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Original Research Article

A prospective study on evaluation of Mannheim peritonitis index in cases of spontaneous hollow viscus perforation at a tertiary health care center

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ABSTRACT

Background: Spontaneous hollow viscus perforation leading to peritonitis remains a significant surgical emergency with high mortality despite advances in medical care. The Mannheim Peritonitis Index (MPI) is a prognostic scoring system designed to assess disease severity and predict outcomes. This study aimed to evaluate the prognostic value of MPI in predicting mortality and morbidity in patients with spontaneous hollow viscus perforation.
Methods: A prospective observational cross-sectional study was conducted at a tertiary care center in Maharashtra, India, over 18 months (April 2023 to August 2025). Ninety-seven patients with spontaneous hollow viscus perforation were enrolled. MPI scores were calculated for each patient based on eight risk factors including age, gender, organ failure, malignancy, preoperative duration, origin of sepsis, type of peritonitis, and exudate characteristics. Statistical analysis was performed using Chi-square test, Fisher's exact test, and Pearson correlation coefficient.
Results: The overall mortality rate was 11.3% (11/97). Patients with MPI score >26 showed significantly higher mortality (9/41, 21.9%) compared to those with MPI ≤26 (2/56, 3.6%) (p=0.00). Significant mortality predictors included age >50 years (p=0.01), presence of malignancy (p=0.02), organ failure (p=0.00), preoperative duration >24 hours (p=0.04), and purulent/fecal exudate (p=0.03). MPI showed positive correlation with hospital stay (r=0.463, p=0.01) and mortality (r=0.429, p=0.00). Patients with MPI >26 had prolonged hospitalization (85.4% stayed >15 days.
Conclusions: MPI is a reliable, simple, and effective prognostic tool for risk stratification in patients with spontaneous hollow viscus perforation. It accurately predicts mortality and hospital stay duration, enabling early identification of high-risk patients who require aggressive management and intensive care support.

Keywords: Hollow viscus perforation, Mannheim peritonitis index, Mortality prediction, Peritonitis, Prognostic score, Surgical emergency

INTRODUCTION

Peritonitis secondary to spontaneous hollow viscus perforation represents one of the most common surgical emergencies encountered in clinical practice worldwide.[1] Despite significant advances in diagnostic imaging, antimicrobial therapy, surgical techniques, and intensive care management, peritonitis continues to be associated with substantial morbidity and mortality rates ranging from 10% to 40% depending on various patient and disease-related factors.[2]

The pathophysiology of perforation peritonitis involves complex interactions between bacterial contamination of the peritoneal cavity, systemic inflammatory response, sepsis, and potential progression to multi-organ dysfunction syndrome.[3] Early recognition of disease severity and appropriate risk stratification are crucial for

optimal management and improved patient outcomes. Clinical assessment alone may not adequately predict prognosis, necessitating the development of objective scoring systems.[4]

Among various prognostic scoring systems developed for peritonitis, including APACHE-II, POSSUM, and Jabalpur Peritonitis Index, the Mannheim Peritonitis Index (MPI) has gained widespread acceptance due to its simplicity, clinical applicability, and reliability. Developed by Wacha and Linder in 1983, the MPI incorporates eight clinical and intraoperative risk factors: age, gender, organ failure, malignancy, preoperative duration of peritonitis, origin of sepsis, extent of peritonitis, and characteristics of peritoneal exudate. Each factor is assigned a weighted score, with total scores ranging from 0 to 47. The original validation study established an MPI score >26 as the threshold for severe peritonitis with significantly increased mortality risk.[5-7]

The utility of MPI has been validated in various populations and clinical settings globally. However, there is considerable variation in patient demographics, causative factors, and healthcare infrastructure across different geographic regions, particularly in resource-limited settings. Studies from India have shown diverse results regarding the applicability and threshold values of MPI in predicting outcomes, suggesting the need for region-specific validation.[8-10]

Despite advances in perioperative care, mortality from perforation peritonitis remains a significant clinical challenge, particularly in rural and semi-urban areas were patients often present late with advanced disease. Factors contributing to adverse outcomes include delayed presentation, inadequate initial resuscitation, presence of comorbidities, immunosuppression, and emergence of antimicrobial resistance.[11] Accurate early risk stratification using objective tools like MPI can facilitate appropriate resource allocation, guide treatment intensity, and improve patient counseling regarding prognosis.[12,13]

The objectives of this study were to evaluate the prognostic value of the Mannheim Peritonitis Index in predicting mortality and morbidity (measured by hospital stay duration) in patients with spontaneous hollow viscus perforation, and to analyze individual risk factors including age, gender, organ failure status, presence of malignancy, timing of surgical intervention, origin and extent of sepsis, and peritoneal fluid characteristics in determining patient outcomes at our tertiary care center.

