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Original Research Article

Accuracy of Scoring Systems for Outcome Prediction of Patients with Peritonitis

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Abstract:

Introduction: Perforation peritonitis is a life-threatening surgical emergency associated with high morbidity and mortality. Early risk stratification using reliable scoring systems is essential for predicting outcomes and guiding management. The Elebute–Stoner grading of sepsis and Mannheim Peritonitis Index (MPI) are commonly used tools, but their comparative accuracy remains inadequately studied. Aim of the study was to evaluate and compare the accuracy of Elebute–Stoner grading of sepsis and Mannheim Peritonitis Index in predicting clinical outcomes in patients with perforation peritonitis.

Material and Methods: This hospital-based observational study included 50 patients aged ≥18 years diagnosed with perforation peritonitis over an 18-month period. Clinical, laboratory, radiological, and intraoperative data were recorded. Each patient was assessed using Elebute–Stoner grading and MPI. Outcomes measured included mortality, postoperative complications, and length of hospital stay. Statistical analysis included sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy.

Results: The majority of patients were males (76%) and aged 31–40 years (28%). Mortality rate was 22%, with postoperative complications in 36% of patients. Mean Elebute–Stoner score was significantly higher in non-survivors (23.8 ± 3.6) compared to survivors (14.2 ± 3.1) (p=0.001). Similarly, MPI scores were higher in non-survivors (32.4 ± 4.8 vs 20.6 ± 4.2; p=0.001). Elebute–Stoner grading demonstrated higher sensitivity (81.8%), specificity (87.2%), and accuracy (86%) compared to MPI (72.7%, 82.1%, and 80%, respectively).

Conclusion: Both Elebute–Stoner grading and MPI are effective predictors of outcomes in perforation peritonitis. However, Elebute–Stoner grading showed marginally superior diagnostic performance and can serve as a simple and reliable bedside tool for early risk stratification.

Keywords: Perforation peritonitis; Mannheim Peritonitis Index; Elebute–Stoner grading; Sepsis scoring; Mortality prediction; Surgical outcomes.

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Introduction

Peritonitis, defined as inflammation of the peritoneal cavity, remains one of the most serious surgical emergencies encountered in general surgery. Among its various etiologies, perforation peritonitis is particularly associated with significant morbidity and mortality, especially in developing countries like India, where delayed presentation, sepsis, and limited access to healthcare facilities contribute to poor outcomes. Despite advances in antimicrobial therapy, imaging modalities, anesthesia, and intensive care management, the mortality rate of perforation peritonitis continues to range between 10% and 40%, depending on severity, comorbidities, and timeliness of intervention [1].

The clinical course of peritonitis is highly variable and influenced by several factors including age, source of infection, extent of contamination, duration before surgical intervention, and host immune response. This heterogeneity necessitates the use of reliable prognostic scoring systems that can objectively assess disease severity, predict outcomes, and guide clinical decision-making. Early identification of high-risk patients is crucial for optimizing management strategies, including aggressive resuscitation, timely surgical intervention, and intensive postoperative care [2].

Several scoring systems have been developed over the years to stratify risk in patients with intra-abdominal infections. Among them, the Elebute–

Stoner grading of sepsis is a relatively simple clinical scoring system based on physiological parameters and clinical assessment of sepsis severity. It classifies patients into mild, moderate, and severe sepsis categories, providing a rapid bedside evaluation tool. However, its utility in predicting outcomes specifically in perforation peritonitis has not been extensively validated across diverse patient populations [3].

On the other hand, the Mannheim Peritonitis Index (MPI), developed in Mannheim, is one of the most widely used scoring systems for peritonitis. It incorporates both clinical and intraoperative findings such as age, organ failure, malignancy, duration of peritonitis, origin of sepsis, extent of peritoneal contamination, and character of exudate. MPI has been shown to be simple, reproducible, and effective in predicting mortality, with higher scores correlating strongly with worse outcomes (4). Several studies have validated MPI as a reliable prognostic indicator; however, variations in cut-off values and predictive accuracy across different populations have been reported [5].

