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Research Article

Prospective Study of the Mannheim Peritonitis Index in Predicting Mortality and Postoperative Complications, with ROC Validation

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ABSTRACT

Background: Secondary peritonitis is a surgical emergency, and reported mortality runs anywhere from 6% to 60% depending on the cause and the patient's condition. The Mannheim Peritonitis Index (MPI) combines clinical and operative findings into a single prognostic score, but it has been validated in only a limited number of populations. We assessed how accurately the MPI predicts mortality and postoperative complications in patients undergoing emergency laparotomy for secondary peritonitis.

Methods: We carried out a prospective observational study of 50 consecutive patients with secondary peritonitis. The MPI was scored intraoperatively, and patients were followed for 30 days after surgery. The primary outcome was 30-day mortality and the secondary outcome was major postoperative complications. Receiver operating characteristic (ROC) analysis was used to identify the optimal cutoff value.

Results: The mean age was 48.6 years, and most patients were men (68%). Hollow viscus perforation was the commonest cause (72%). The mean MPI was 24.8 (range 8–47), and overall mortality was 18%. For predicting death, the area under the ROC curve (AUC) was 0.89 (95% CI 0.79–0.99). An MPI cutoff of 26 gave 88.9% sensitivity and 82.9% specificity. Patients scoring above 26 had significantly more complications ($p < 0.001$).

Conclusions: The MPI predicts both death and morbidity reliably in secondary peritonitis. A score above 26 marks out high-risk patients who need closer monitoring.

Keywords: Mannheim Peritonitis Index, Secondary Peritonitis, Mortality Prediction, Roc Analysis, Postoperative Complications.

INTRODUCTION

BACKGROUND

Secondary peritonitis from hollow viscus perforation remains one of the harder emergencies in general surgery. Operative technique, antibiotics, and intensive care have all improved over the years, yet mortality is still high. Picking out the patients most likely to do badly, early on, would help direct resources and decide how aggressively to treat.

Several scoring systems try to predict outcome in peritonitis. The Mannheim Peritonitis Index, described by Wacha and Linder in 1983, uses eight risk factors taken from the bedside and from the operative findings: age, sex, organ failure, malignancy, duration of peritonitis, origin of sepsis, extent of spread, and the character of the exudate. The index was derived from a review of 1253 patients treated for peritonitis at the University of Mannheim between 1963 and 1979. Each adverse factor carries a weighted score.

Mannheim Peritonitis Index components

Risk factor	Score
Age over 50 years	5
Female sex	5
Organ failure present	7
Malignancy	4
Preoperative duration over 24 hours	4
Non-colonic origin of sepsis	4
Diffuse generalised peritonitis	6
Exudate (clear/cloudy/faecal)	0/6/12

Billing *et al*. found 97% survival when the MPI was below 21, 65% for scores of 21–29, and only 17% once the score passed 29. A meta-analysis by Salamone *et al*. confirmed that the MPI discriminates acceptably across several cohorts, though differences in study populations and outcome definitions limited the pooled analysis. Later validation studies from different regions reported a range of results, which is why local validation matters. Comparative work has also set the MPI against APACHE II, POSSUM, and the Peritonitis Index of Altona. Most of these studies found similar predictive accuracy, with the MPI having the practical edge of being simple and scorable in theatre.

Because the MPI needs no laboratory work, it suits resource-limited settings where more elaborate, laboratory-based scores are not practical. Even so, it needs testing in different patient populations before its results can be trusted locally. This study set out to see how well the MPI predicts mortality and postoperative complications in patients presenting with secondary peritonitis at our hospital, and to identify the optimal MPI cutoff using ROC curve analysis. We expected it to show acceptable discrimination for both outcomes.

METHODS

STUDY DESIGN

This was a prospective observational study at Government medical college and hospital, Chidambaram, Tamil Nadu, a tertiary care centre, over 18 months from January 2024 to June 2025.

