Section: Cardiothoracic Surgery

Original Research Article

VALIDATION OF THE MANNHEIM PERITONITIS INDEX FOR PREDICTING MORTALITY IN SECONDARY PERITONITIS: A PROSPECTIVE OBSERVATIONAL STUDY FROM A TERTIARY CARE TEACHING HOSPITAL IN INDIA

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ABSTRACT

Background: Secondary peritonitis is one of the most common life-threatening surgical emergencies encountered worldwide. Despite major advances in surgical techniques, antimicrobial therapy, anaesthesia, and intensive care medicine, mortality remains high, particularly among patients presenting with delayed diagnosis, extensive peritoneal contamination, and sepsis. Objectives: To evaluate the prognostic accuracy of the Mannheim Peritonitis Index in predicting mortality among patients with secondary peritonitis and to analyse the relationship between MPI score, postoperative complications, and clinical outcome. **Materials and Methods:** This prospective observational study was conducted over a two-year period from January 2007 to January 2009 in the Department of General Surgery, Government Wenlock Hospital, Kasturba Medical College, Mangalore, Karnataka, India. **Results:** In this prospective observational study, increasing MPI scores demonstrated a strong association with mortality. Patients with MPI scores below 21 had excellent survival, whereas mortality increased dramatically among patients with scores of 30 or greater. An MPI score greater than 26 accurately identified patients at high risk of death. **Conclusion:** The findings of this study support the routine use of the Mannheim Peritonitis Index as an effective bedside prognostic tool in the management of secondary peritonitis, particularly in resource-limited healthcare settings.
Keywords: Mannheim Peritonitis Index, Mortality, Secondary Peritonitis.

INTRODUCTION

Secondary peritonitis is one of the most common life-threatening surgical emergencies encountered worldwide. Despite major advances in surgical techniques, antimicrobial therapy, anaesthesia, and intensive care medicine, mortality remains high, particularly among patients presenting with delayed diagnosis, extensive peritoneal contamination, and sepsis. Early identification of high-risk patients is essential for optimizing perioperative management, improving clinical decision-making, and ensuring appropriate utilization of intensive care resources. Several prognostic scoring systems have been proposed for risk stratification in patients with secondary peritonitis. Among these, the Mannheim Peritonitis Index (MPI) has gained widespread acceptance because it combines simple clinical and intraoperative variables that are readily available during emergency surgery and provides an objective estimate of mortality risk. Aim: To evaluate the prognostic accuracy of the Mannheim Peritonitis Index in predicting mortality among patients with secondary peritonitis and to analyse the relationship between MPI score, postoperative complications, and clinical outcome.

MATERIALS AND METHODS

Study Design: This prospective observational study was conducted over a two-year period from **January 2007 to January 2009** in the Department of General Surgery, Government Wenlock Hospital, Kasturba Medical College, Mangalore, Karnataka, India. The study was designed to evaluate the prognostic accuracy of the Mannheim Peritonitis Index (MPI) in predicting mortality among patients presenting with secondary peritonitis. Government Wenlock Hospital is a tertiary referral teaching hospital that caters to patients from coastal Karnataka and neighbouring regions, receiving a large number of emergency surgical admissions involving gastrointestinal perforations and diffuse peritonitis. **Study Population:** A total of **60 consecutive patients** diagnosed with secondary peritonitis and undergoing emergency laparotomy were prospectively enrolled.

Secondary peritonitis was diagnosed based on:

- Clinical presentation
- Physical examination
- Radiological investigations
- Operative findings

Only patients with surgically confirmed secondary peritonitis were included.