Previous studies comparing various scoring systems, including MPI, Acute Physiology and Chronic Health Evaluation (APACHE II), and Sequential Organ Failure Assessment (SOFA), have demonstrated that while complex scoring systems may offer high predictive accuracy, they are often impractical in emergency settings due to the need for extensive laboratory data and calculations (6). In contrast, simpler scoring systems like MPI and Elebute–Stoner grading may offer a balance between ease of use and clinical utility, particularly in resource-limited settings [7].

Despite the availability of these scoring systems, there remains a lack of consensus regarding the most appropriate and accurate tool for predicting outcomes in perforation peritonitis. Moreover, limited studies have directly compared Elebute–Stoner grading with MPI in the same cohort of patients, especially in the Indian clinical context. This represents a significant research gap, as population-specific factors such as delayed presentation, nutritional status, and spectrum of etiologies may influence the performance of these scoring systems [8].

Additionally, most existing studies focus primarily on mortality as the outcome measure, with relatively less emphasis on morbidity indicators such as postoperative complications, length of hospital stay, and need for intensive care. A comprehensive evaluation incorporating both mortality and morbidity outcomes is essential to fully understand the prognostic utility of these scoring systems [9]. Therefore, the present study is undertaken to evaluate and compare the accuracy of Elebute–Stoner grading of sepsis and Mannheim Peritonitis Index in predicting clinical outcomes in patients with perforation peritonitis. The study also aims to analyze the demographic and clinical profile of patients, assess the relationship between clinical, laboratory, radiological, and operative findings with outcomes, and determine key statistical measures such as sensitivity, specificity, and predictive values. By identifying the most reliable and practical scoring system, this study seeks to facilitate early risk stratification and improve clinical decision-making, ultimately contributing to better patient outcomes in perforation peritonitis [10].

Material and Methods

Study Design and Setting: This study was conducted as a hospital-based observational study in the Surgical Intensive Care Unit (ICU) of a tertiary care center. The study was carried out over a period of 18 months with sample size of 50 patients All eligible patients admitted with a diagnosis of perforation peritonitis during the study period were included.

Study Population: The study population consisted of adult patients presenting with clinical features suggestive of perforation peritonitis. Diagnosis was based on clinical signs such as abdominal tenderness, guarding, rigidity, and rebound tenderness, along with radiological evidence like the presence of free air under the diaphragm on X-ray.

Inclusion Criteria

- Patients aged 18 years and above
- Patients diagnosed with spontaneous perforation peritonitis
- Patients with isolated traumatic perforation peritonitis
- Patients presenting with classical clinical features of peritonitis and radiological confirmation

Exclusion Criteria

- Patients below 18 years of age
- Patients with peritonitis due to causes other than perforation (e.g., chemotherapy-induced or disseminated malignancy)
- Iatrogenic peritonitis cases
- Patients with traumatic perforation peritonitis associated with multiple organ injuries

Study Tools

The following prognostic scoring systems were utilized for assessment:

- Elebute–Stoner grading of sepsis
- Mannheim Peritonitis Index (MPI)

These tools were applied to each patient to evaluate disease severity and predict clinical outcomes, including morbidity and mortality.

Data Collection: Data collection was performed systematically for all enrolled patients using a structured proforma:

Clinical History

- Age, sex
- Presenting symptoms
- Duration of symptoms prior to hospital admission

Clinical Examination

- General physical examination
- Vital parameters (pulse, blood pressure, temperature, respiratory rate)
- Detailed systemic examination

Investigations

- Routine hematological and biochemical investigations
- Radiological investigations including X-ray abdomen

Operative Findings

- All patients underwent laparotomy after stabilization
- Intraoperative findings such as site of perforation, extent of contamination, and nature of peritoneal fluid were recorded

Scoring Assessment

- Each patient was assigned scores based on Elebute–Stoner grading and Mannheim Peritonitis Index

Follow-up and Outcome Assessment

- Patients were monitored throughout their hospital stay
- Postoperative recovery and complications were documented
- Length of hospital stay was recorded as an indicator of morbidity
- Mortality, if any, was noted along with the cause of death

Outcome Comparison: Predicted outcomes based on scoring systems were compared with actual clinical outcomes

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using appropriate statistical software (SPSS V 22.0).

Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The predictive performance of the scoring systems was evaluated using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. Association between scoring categories and outcomes such as mortality, morbidity, and hospital stay was assessed using appropriate statistical tests. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1: Age and Gender Distribution of Study Population (n = 50)

Variable	Category	Number (N)	Percentage (%)
Age (years)	18–30	12	24.0
	31–40	14	28.0
	41–55	13	26.0
	56–65	7	14.0
	>65	4	8.0
Gender	Male	38	76.0
	Female	12	24.0

The table 1 depicts the demographic profile of patients included in the study.

The majority of patients belonged to the younger and middle-aged groups, with the highest proportion in the 31–40 years age group (28%), followed by 41–55 years (26%) and 18–30 years (24%). Patients above 65 years constituted the smallest group (8%). This distribution indicates that perforation peritonitis predominantly affects individuals in the economically productive age group. A marked male predominance was observed, with males accounting for 76% of cases compared to 24% females, suggesting higher exposure to risk factors such as peptic ulcer disease, smoking, and delayed healthcare-seeking behavior among males.

Table 2: Clinical Presentation and Physiological Status at Admission (n = 50)

Parameter	Category	N (%)
Key symptoms	Pain abdomen	50 (100)
	Abdominal distension	36 (72)
	Vomiting	34 (68)
	Fever	31 (62)
	Constipation	28 (56)
Neurological status	GCS ≥15	30 (60)
	GCS <15	20 (40)
Hemodynamic status	Stable (normotensive)	33 (66)

	Shock (hypotension/non-recordable)	17 (34)
Tachycardia (>100 bpm)	Present	27 (54)
	Absent	23 (46)
Jaundice	Present	6 (12)
	Absent	44 (88)

The table 2 summarizes the clinical presentation and physiological status of patients at admission. Abdominal pain was the universal presenting symptom (100%), followed by abdominal distension (72%), vomiting (68%), fever (62%), and constipation (56%), reflecting the classical presentation of perforation peritonitis. Neurological assessment showed that 60% of patients had a normal Glasgow Coma Scale (GCS ≥15), while 40% had altered sensorium (GCS <15), indicating varying degrees of systemic involvement. Hemodynamic evaluation revealed that 66% of patients were stable at presentation, whereas 34% were in shock, highlighting the severity of sepsis in a significant proportion. Tachycardia was observed in 54% of patients, consistent with systemic inflammatory response, while jaundice was present in 12% of cases, suggesting possible hepatic dysfunction or advanced disease.

Table 3: Clinical Severity, Laboratory and Radiological Profile (n = 50)

Parameter	Category	N (%)
Abdominal signs	Diffuse peritonitis (diffuse tenderness/rigidity)	36 (72)
	Localized tenderness	14 (28)
Intraperitoneal fluid	None	10 (20)
	Minimal	24 (48)
	Massive	16 (32)
Leukocytosis	>10,000 cells/mm³	44 (88)
	Normal	6 (12)
Renal dysfunction	Present (Cr >1.5 mg/dL)	22 (44)
	Absent	28 (56)
Metabolic acidosis (ABG)	Present	29 (58)
	Absent	21 (42)
Radiological findings	Pneumoperitoneum (X-ray)	39 (78)
	Other findings	11 (22)
USG findings	Dilated bowel loops	30 (60)
	Fluid collection	20 (40)

The table 3 demonstrates the severity of disease based on abdominal findings, laboratory parameters, and radiological evaluation.

A majority of patients (72%) presented with features of diffuse peritonitis, indicating advanced intra-abdominal infection, while 28% had localized tenderness. Intraperitoneal fluid was present in 80% of patients, with minimal fluid in 48% and massive collections in 32%, reflecting varying degrees of peritoneal contamination. Laboratory findings revealed leukocytosis in 88% of patients, suggesting a strong systemic inflammatory response. Renal dysfunction was observed in 44% of cases, indicating significant organ involvement. Metabolic acidosis was present in 58% of patients, further emphasizing the severity of sepsis and physiological derangement.

