the most common surgical infections in the world, and is often associated with delayed presentation and systemic sepsis [12]. This male predominance is consistent with our study and the other studies in that smoking, alcohol use, and the use of Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) are all associated with the risk of mucosal damage and perforation of ulcers. Smoking (30%), alcohol use (22%) and taking NSAIDs (12%) were frequent precipitating factors in the present study.

The other comorbidities, diabetes mellitus (10%) and hypertension (8%) were also common, which add to the postoperative risks. These findings were similar to that observed by Shah *et al.*, [11] who reported that out of 50 patients, 18 patients presented in preoperative shock of which 77.78% developed postoperative complications and 38.89% died postoperatively. Overall, the morbidity rate (62%) and mortality rate (14%) in our study are within the range of the above studies. In our population, the Modified Boey's Score was able to clearly distinguish the patients as to the prognostic groups with mortality rates of 0%, 3.12%, 16.67%, and 100% for the scores of 0, 1, 2, and 3 respectively while the morbidity rates of 4.35%, 31.25%, 88.89%, and 57.14% respectively.

These findings are comparable to Shah *et al.*, [11] whose findings showed a near identical percentage and a good linear relationship when increasing Boey score and adverse outcome are compared. Both studies found that the Modified Boey's Score was a more accurate and practical assessment than the MPI and the results were statistically significant on the ROC curve ($p<0.001$). It is interesting to compare the results of our study with those of Sazhin *et al.*, [13]. In the above large multicentre retrospective study of 153 patients performed in the surgical clinics of Pirogov Russian National Research Medical University, six prognostic scoring systems were assessed: Modified Boey (mBoey), Boey, Peptic Ulcer Perforation (PULP), ASA (American Society of Anesthesiology), MPI (Mortality Prediction Index), and WSES Sepsis Severity Score [3]. All models showed good levels of predictive power, with the best results obtained by the modified Boey (mBoey) model (which added an age factor) for both morbidity (AUC 0.932) and mortality (AUC 0.943).

The original Boey score, PULP and ASA were also classified as “excellent”, with the WSES SSS and MPI having a lower level of discrimination. The results indicate that the age explicitly added to the Boey system improves its prognostic ability. Our results confirm this finding, with the Modified Boey's Score (AUC 0.81) being more accurate than MPI (AUC 0.68), indicating that the standard preoperative use of the Boey is still a better predictor. In further versions of the score, predictive accuracy could be further improved by adding an age parameter as suggested by Sazhin *et al.* The PULP, MPI, ASA, and Jabalpur Score (JS) [14] was compared using several scoring systems in an observational study of 45 patients suffering from surgically treated PPU at the Karnataka Institute of Medical Sciences, Hubli, India [14]. When they compared the accuracy of their prediction of mortality, they found that the MPI and JS were the most accurate ($p < 0.001$ and 0.007 , respectively), while the PULP score showed higher accuracy in predicting postoperative complications ($p = 0.047$).

The author found that use of MPI is beneficial for determining the severity of peritonitis in the acute phase and to select high-risk patients, especially in trials conducted in resource-limited environments. These results partially confirmed the results of this study as the Modified Boey's Score had higher sensitivity (88.9%) and specificity (78.5%), whereas MPI (cutoff > 17) had higher sensitivity (73.2%) and lower specificity (60%). Therefore, the advantage of using MPI will still be useful if the patient is seen to have severe intra-abdominal sepsis, but because of the complexity of this system and the requirement of the intraoperative findings, it is less useful in the preoperative period than the Modified Boey's Score. 43 Wijaya *et al.*, [15] retrospectively compared the predictive value of MPI and Boey Score among 31 patients who underwent laparotomy for gastric perforation in a tertiary hospital in Indonesia [15]. Their cohort had a median age of 62 years, which is significantly older than in our study (46 years), indicative of the shift towards an older presentation in Southeast Asia. The majority of patients were late children (> 24 hours, 90.3%) and 48.4% had preoperative shock which is comparable to this study's 28%. Wijaya *et al.* determined an optimal MPI cutoff ≥ 22 with sensitivity 87.5%, specificity 40%, and accuracy 74.19%. Sensitivity and specificities for Boey score (cutoff ≥ 2) were 75% and 53.3%, respectively. MPI has been more sensitive in detecting high-risk patients, but it was less specific, resulting in lower accuracy of mortality prediction.

The author concluded that MPI is beneficial for the identification of high-risk cases, whereas the simpler Boey Score is still helpful to provide initial assessment in a rapid manner [15]. Similar results have been obtained in our study: both systems proved to be predictive but the Modified Boey's Score can be used preoperatively and is more clinically usable. The AUC for Boey (0.81) was comparable with those obtained by Wijaya *et al.*, (2012) (AUC 0.84 for Boey and 0.68 for MPI) and indicate that Boey's predictive balance of sensitivity and specificity is the superior method. The allure of the Boey framework in both its standard and modified forms is that both include parameters which reflect the disease process as well as physiological derangement (shock, comorbidities). Age is further shown to improve prediction accuracy as emphasised by Sazhin *et al.*, [13], which could be relevant in environments experiencing ageing populations. In a similar fashion, Koranne *et al.*, [14] and Wijaya *et al.*, [15] showed that MPI has merit as a surgical risk assessment tool after laparotomy, but it is not as easy to use and bedside applicable as the Boey system. From an overall perspective on morbidity and mortality trends in these

studies, our results are consistent with the global data.

The overall morbidity was found to be 62% in our study, similar to the result obtained by Shah *et al.*, [11] and comparable to the range of the morbidity of bacterial peritonitis patients obtained by Dani *et al.*, [12]. The mortality rate in our cohort was slightly lower (14%) than reported by Koranne *et al.*, [14] (15.5%) and Wijaya *et al.*, [15] (16%), possibly because of smaller perforation sizes (mean 0.9 cm) and the surgical intervention that was performed at an earlier stage. Importantly, the Modified Boey's Score correctly predicted mortality escalation with increasing scores, and mortality was perfect (100%) at score 3. This discovery mirrors Shah *et al.*, [11] where mortality also was 100% for patients with a score of

Conclusion

It was observed that Modified Boey's Score is a simpler, faster and more accurate scoring system than the Mannheim Peritonitis Index for prediction of morbidity and mortality in patients with diffuse peritonitis due to perforated peptic ulcer. The morbidity and mortality in this study were found to be proportional with the increasing Boey score, which highlights the strong correlation between Boey score and the severity of disease and postoperative results. The Modified Boey's Score had a higher predictive accuracy than MPI in Receiver Operating Characteristic (ROC) analysis. The Modified Boey's Score is an easy-to-use pre-operative risk assessment tool that will be useful to counsel the patient in an emergency surgical situation and to plan their surgery and recovery effectively.

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