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ORIGINAL ARTICLE

Evaluation of Mannheim Peritonitis Index in Predicting Morbidity and Mortality in Patients with Peritonitis Due to Hollow Viscus Perforation: A Prospective Observational Study

Sabari Balaji,[1] Suraj Subramanian,[2] Rajkumar K S[3] and Jeevithan Shanmugam[4,*]
[1]*Assistant Professor in General Surgery, KMCH Institute of Health Sciences and Research, Coimbatore 14.*
[2]*Associate Professor in General Surgery, KMCH Institute of Health Sciences and Research, Coimbatore 14.*
[3]*Surgery Consultant, Kovai Medical Center and Hospital Pvt Ltd, Coimbatore -14*
[4]*Professor in Community Medicine, KMCH Institute of Health Sciences and Research, Coimbatore 14.*

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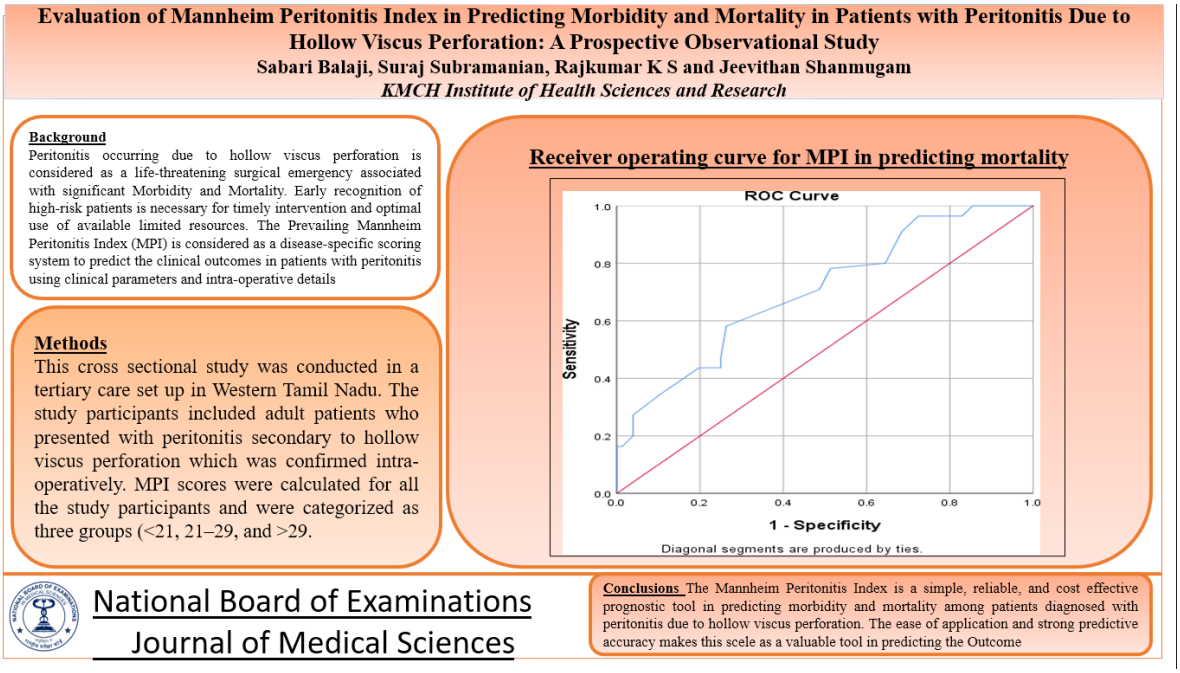
Abstract