Radiologically, pneumoperitoneum was detected in 78% of cases on X-ray, confirming perforation, while ultrasonography showed dilated bowel loops in 60% and intra-abdominal fluid collections in 40% of patients.

Table 4: Operative Findings and Intraoperative Severity (n = 50)

Parameter	Category	N (%)
Extent of peritonitis	Generalized (gross/suppurative)	36 (72)
	Localized (inter-loop)	14 (28)
Type of exudate	Clear	8 (16)
	Purulent/Feculent	42 (84)
Bowel viability	Normal	27 (54)
	Gangrenous (segmental/massive)	23 (46)
Intraoperative instability	Present (hypotension/cardiac arrest)	19 (38)
	Absent	31 (62)
Duration of surgery	≤3 hours	35 (70)
	>3 hours	15 (30)

The table 4 outlines the intraoperative findings reflecting the severity of peritonitis and surgical course. A majority of patients (72%) had generalized peritonitis, while 28% had localized disease, indicating that most cases presented at an advanced stage.

The nature of exudate was predominantly purulent or feculent in 84% of patients, suggesting severe contamination and infection, whereas only 16% had clear fluid. Assessment of bowel viability showed that 46% of patients had gangrenous changes, highlighting significant ischemic damage and delayed presentation. Intraoperative instability, including hypotension or cardiac arrest, was observed in 38% of patients, indicating severe systemic compromise during surgery.

Regarding operative duration, most surgeries (70%) were completed within 3 hours, while 30% extended beyond 3 hours, likely reflecting increased complexity and severity of intra-abdominal pathology.

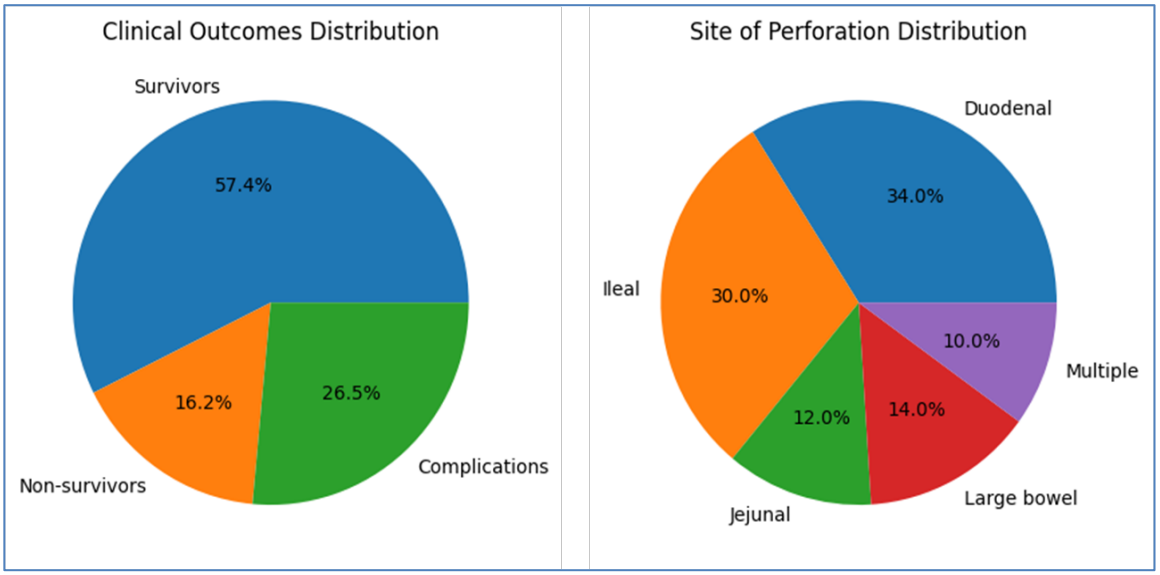

Figure 1: Site of Perforation and Clinical Outcomes (n = 50)

Mean hospital stay: 9.6 ± 3.8 days

The figure 1 presents the distribution of perforation sites along with clinical outcomes.