Inclusion Criteria

Patients fulfilling all of the following criteria were included:

- Age ≥18 years
- Secondary peritonitis due to hollow viscus perforation
- Emergency exploratory laparotomy
- Intraoperative confirmation of secondary peritonitis
- Willingness to participate in the study

Exclusion Criteria

The following patients were excluded:

- Primary bacterial peritonitis
- Traumatic hollow viscus perforation
- Tertiary (postoperative) peritonitis
- Patients managed conservatively
- Patients with incomplete clinical records

Clinical Evaluation

A detailed clinical history was obtained from every patient regarding:

- Duration of abdominal pain
- Vomiting
- Fever
- Abdominal distension
- Constipation
- Previous abdominal surgery
- History of peptic ulcer disease
- Smoking
- Alcohol intake
- Drug history
- Associated medical illnesses

General examination included:

- Temperature
- Pulse
- Blood pressure
- Respiratory rate
- Hydration status
- Pallor
- Icterus
- Cyanosis

Systemic examination included assessment for evidence of:

- Septic shock
- Organ failure
- Respiratory distress

Abdominal examination assessed:

- Tenderness
- Guarding
- Rigidity
- Rebound tenderness
- Bowel sounds
- Abdominal distension

Laboratory Investigations

All patients underwent routine laboratory evaluation including:

- Complete blood count
- Blood grouping and cross-matching
- Random blood sugar
- Blood urea
- Serum creatinine
- Serum electrolytes
- Liver function tests
- Urine examination

Radiological Evaluation

All patients underwent:

- Plain erect chest radiograph
- Plain abdominal radiograph

Ultrasonography of the abdomen was performed whenever indicated to identify free intraperitoneal fluid or associated intra-abdominal pathology.

Preoperative Management

All patients received standardized preoperative resuscitation including:

- Intravenous crystalloid fluids
- Electrolyte correction
- Nasogastric decompression
- Urinary catheterization
- Broad-spectrum intravenous antibiotics
- Analgesics

Patients with septic shock underwent aggressive haemodynamic stabilization before surgery whenever feasible.

Operative Procedure

mergency exploratory laparotomy was performed under general anaesthesia.

The operative procedure depended upon:

- Etiology
- Site of perforation
- Degree of contamination
- General condition of the patient

Common procedures performed included:

- Graham's omental patch repair
- Primary closure of perforation
- Segmental bowel resection with primary anastomosis
- Right hemicolectomy
- Left hemicolectomy
- Total colectomy
- Diversion stoma whenever indicated

After definitive surgery, the peritoneal cavity was thoroughly irrigated with warm normal saline and drains were placed according to operative findings.

Mannheim Peritonitis Index

The Mannheim Peritonitis Index was calculated intraoperatively for every patient according to the original description by Wacha et al.

The score comprises eight prognostic variables.

Table 1: Mannheim Peritonitis Index Variables

Variable	Score
Age >50 years	5
Female sex	5
Organ failure	7
Malignancy	4
Duration of peritonitis >24 hours	4
Non-colonic origin of sepsis	4
Diffuse generalized peritonitis	6
Clear exudate	0
Purulent exudate	6
Faecal exudate	12

Maximum possible score = **47**

Patients were stratified into three groups:

- MPI <21
- MPI 21–29
- MPI ≥30

A second analysis was performed using the established cut-off value of **26**.

Outcome Measures

Primary Outcome

- In-hospital mortality

Secondary Outcomes

- Surgical site infection
- Respiratory tract infection
- Septicaemia
- Burst abdomen
- Enterocutaneous fistula
- Length of hospital stay
- Requirement for bowel resection

Statistical Analysis

Data were analysed using the **Statistical Package for Social Sciences (SPSS)**.

Continuous variables were expressed as **mean ± standard deviation**, whereas categorical variables were presented as **frequency and percentage**.

Associations between MPI categories and mortality were analysed using the **Chi-square test**.

dds ratios were calculated where appropriate.

A **p-value <0.05** was considered statistically significant.

RESULTS

Baseline Characteristics

A total of **60 patients** were included.

The mean age was **44.3 ± 17.3 years** (range: 18–80 years).

The largest proportion of patients belonged to the **21–30-year** age group.

There was a marked male predominance, with **48 males (80%)** and **12 females (20%)**, giving a male-to-female ratio of **4:1**.

Table 2: Baseline Characteristics

Characteristic	Value
Total patients	60
Mean age (years)	44.3 ± 17.3
Age range	18–80
Male	48 (80%)
Female	12 (20%)

Etiology of Secondary Peritonitis

Duodenal perforation was the commonest cause of secondary peritonitis, accounting for **30%** of all patients.