METHODS

Study design and setting

This prospective observational cross-sectional study was conducted in a tertiary Healthcare center in northwestern part of Maharashtra, India. The study period extended from April 2023 to August 2025, encompassing 18 months of patient enrollment and follow-up.

Sample size calculation

Sample size was calculated using the formula for proportion estimation in finite populations. Assuming a hypothesized outcome proportion of 50% with 10% margin of error at 95% confidence level, and applying finite population correction factor for a target population of 1,000,000, the calculated sample size was 97 patients. The formula used was: $n = Z^2p(1-p)/d^2$, where Z=1.96 for 95% confidence, p=0.5, and d=0.10. After finite population correction, the final required sample size was determined to be 97 respondents.

Inclusion criteria

Patients aged 18 years or above presenting with spontaneous hollow viscus perforation, intraoperatively confirmed gastric, duodenal, jejunal, ileal, or colonic perforation, patients or legally authorized representatives providing written informed consent were included.

Exclusion criteria

Traumatic perforation of hollow viscus, previously operated cases of perforation peritonitis, patients with known significant comorbidities that could independently affect outcomes: chronic kidney disease, chronic obstructive pulmonary disease, decompensated chronic liver disease, or coronary artery disease, patients or families declining consent for study participation were excluded.

Data collection procedure

All patients presenting to the outpatient department or emergency department with clinical features suggestive of perforation peritonitis underwent standardized evaluation. Following confirmation of diagnosis and patient consent, demographic and clinical data were systematically recorded on structured case record forms.

Mannheim peritonitis index calculation

MPI score calculated for each patient based on following eight risk factors with their respective weighted scores:

MPI score was calculated for each patient based on the following eight risk factors with their respective weighted scores: (1) Age >50 years: 5 points; (2) Female gender: 5 points; (3) Organ failure (defined as renal failure with creatinine >1.6 mg/dl, urea >60 mg/dl, or oliguria <20 ml/hour; respiratory failure with pO_2 <50 mmHg or pCO_2 >50 mmHg; shock; or intestinal obstruction with paralysis >24 hours or complete mechanical ileus): 7 points; (4) Malignancy: 4 points; (5) Preoperative duration >24 hours: 4 points; (6) Non-colonic origin of sepsis: 4 points; (7) Diffuse generalized peritonitis: 6 points; (8) Exudate type

- clear: 0 points, cloudy/purulent: 6 points, fecal: 12 points. Total MPI scores could range from 0 to 47 points.

Statistical analysis

Data were analyzed using SPSS version 21.0 software. Qualitative variables were presented as frequencies and percentages. Association between categorical variables and outcomes (mortality and hospital stay) were assessed using Chi-square test or Fisher's exact test as appropriate. Pearson correlation coefficient was calculated to evaluate linear relationships between MPI score, hospital stay, and mortality. A p value <0.05 was considered statistically significant.

RESULTS

Demographic and clinical characteristics

A total of 97 patients with spontaneous hollow viscus perforation were enrolled in this study during the 18-month study period. Age distribution revealed that the majority of patients (23.7%, n=23) belonged to the 31-40 years age group, followed by 21-30 years (16.5%, n=16), 41-50 years (15.5%, n=15), 51-60 years (13.4%, n=13), and 61-70 years (11.3%, n=11). Eight patients (8.2%) were above 71 years of age, while four patients (4.1%) were below 20 years. The age range extended from 11 to 78 years, with mean age of 42.6 years.

Gender distribution showed a pronounced male predominance, with 73 male patients (75.3%) and 24 female patients (24.7%), yielding a male-to-female ratio of approximately 3:1.