Introduction: Peritonitis occurring due to hollow viscus perforation is considered as a life-threatening surgical emergency associated with significant Morbidity and Mortality. Early recognition of high-risk patients is necessary for timely intervention and optimal use of available limited resources. The Prevailing Mannheim Peritonitis Index (MPI) is considered as a disease-specific scoring system to predict the clinical outcomes in patients with peritonitis using clinical parameters and intra-operative details. **Materials and Methods:** This cross sectional study was conducted in a tertiary care set up in Western Tamil Nadu. The study participants included adult patients who presented with peritonitis secondary to hollow viscus perforation which was confirmed intra-operatively. MPI scores were calculated for all the study participants and were categorized as three groups (<21, 21–29, and >29. **Results:** A total of 131 study participants were included in the study. The mean age was 53.49 ± 14.26 years. The mean MPI score observed was 21.36 ± 6.36. Around 42% of participants had any one morbidity. Mortality was observed in 3.1% of the study population. As the MPI scores increased, significantly higher rates of renal complications, ICU admission, prolonged hospital stay, and overall morbidity ($p < 0.05$) were observed. MPI demonstrated excellent predictive accuracy for mortality (AUC 0.978) and moderate accuracy for morbidity (AUC 0.704). **Conclusion:** The Mannheim Peritonitis Index is a simple, reliable, and cost effective prognostic tool in predicting morbidity and mortality among patients diagnosed with peritonitis due to hollow viscus perforation. The ease of application and strong predictive accuracy makes this scele as a valuable tool in predicting the Outcome, particularly in resource-limited settings for early risk stratification and management planning.

Keywords: Peritonitis, Hollow viscus perforation, Mannheim Peritonitis Index, Morbidity, Mortality

*Corresponding Author: Jeevithan Shanmugam
Email: dr.jeevithan@gmail.com

Graphical Abstract



Introduction

Peritonitis is defined as the inflammation of peritoneum and/or peritoneal cavity, which commonly results due to bacterial contamination that originates from the gastrointestinal tract [1]. Peritonitis is a life-threatening surgical emergency and it represents a major proportion of acute abdomen cases presenting to emergency departments [2]. Approximately 25% (one-fourth) of acute abdominal emergencies are attributed to perforations of the Gastrointestinal tract, with reported mortality rates ranging between 6% and 27%, depending on the severity of disease and timing of intervention [3-5].

In spite of the recent advances in surgical techniques, antibiotic therapy, and also critical care support, perforation peritonitis still continues to pose a significant diagnostic and therapeutic challenge, particularly among low- and middle-income countries [6]. Delayed presentation along with advancement of the disease at admission, widespread peritoneal contamination, and associated organ dysfunction contribute to the increased morbidity and mortality. Early surgical intervention remains the cornerstone in the management, and timely identification of those with high risk is crucial for optimizing perioperative care and resource allocation [1].

Several scoring systems has been developed to assess the disease severity and to predict the outcomes in patients diagnosed with peritonitis which includes the Acute Physiological and Chronic Health Evaluation (APACHE II), Sepsis Severity Score, Peritonitis Index Altona, Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM), and the Mannheim Peritonitis Index (MPI). Among these, MPI is a disease-specific scoring system designed exclusively for patients with peritonitis using simple

clinical and intraoperative parameters [7]. Developed by Wacha and Linder in 1983 through a retrospective analysis on 1253 patients, MPI incorporates eight independent prognostic factors and it categorizes patients according to predicted risk of morbidity and mortality. Literature suggests that MPI scores exceeding 26 have been shown to have significantly higher mortality rates [8].

The Mannheim Peritonitis Index has gained acceptance worldwide due to its simplicity, cost-effectiveness, and ease of application, particularly in resource-limited settings where the access to advanced investigations and intensive care facilities are restricted [7]. MPI does not require any complex laboratory parameters or any specialized equipment and it can be calculated intra-operatively, thereby allowing early risk stratification and guiding in postoperative management decisions. Although several International literatures have validated the prognostic utility of MPI, there is a relative paucity of in Indian literature regarding the accuracy of MPI in predicting morbidity and mortality among patients with peritonitis due to hollow viscus perforation [1].

The present study was undertaken to evaluate the effectiveness of the Mannheim Peritonitis Index in predicting postoperative morbidity and mortality in patients with peritonitis due to hollow viscus perforation and to assess its utility as a practical prognostic tool in a tertiary care setting.

Materials and Methods

This Cross sectional study was conducted in the Department of General Surgery at a tertiary-care teaching hospital in Coimbatore, India, between November 2020 to December 2021. Adult patients aged 18 years and above who presented with clinical features of peritonitis due to hollow viscus perforation, which was then subsequently confirmed by intra-operative findings were included in the study. Patients with traumatic hollow viscous perforation and patients with other significant comorbid illnesses likely to independently affect outcomes were excluded from the study.

Prior to the commencement of the study, Scientific and Ethical committee approval for the study were obtained. All eligible participants were informed in detail about the nature and purpose of the study. Patient information sheet was provided to each participant and adequate time was given to read and understand them. All ethical issues pertaining to the study was addressed as per Helsinski Declaration. Written informed consent was obtained from all participants after they confirm the participation in the study. Patient data was confidential and the standard of care was maintained irrespective of the participation in the study.