Table 3: Etiology

Cause	n (%)
Duodenal perforation	18 (30.0)
Ileal perforation	12 (20.0)
Gastric perforation	10 (16.7)
Appendicular perforation	6 (10.0)
Jejunal perforation	5 (8.3)
Colonic perforation	4 (6.7)

Gangrenous bowel	3 (5.0)
Anastomotic leak	2 (3.3)

Duodenal, ileal and gastric perforations together accounted for nearly two-thirds of all cases.

Clinical Presentation

Every patient presented with abdominal pain and generalized peritonitis.

The common presenting features were:

- Abdominal pain (100%)
- Tenderness (100%)
- Guarding
- Rigidity
- Vomiting
- Fever
- Abdominal distension

Patients presenting after more than 24 hours from symptom onset generally had higher MPI scores and poorer outcomes.

Operative Procedures

The operative procedure depended upon the site and pathology of perforation.

The common operations performed were:

- Graham's omental patch repair
- Primary closure
- Segmental bowel resection with anastomosis
- Right hemicolectomy
- Left hemicolectomy
- Total colectomy

All patients underwent generous peritoneal lavage before abdominal closure.

Mannheim Peritonitis Index Distribution

MPI scores ranged from **4 to 43**.

The mean MPI score was **26.5**.

Table 4: Distribution of MPI Scores

MPI Category	Patients (%)
<21	33 (55.0)
21–29	15 (25.0)
≥30	12 (20.0)

Mortality

The overall mortality was **20% (12/60 patients).**

Mortality increased significantly with increasing MPI scores.

Table 5: Mortality According to MPI Category

MPI	Patients	Deaths	Mortality
<21	33	0	0%
21–29	15	2	13.3%
≥30	12	10	83.3%

The association between MPI category and mortality was highly significant (**Chi-square, p <0.001**).

Mortality Using the MPI Cut-off of 26

Patients were further analysed according to the validated MPI threshold.

Table 6: MPI ≤26 Versus MPI >26

MPI	Patients	Deaths	Mortality
≤26	45	0	0%
>26	15	12	80%

The difference was statistically highly significant (**p <0.001**).

Postoperative Complications

The common postoperative complications observed were:

- Surgical site infection
- Respiratory tract infection
- Septiciemia
- Burst abdomen
- Enterocutaneous fistula

Patients with higher MPI scores had significantly higher postoperative morbidity, prolonged hospital stay, and increased mortality.

Summary of Results

The principal findings of this study were:

- Overall mortality was 20%.
- Duodenal perforation was the commonest etiology of secondary peritonitis.
- Mortality increased progressively with increasing MPI scores.
- No mortality occurred in patients with MPI <21.
- Patients with MPI ≥30 had an 83.3% mortality rate.
- An MPI cut-off of 26 accurately identified patients at high risk of death.

The Mannheim Peritonitis Index showed excellent prognostic performance and was strongly associated with in-hospital mortality (**p <0.001**).

DISCUSSION

Secondary peritonitis continues to be one of the most challenging surgical emergencies encountered worldwide and remains an important cause of postoperative morbidity and mortality despite remarkable advances in perioperative care. The outcome depends on multiple interacting factors, including patient characteristics, duration of peritoneal contamination, severity of sepsis, physiological reserve, and the effectiveness of source control. Early identification of patients at high risk of adverse outcomes is therefore essential to optimize perioperative management and improve survival.

The present prospective observational study evaluated the prognostic value of the Mannheim Peritonitis Index (MPI) in 60 patients with secondary peritonitis. Our findings demonstrate that the MPI is a simple, reliable, and clinically useful scoring system with excellent ability to predict mortality in patients undergoing emergency surgery for secondary peritonitis.

Demographic Profile

The mean age of the study population was **44.3 years**, with patients ranging from 18 to 80 years of age. Most patients belonged to the third and fourth decades of life. This observation is consistent with previous Indian studies, where perforation peritonitis predominantly affects younger adults compared with Western populations.