The most common site of perforation was the duodenum (34%), followed by the ileum (30%), indicating that upper gastrointestinal perforations were slightly more prevalent in this study population. Jejunal (12%), large bowel (14%), and multiple perforations (10%) were less frequently observed. In terms of outcomes, the majority of patients survived (78%), while the mortality rate was 22%, reflecting the serious nature of perforation peritonitis. Postoperative complications were noted in 36% of patients, indicating a considerable burden of morbidity even among survivors.

Table 5: Comparison of Scoring Systems with Clinical Outcomes (n = 50)

Scoring System	Outcome	Mean ± SD	p-value
Elebute–Stoner	Survivors	14.2 ± 3.1	0.001
	Non-survivors	23.8 ± 3.6	
MPI	Survivors	20.6 ± 4.2	0.001
	Non-survivors	32.4 ± 4.8	

The table 5 compares the mean scores of Elebute–Stoner grading and Mannheim Peritonitis Index (MPI) between survivors and non-survivors.

For both scoring systems, significantly higher mean scores were observed in non-survivors compared to survivors. The mean Elebute–Stoner score was 14.2 ± 3.1 among survivors and increased markedly to 23.8 ± 3.6 in non-survivors. Similarly, the mean MPI score was 20.6 ± 4.2 in survivors and 32.4 ± 4.8 in non-survivors.

The differences in scores between the two outcome groups were statistically significant ($p = 0.001$), indicating a strong association between higher scores and increased mortality.

Table 6: Diagnostic Performance of Scoring Systems in Predicting Outcomes (n = 50)

Parameter	Elebute–Stoner (%)	MPI (%)
Sensitivity	81.8	72.7
Specificity	87.2	82.1
PPV	69.2	61.5
NPV	92.3	88.6
Accuracy	86.0	80.0

The table 6 summarizes the diagnostic performance of Elebute–Stoner grading and Mannheim Peritonitis Index (MPI) in predicting clinical outcomes. Elebute–Stoner grading demonstrated higher sensitivity (81.8%) compared to MPI (72.7%), indicating better ability to correctly identify patients at risk of mortality. Similarly, specificity was higher for Elebute–Stoner (87.2%) than MPI (82.1%), reflecting improved accuracy in identifying survivors.

Positive predictive value (PPV) and negative predictive value (NPV) were also superior with Elebute–Stoner grading (69.2% and 92.3%, respectively) compared to MPI (61.5% and 88.6%). Notably, the high NPV of both scoring systems suggests their usefulness in ruling out mortality in low-risk patients.

Discussion

Perforation peritonitis continues to be a major surgical emergency associated with significant morbidity and mortality despite advances in surgical and critical care management. The present study evaluated the prognostic accuracy of Elebute–Stoner grading of sepsis and Mannheim Peritonitis Index (MPI) in predicting clinical outcomes in 50 patients with perforation peritonitis. The findings of this study provide important insights into patient demographics, clinical presentation, operative findings, and the comparative effectiveness of these scoring systems.

In the present study, the majority of patients belonged to the younger and middle-aged groups, with the highest incidence in the 31–40 years age group (28%), followed by 41–55 years (26%). This observation is consistent with studies from developing countries, where perforation peritonitis commonly affects younger individuals due to higher prevalence of infectious etiologies and delayed healthcare access.

Similar age distributions have been reported by Sharma et al. [8] and Singh et al. [9], highlighting that the disease burden is more prominent in economically productive age groups. Male predominance (76%) observed in this study is also consistent with earlier reports, possibly due to higher exposure to risk factors such as smoking, alcohol consumption, and peptic ulcer disease [11].

Clinically, all patients presented with abdominal pain (100%), followed by abdominal distension (72%), vomiting (68%), and fever (62%). These findings are in agreement with classical descriptions of perforation peritonitis and are comparable to those reported by Malik et al. [10] and Jhobta et al. [11]. The mean duration of symptoms before presentation was 2.8 ± 1.4 days, indicating delayed presentation, which is a critical determinant of disease severity and outcome. Delayed presentation has been consistently associated with increased risk of sepsis, organ dysfunction, and mortality, as emphasized in previous studies [12].