Consecutive recruitment of all eligible patients was done in the study period. Detailed clinical history was collected using a structured proforma. Demographic details, duration of symptoms, clinical examination findings, intraoperative observations were noted and postoperative period was monitored. The Mannheim Peritonitis Index (MPI) score was calculated for each patient based on predefined criteria, taking the age, sex of the partcipant, duration of peritonitis, presence/absence of organ failure, malignancy, origin of sepsis, extent of peritonitis, and the nature of peritoneal exudate into consideration. The total MPI score was derived by adding the individual

risk factor scores. Based on the total score, patients were categorised into three risk categories: MPI <21, MPI 21–29, and MPI >29.

All patients had appropriate surgical intervention according to the underlying pathology and were followed by standardized postoperative management. They were followed up during their hospital stay, upto a month after surgery for other outcomes. Mortality was defined as death occurring during the stay in hospital following surgery. Morbidity was defined as the occurrence of one or more postoperative complications including renal or pulmonary or wound-related complications, requirement for admission in intensive care unit, or prolonged hospital stay exceeding six days.

Renal complications, pulmonary complications, wound complications, ICU admission, duration of hospital stay, overall morbidity, and mortality were taken as outcome variables, while MPI score served as the primary explanatory variable. Data were coded and entered in Microsoft Excel and analyzed using SPSS 27. Descriptive statistics was used to summarize baseline characteristics and outcomes and Mean/standard Deviation was used for continuous variables and categorical variables being expressed as frequency and percentage. Association between MPI score categories and outcomes were assessed using the chi-square test. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the predictive performance of MPI for mortality and morbidity. Sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy, and area under the curve were calculated with corresponding confidence intervals. A p value of less than 0.05 was considered statistically significant.

Results

Table 1 summarizes the baseline demographic and clinical characteristics of the study population and also the distribution of Mannheim Peritonitis Index (MPI) scores. The mean age of the study population was 53.49 ± 14.26, with more than two thirds (68.7%) above 50 years, and a male preponderance (69.5%). A majority of participants (71%) presented with generalized peritonitis and around 96.1% had purulent or fecal contamination. The mean MPI score was 21.36 ± 6.36, with nearly half of the participants (47.3%) classified in the intermediate-risk category (MPI 21–29) and approximately one-tenth in the high-risk category (MPI >29), indicating a heterogeneous population suitable for prognostic stratification using MPI.

Table 1. Baseline demographic, clinical characteristics, and MPI distribution of the study population (N = 131)

Variable	Value
Age (years), mean ± SD	53.49 ± 14.26
Age >50 years	90 (68.7%)
Male sex	91 (69.5%)
Pre-operative duration >24 h	27 (20.6%)
Generalized peritonitis	93 (71.0%)
Purulent/Fecal exudate	126 (96.1%)
Organ failure	22 (16.8%)
Malignancy	10 (7.6%)
MPI score, mean ± SD	21.36 ± 6.36
MPI <21	55 (42.0%)
MPI 21–29	62 (47.3%)
MPI >29	14 (10.7%)

Overall morbidity was 41.9%, showing the significant percentage of complications associated with peritonitis due to hollow viscus perforation. Renal complications were the most common (19.1%), followed by pulmonary (15.3%) and wound-related complications (14.5%). Nearly one-fifth (19.1%) of patients needed Intensive care and nearly half had prolonged hospital stay exceeding six days (49.6%). Despite the high morbidity, the overall mortality rate was relatively low at 3.1%, which shows timely surgical intervention and post-operative care (Table 2).

Table 2. Post-operative outcomes in the study population (N = 131)

Outcome	n (%)
Overall morbidity	55 (41.9%)
Renal complications	25 (19.1%)
Pulmonary complications	20 (15.3%)
Wound complications	19 (14.5%)
ICU admission	25 (19.1%)
Prolonged hospital stay (>6 days)	63 (49.6%)
Mortality	4 (3.1%)

As depicted in Table 3, there was a clear and gradual increase in adverse post-operative outcomes with rising MPI score categories. Renal complications, ICU admission, prolonged hospital stay, and overall morbidity were significantly more common in participants with higher MPI scores ($p < 0.05$). Overall morbidity increased from 30.9% in patients with MPI <21 to 78.6% in those with MPI >29. It is to be noted that all deaths in the study occurred only in patients with MPI scores greater than 29, showing a strong association between mortality and increased MPI scores.