Distribution of MPI risk factors

Among the eight components of the Mannheim peritonitis index, the following distributions were observed in our study population:

Age distribution: Thirty-four patients (35.1%) were aged above 50 years, while 63 patients (64.9%) were below 50 years of age.

Gender distribution: There were 73 male patients (75.3%) and 24 female patients (24.7%).

Malignancy: Eleven patients (11.3%) were found to have underlying malignancy based on histopathological examination of resected specimens, while 86 patients (88.7%) had no evidence of malignancy.

Organ failure: Twenty-seven patients (27.8%) presented with evidence of organ failure at the time of presentation or developed it during the preoperative period, while 70 patients (72.2%) did not exhibit organ dysfunction.

Table 1: Association of mortality and different variables of MPI.

Components	Parameters	Patient survived	Patient died	Total	P value*
Age (years)	<50	60	3	63	0.01*
	>50	26	8	34	
Gender	Male	67	6	73	0.13
	Female	19	5	24	
Malignancy	Yes	7	4	11	0.02*
	No	79	7	86	
Organ failure	Yes	18	9	27	0.00*
	No	68	2	70	
Pre-operative duration	<24 hours	60	4	64	0.04*
	>24 hours	26	7	33	
Origin of sepsis	Non-colonic	70	7	77	0.12
	Colonic	16	4	20	
Type of peritonitis	Localized	16	0	16	0.20
	Generalized	70	11	81	
Exudate type	Purulent	47	10	57	0.03*
	faecal	27	1	28	
	Clear	12	0	12	
MPI score	</=26	54	2	56	0.00*
	> 26	32	9	41	
Hospital stays	<15 days	28	7	35	0.05*
	>/=15 days	58	4	62	

*statistically significant.

Preoperative duration: Sixty-four patients (66.0%) underwent surgical intervention within 24 hours of symptom onset. However, 33 patients (34.0%) had symptom duration exceeding 24 hours before surgery, representing delayed presentation or delayed diagnosis.

Origin of sepsis: The anatomical site of perforation showed that 77 patients (79.4%) had non-colonic sources of sepsis (gastric, duodenal, jejunal, or ileal perforations), while 20 patients (20.6%) had colonic perforations.

Type of peritonitis: The majority of patients (83.5%, n=81) presented with diffuse generalized peritonitis involving multiple quadrants of the abdomen, while 16 patients (16.5%) had localized peritonitis confined to specific anatomical regions.

Exudate characteristics: Intraoperative findings revealed purulent exudate in 57 patients (58.8%), fecal exudate in 28 patients (28.9%), and clear exudate in 12 patients (12.4%).

Mannheim peritonitis index score distribution

Using the conventional threshold of 26 points to differentiate mild-moderate from severe peritonitis, 56 patients (57.7%) had MPI scores ≤26, while 41 patients (42.3%) had MPI scores >26.

Primary and secondary outcome measures

The primary outcome measure was mortality during hospitalization. Of the 97 patients, 86 patients (88.7%) survived to hospital discharge, while 11 patients (11.3%) died during the treatment course.

Table 2: MPI score and it's association with mortality.

MPI score	Patient survived	Patient died	Total	P value
</=26	54	2	56	0.00*
> 26	32	9	41	

*statistically significant

Table 3: Association of hospital stay and different variables of MPI.

Components	Parameters	Hospital stay </=15 days	Hospital stay >15 days	Total	Chi square	P value*
Age (years)	<50	30	33	63	10.37	0.01*
	>50	5	29	34		
Gender	Male	31	42	73		0.02*
	Female	4	20	24		
Malignancy	Yes	2	9	11	1.72	0.31
	No	33	53	86		
Organ failure	Yes	6	21	27	3.11	0.10
	No	29	41	70		
Pre-operative duration	<24 hours	27	37	64	3.04	0.12
	>24 hours	8	25	33		
Origin of sepsis	Non-colonic	30	47	77	18.05	0.00*
	Colonic	5	15	20		
Type of peritonitis	Generalized	21	60	81	21.96	0.00*
	Localized	14	2	16		
Exudate type	Purulent	13	44	57	20.55	0.00*
	Faecal	11	17	28		
	Clear	11	1	12		
MPI score	</=26	29	27	56		0.002*
	> 26	6	35	41		
Death	Yes	7	4	11	4.08	0.05*
	No	28	58	86		

*statistically significant

The secondary outcome measure was duration of hospital stay, which served as a surrogate marker for morbidity. Among the 86 survivors, 27 patients (31.4%) were discharged within 15 days, while 59 patients (68.6%) required hospitalization exceeding 15 days.