A striking male predominance (80%) was observed in the present study. Similar findings have been reported by several investigators and probably reflect the higher prevalence of smoking, alcohol consumption, peptic ulcer disease, and delayed healthcare-seeking behaviour among males in the Indian population.

In contrast, Western studies generally report an older patient population because diverticular disease and colorectal malignancy account for a larger proportion of perforations.

Etiology of Secondary Peritonitis

Duodenal perforation was the commonest cause of secondary peritonitis (30%), followed by ileal perforation (20%) and gastric perforation (16.7%).

This pattern is consistent with the epidemiology of perforation peritonitis in India, where peptic ulcer disease continues to be an important cause of emergency laparotomy. Several studies from the Indian subcontinent have similarly reported upper gastrointestinal perforations as the leading etiology.

In contrast, studies from Europe and North America frequently identify colonic perforations secondary to diverticular disease or colorectal carcinoma as the predominant cause of secondary peritonitis.

These regional differences emphasize the importance of validating prognostic scoring systems within local patient populations.

Mannheim Peritonitis Index as a Prognostic Tool

The principal finding of this study is the excellent prognostic accuracy of the Mannheim Peritonitis Index.

The overall mortality rate in our study was **20%**, which is comparable with mortality rates reported in contemporary tertiary care centres managing generalized peritonitis.

More importantly, mortality increased progressively with increasing MPI scores.

Patients with MPI scores below 21 experienced **100% survival**, whereas mortality increased to **13.3%**among patients with scores between 21 and 29 and reached **83.3%** among patients with scores of 30 or more.

Similarly, when an MPI cut-off of **26** was used, mortality was **80%** among patients with MPI scores greater than 26, whereas no deaths occurred among patients with scores of 26 or below.

These findings clearly demonstrate that the MPI effectively distinguishes low-risk and high-risk patients.

Comparison with Published Literature

The original study by **Wacha et al.** first demonstrated that mortality increased dramatically with increasing MPI scores.

Subsequently, **Billing et al.**, in one of the largest validation studies involving over 2,000 patients, confirmed that the MPI accurately predicts mortality across different patient populations.

Similarly, **Notash et al.** demonstrated that patients with MPI scores exceeding 26 had significantly higher mortality than patients with lower scores.

The findings of the present study closely parallel these landmark publications.

More recent studies from India, Turkey, Egypt, Brazil, and Europe have consistently reported that mortality increases sharply once MPI exceeds 26–29 points.

The mortality pattern observed in our study therefore supports the continued validity of the MPI across diverse healthcare settings.

Clinical Implications

Routine calculation of the Mannheim Peritonitis Index offers several practical advantages.

Patients with high MPI scores should receive:

- Early intensive care admission
- Aggressive haemodynamic optimisation
- Broad-spectrum antibiotic therapy
- Close postoperative monitoring
- Early recognition of septic complications
- Timely surgical re-intervention when required

The MPI also provides an objective method of communicating disease severity among surgeons, anaesthesiologists, intensivists, and nursing teams.

Furthermore, it assists surgeons in counselling patients and their families regarding prognosis.

CONCLUSION

The Mannheim Peritonitis Index is a simple, practical, reliable, and effective prognostic scoring system for patients with secondary peritonitis.

In this prospective observational study, increasing MPI scores demonstrated a strong association with mortality. Patients with MPI scores below 21 had excellent survival, whereas mortality increased dramatically among patients with scores of 30 or greater. An MPI score greater than 26 accurately identified patients at high risk of death.

Because the MPI relies on simple clinical and intraoperative findings, it can be easily incorporated into routine emergency surgical practice. Its use facilitates early risk stratification, guides perioperative decision-making, assists in intensive care utilization, and provides objective prognostic information for clinicians and patients.

The findings of this study support the routine use of the Mannheim Peritonitis Index as an effective bedside prognostic tool in the management of secondary peritonitis, particularly in resource-limited healthcare settings.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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Ethical Approval

The study was conducted after obtaining approval from the Institutional Ethics Committee of Kasturba Medical College, Mangalore. Written informed consent was obtained from all participants before inclusion in the study.

(Please replace this statement with the exact ethics approval details from your original records if available.)

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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