Table 3. Association between MPI score categories and post-operative outcomes (N = 131)

Outcome	MPI <21	MPI 21–29	MPI >29	p value
Renal complications	5 (9.1%)	14 (22.6%)	6 (42.9%)	0.010
Pulmonary complications	4 (7.3%)	13 (21.0%)	3 (21.4%)	0.096
ICU admission	8 (14.5%)	10 (16.1%)	7 (50.0%)	0.008
Prolonged stay (>6 days)	20 (36.4%)	38 (61.3%)	5 (50.0%)	0.027
Overall morbidity	17 (30.9%)	28 (45.2%)	11 (78.6%)	0.005
Mortality	0	0	4 (28.6%)	—

Table 4 shows the diagnostic performance of MPI in predicting outcomes. MPI showed commendable predictive accuracy for mortality at a cut-off value of ≥29, with high sensitivity and specificity. This was supported by receiver operating characteristic (ROC) curve analysis, where Figure 1 shows an area under the curve (AUC) of 0.978, highlighting the discriminative ability of MPI for mortality prediction. For morbidity prediction, MPI showed moderate predictive performance at an optimal cut-off of ≥20.5, with Figure 2 demonstrating an AUC of 0.704, showing acceptable but comparatively lesser discriminative ability for predicting post-operative complications.

Table 4. Diagnostic accuracy of MPI in predicting mortality and morbidity

Parameter	Mortality (MPI ≥29)	Morbidity (MPI ≥20.5)
Sensitivity	100.0%	70.9%
Specificity	92.1%	51.3%
Positive predictive value	28.6%	51.3%
Negative predictive value	100.0%	70.9%
Diagnostic accuracy	92.4%	59.5%
AUC (ROC)	0.978	0.704

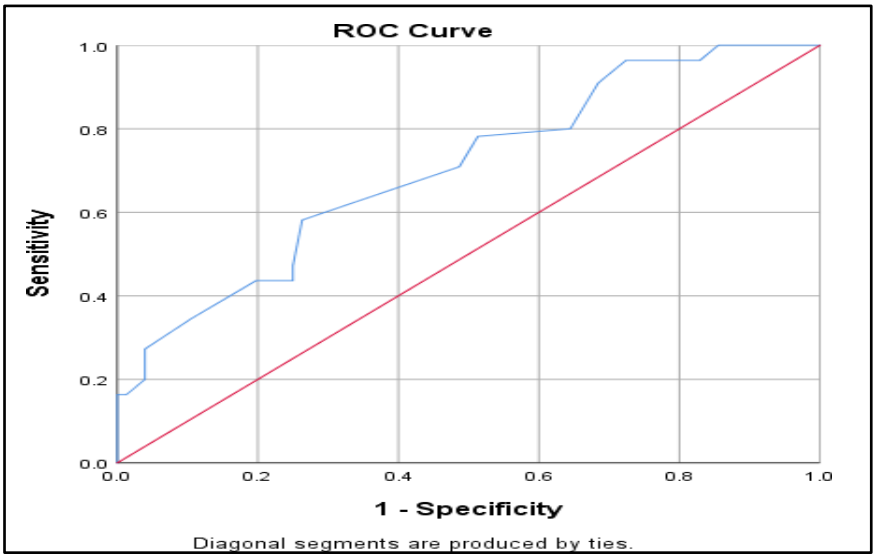


Figure 1. Receiver operating curve for MPI in predicting mortality (N=131)