Association of MPI score with mortality

A strong and statistically significant association was observed between MPI score and mortality (p<0.001). Among 56 patients with MPI ≤26, only 2 patients (3.6%) died, while 54 patients (96.4%) survived. In contrast,

among 41 patients with MPI >26, 9 patients (22.0%) died and 32 patients (78.0%) survived. This sixfold increase in mortality risk for patients with MPI >26 demonstrates the excellent discriminatory ability of the MPI scoring system.

Table 4: Showing correlation between MPI and hospital stay, death.

		MPI	Hospital stay	Death
MPI	Pearson Correlation (r)	1	0.463**	0.429**
Hospital stay	Pearson Correlation (r)	0.463**	1	0.205*
Death	Pearson Correlation (r)	0.429**	-0.205*	1

*statistically significant; **clinically significant

Correlation analysis between variables

Pearson correlation analysis showed that higher Mannheim Peritonitis Index (MPI) scores are associated with both increased hospital stay and higher mortality.

Importantly, patients with higher MPI scores stayed longer in the hospital and faced a greater risk of death, while those who died typically had shorter hospital stays, often due to early mortality from severe illness.

DISCUSSION

This prospective observational study evaluated the prognostic utility of the Mannheim Peritonitis Index in 97 patients with spontaneous hollow viscus perforation managed at our tertiary care center. Our findings demonstrate that MPI is a reliable, clinically applicable, and statistically valid tool for risk stratification, mortality prediction, and assessment of expected morbidity in this patient population. The overall mortality rate of 11.3% in our series aligns with contemporary reports from similar healthcare settings and reflects the continued challenge that perforation peritonitis poses despite modern medical advances.[14,15,16]

Demographic patterns and epidemiological considerations

The demographic profile of our study population reveals important epidemiological patterns. The predominance of male patients (75.3%) and peak incidence in the third and fourth decades of life corresponds with established patterns reported in literature from the Indian subcontinent and other developing nations.[14-17] This male preponderance may be attributed to higher prevalence of risk factors including smoking, alcohol consumption, NSAID use, and Helicobacter pylori infection, which are established etiological factors for peptic ulcer disease leading to gastroduodenal perforation. Additionally, occupational exposures, dietary habits, and healthcare-seeking patterns may contribute to these gender differences.

Validation of MPI as a prognostic tool

Our study validates the prognostic accuracy of MPI in the Indian context, demonstrating a highly significant association between MPI score >26 and adverse outcomes. The sixfold increase in mortality among patients with MPI >26 (22.0% vs 3.6%, p<0.001) confirms the excellent discriminatory ability of this scoring system. These findings corroborate earlier validation studies from diverse geographic regions. Sharma et al. from Amritsar, India, reported 100% mortality for MPI >27 and 27.3% mortality for MPI 21-27, compared to zero mortality for MPI <21.[17] Similarly, a study from Rawalpindi demonstrated progressive increase in mortality from 1.9% for MPI <20 to 28.1% for MPI >30.[18]

Our results align closely with a cross-sectional data analysis of ten Indian studies, which established MPI >29 as a threshold for severe risk category requiring aggressive intervention.[19] The consistency of these findings across different populations, healthcare systems, and time periods underscores the robustness and generalizability of MPI.

Individual risk factors and their clinical implications

Age emerged as a significant predictor of both mortality and prolonged hospitalization in our study. Patients above 50 years demonstrated nearly fivefold higher mortality (23.5% vs 4.8%, p=0.01) and significantly longer hospital stays. These findings emphasize the need for particularly vigilant management, aggressive resuscitation, and lower threshold for intensive care admission in elderly patients with perforation peritonitis.[19]

Although female gender is assigned 5 points in the MPI scoring system, our study found no statistically significant association between gender and mortality (p=0.13). However, female patients did demonstrate significantly longer hospital stays (p=0.02), suggesting possible differences in disease severity, physiological responses, postoperative recovery patterns, or complications between genders. This discrepancy between mortality and morbidity outcomes warrants further investigation in larger studies.