On general examination, a significant proportion of patients presented with hemodynamic instability and altered sensorium. Approximately 34% of patients were in shock at admission, and 40% had a Glasgow Coma Scale (GCS) score less than 15. These findings reflect the systemic impact of sepsis and correlate with poor prognosis. Similar associations between hypotension, altered mental status, and adverse outcomes have been reported by Bohnen et al. [7] and later studies [13]. Tachycardia (>100 bpm) observed in 54% of patients further underscores the presence of systemic inflammatory response.

Laboratory parameters revealed leukocytosis in 88% of patients, renal dysfunction in 44%, and metabolic acidosis in 58%. These parameters are well-established markers of sepsis severity and organ dysfunction. Previous studies have demonstrated that elevated total leukocyte count, deranged renal function, and metabolic acidosis are significant predictors of mortality in peritonitis [14]. The presence of pneumoperitoneum in 78% of cases on abdominal X-ray confirms its diagnostic utility, while ultrasonography findings of dilated bowel loops and fluid collections further supported the diagnosis.

Operative findings in the present study showed that 72% of patients had generalized peritonitis, with purulent or feculent exudate in 84% of cases. Bowel gangrene was observed in 46% of patients, indicating advanced disease at presentation. These findings are comparable to those reported by Billing et al. [5], who highlighted the extent of contamination and nature of exudate as strong predictors of outcome. Intraoperative instability was noted in 38% of patients, further reflecting the severity of illness and its impact on surgical outcomes.

The most common site of perforation in this study was the duodenum (34%), followed by ileum (30%), which is consistent with patterns observed in developing countries. This contrasts with Western studies, where colonic perforations are more common [15]. The overall mortality rate in the present study was 22%, which falls within the reported range of 10–40% in literature [1]. Postoperative complications were observed in 36% of patients, indicating significant morbidity associated with the condition.

A key objective of the study was to evaluate the predictive accuracy of Elebute–Stoner grading and MPI. The mean Elebute–Stoner score among non-survivors (23.8 ± 3.6) was significantly higher than that of survivors (14.2 ± 3.1), with a p-value of 0.001. Similarly, MPI scores were significantly higher in non-survivors (32.4 ± 4.8) compared to survivors (20.6 ± 4.2). These findings are consistent with earlier studies validating MPI as a reliable predictor of mortality [4,5].

In terms of diagnostic performance, Elebute–Stoner grading demonstrated higher sensitivity (81.8%), specificity (87.2%), and overall accuracy (86%) compared to MPI (sensitivity 72.7%, specificity 82.1%, and accuracy 80%). This suggests that Elebute–Stoner grading may have a slight advantage in predicting outcomes in this patient population. While MPI has been widely studied and validated, fewer studies have evaluated Elebute–Stoner grading, making this comparison particularly valuable. Similar findings have been reported by Singh et al. [9], who noted that simpler scoring systems may perform comparably or even better than complex indices in certain settings.

The ability of both scoring systems to stratify patients into risk categories is clinically significant. Higher scores correlated strongly with increased mortality, morbidity, and prolonged hospital stay. This supports the use of these scoring systems for early identification of high-risk patients, allowing timely intervention and improved resource allocation. Previous studies have emphasized the importance of early risk stratification in improving outcomes in peritonitis [16].

However, the present study has certain limitations. Being a single-center study with a relatively small sample size, the findings may not be generalizable to all populations. Additionally, variations in management protocols and patient characteristics may influence outcomes. Despite these limitations, the study provides valuable comparative data on two widely used scoring systems in a real-world clinical setting.

Conclusion

The present study demonstrates that both Elebute–Stoner grading of sepsis and Mannheim Peritonitis Index are effective tools for predicting mortality and morbidity in patients with perforation peritonitis. Both scoring systems showed a significant correlation with clinical outcomes, with higher scores associated with increased mortality, complications, and longer hospital stay.

However, Elebute–Stoner grading exhibited marginally superior sensitivity, specificity, and overall accuracy compared to MPI in this study. Its simplicity and ease of application make it a valuable bedside tool, especially in resource-limited settings. MPI, on the other hand, remains a robust and well-validated scoring system incorporating intraoperative findings.

Early application of these scoring systems can aid in prompt identification of high-risk patients, enabling timely surgical intervention and intensive care management, ultimately improving patient outcomes.

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