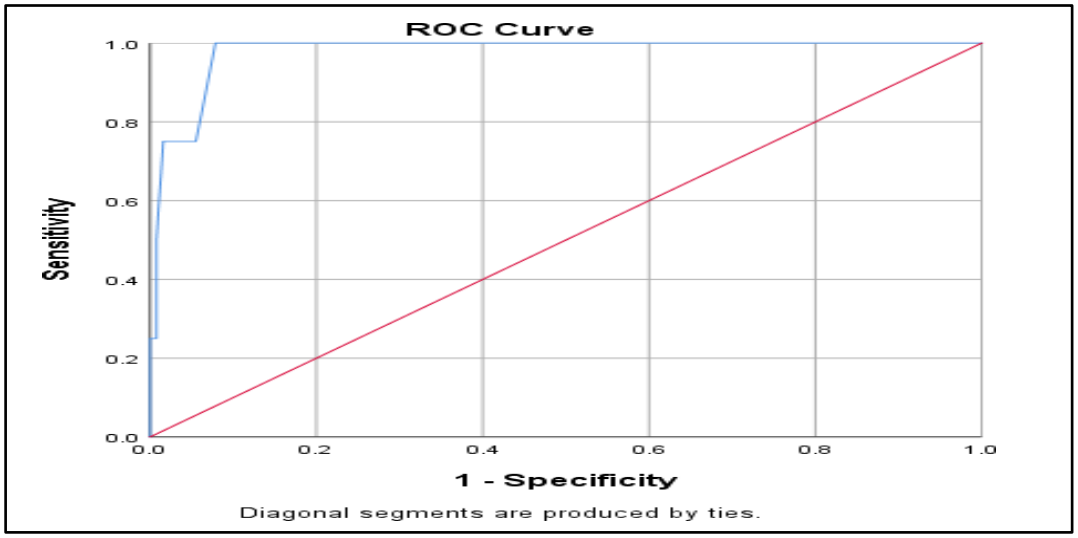


Figure 2. Receiver operating curve for MPI in predicting mortality (N=131)

Discussion

Hollow viscus perforation causing peritonitis is a major surgical emergency even in this era. It is associated with significant morbidity and mortality, especially in low- and middle-income countries due to delay in presentation and limited access to advanced critical care facilities [9,10]. Early identification of high-risk individuals is important to guide timely surgery, better postoperative management and improve outcomes. Prognostic scoring systems play an important role in this context by enabling objective assessment of disease severity [11].

In our present study, majority of participants were elderly (more than 50 years), with a male predominance. Results of several Indian studies on perforation peritonitis were also consistent with our results [12-15]. Advanced age has been consistently associated with poor outcomes in peritonitis due to decrease in physiological reserve and increased prevalence of comorbidities [15]. The predominance of generalized peritonitis and purulent or fecal contamination in our cohort suggests delayed presentation, a pattern that was frequently reported in developing countries [13,16]. Our results highlight the continued challenge of late diagnosis and referral, which adversely affects the prognosis.

A key strength of our study is the demonstration of a linear positive association between increasing Mannheim Peritonitis Index (MPI) scores and adverse postoperative outcomes. Participants with higher MPI scores experienced a significantly higher rates of renal complications, ICU admission, prolonged hospital stay, and overall morbidity. Similar associations have been reported in many Indian and international studies which reinforces the reliability of MPI as a prognostic tool [4,17-22]. Our finding that all deaths occurred exclusively in participants with MPI scores greater than 29 further underscores a strong predictive value of MPI for mortality which is consistent with observations by Wacha and Linder [8.,23,24].

The excellent predictive accuracy of MPI for mortality observed in this study, as reflected by a high area under the ROC curve, is comparable to reports obtained from both national and international Studies [15,17-22,25-27]. A major advantage of MPI lies in its ease of assessment and its reliance on clinical and intraoperative parameters, making it suitable for resource-limited settings [7,28]. Unlike APACHE II and POSSUM, MPI scoring system doesn't require extensive laboratory data or postoperative physiological monitoring, allowing early risk stratification at the time of surgery.

However, while MPI showed an excellent predictive accuracy for mortality, its predictive ability for morbidity is not significant, consistent with previous studies done in the past [19,20,22]. Postoperative morbidity is influenced by many factors along with disease severity at presentation, surgical technique, perioperative care, nutritional status, and hospital-specific practices. The relatively lower specificity for morbidity prediction in the present study is explained by this, and highlighting the limitation of MPI when used as a standalone tool for predicting non-fatal complications.

Conclusion

Our study findings support using Mannheim Peritonitis Index as a simple, reliable, and cost-effective prognostic scoring system for peritonitis secondary to hollow viscus perforation especially in resource poor settings. Early identification of high-risk patients can be done using MPI, and they may benefit from aggressive surgical and postoperative management, closer monitoring, and intensive care support. Its ease of use and strong predictive value make it specially of wide use in limited resource setting, where timely decision-making is life saving and for better patient outcomes.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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