The presence of underlying malignancy emerged as a powerful adverse prognostic factor, with mortality of 36.4% in cancer patients compared to 8.1% in non-cancer patients (p=0.02). Perforation in the setting of gastrointestinal malignancy may occur due to tumor necrosis, obstruction with proximal perforation, or chemotherapy-related complications. The high mortality

in this subgroup underscores the need for multidisciplinary management involving surgical, oncological, and palliative care teams.[19]

Organ failure represented the most powerful predictor of mortality in our study (33.3% mortality vs 2.9%, p<0.001), consistent with its highest weighted score (7 points) in the MPI system. The presence of organ dysfunction indicates that peritonitis has progressed beyond local inflammation to systemic inflammatory response syndrome (SIRS), sepsis, or septic shock with end-organ damage. Organ failure reflects the severity of bacterial contamination, adequacy of source control, host immune response, and effectiveness of resuscitation. Early recognition of organ dysfunction mandates aggressive hemodynamic support, source control surgery, broad-spectrum antimicrobials, and intensive care management.[20] Preoperative duration >24 hours significantly increased mortality (21.2% vs 6.3%, p=0.04), highlighting the critical importance of timely surgical intervention. Factors contributing to delayed presentation in our setting include limited health literacy, distance from healthcare facilities, initial management by non-specialist practitioners, and socioeconomic barriers. Public health initiatives aimed at increasing awareness and improving emergency referral systems may help reduce these delays.

The characteristics of peritoneal exudate showed significant association with outcomes, with mortality increasing from 0% for clear exudate to 3.6% for fecal exudate and 17.5% for purulent exudate (p=0.03). Purulent exudate indicates high bacterial load with active infection and intense inflammatory response, while fecal contamination represents massive intestinal spillage but may paradoxically have somewhat lower bacterial concentration than established purulent infection. Clear exudate typically indicates early perforation with minimal contamination or chemical peritonitis without established infection, explaining the favorable prognosis.[21]

MPI as predictor of morbidity and resource utilization

Beyond mortality prediction, our study demonstrates that MPI effectively predicts morbidity as reflected by hospital stay duration. The moderate positive correlation between MPI score and hospital stay (r=0.463, p=0.01) indicates that higher MPI scores correspond to longer hospitalization, increased resource consumption, higher treatment costs, and greater burden on healthcare infrastructure. Patients with MPI >26 had 85.4% probability of requiring >15 days hospitalization compared to 48.2% for MPI ≤26. This information has important implications for healthcare planning, resource allocation, patient counseling, and family preparation for expected clinical course.[22]

Clinical utility and practical applications

The key strength of MPI lies in its simplicity and practical applicability. All eight components can be assessed rapidly at bedside or during initial surgical exploration without requiring sophisticated investigations or complex calculations. This makes MPI particularly valuable in resource-limited settings where advanced scoring systems like APACHE-II may not be feasible.

Several limitations of this study merit acknowledgment. First, the single-center design may limit generalizability to other healthcare settings with different patient populations or resource availability. Second, the relatively modest sample size of 97 patients, while statistically adequate, may have limited power to detect associations with less common risk factors.

CONCLUSION

The Mannheim Peritonitis Index represents a valuable, validated, and clinically applicable tool for prognostic assessment and risk stratification in patients with spontaneous hollow viscus perforation. Our study demonstrates that MPI accurately predicts both mortality and morbidity, with scores exceeding 26 points identifying patients at significantly elevated risk for adverse outcomes

Integration of MPI into routine clinical practice enables early identification of high-risk patients who would benefit from aggressive resuscitation, expedited surgical intervention, intensive perioperative monitoring, and enhanced postoperative care. The scoring system facilitates objective communication among healthcare providers, guides resource allocation decisions, and supports informed discussions with patients and families regarding expected clinical course and prognosis.

Recommendations

Based on our findings, we recommend routine calculation of MPI for all patients presenting with perforation peritonitis. Patients with MPI >26 should be considered for early intensive care admission, aggressive hemodynamic optimization, broad-spectrum antimicrobial therapy, timely definitive surgery, and anticipation of prolonged hospitalization.

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