SAMPLE SIZE

We enrolled 50 consecutive patients who met the inclusion criteria. The sample size assumed an expected mortality of about 20% and drew on the MPI's predictive accuracy in earlier work, giving 80% power at a 5% significance level.

INCLUSION CRITERIA

Age 18 years or above.
Clinical and radiological diagnosis of secondary peritonitis.
Undergoing emergency laparotomy.
Informed consent obtained.

EXCLUSION CRITERIA

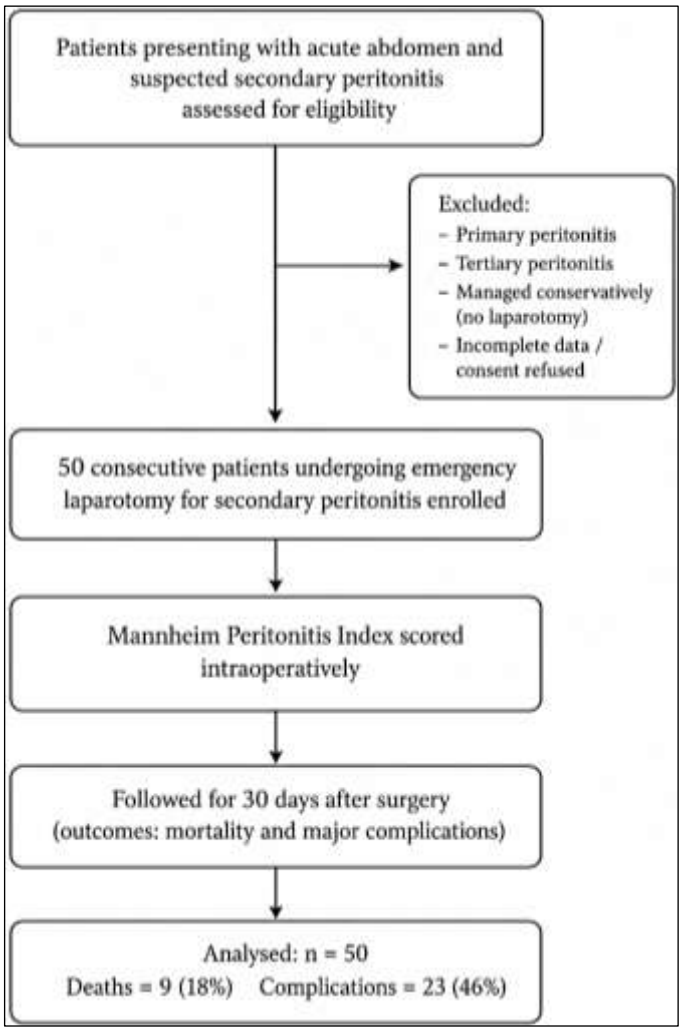
Primary peritonitis.
Tertiary peritonitis.
Patients managed conservatively.
Incomplete data.
Refusal of consent.

DATA COLLECTION

A structured proforma captured demographic details, clinical presentation, operative findings, and the postoperative course. The MPI was scored in theatre from direct inspection of the peritoneal cavity.

OUTCOME MEASURES

The primary outcome was 30-day mortality. Secondary outcomes were wound infection, respiratory complications, anastomotic leak, renal impairment, sepsis, and the need for relaparotomy.



Patient enrolment and follow-up.

FOLLOW-UP

All patients were followed for 30 days after surgery. Those discharged earlier were reviewed in the outpatient clinic or contacted by telephone.

STATISTICAL ANALYSIS

Data were entered in Microsoft Excel and analysed in SPSS version 25.0. Continuous variables are given as mean with standard deviation, or as median with interquartile range where the distribution was skewed. Categorical variables are given as counts and percentages.

The chi-square test, or Fisher's exact test where cell counts were small, compared categorical variables between survivors and non-survivors. The independent t-test, or the Mann-Whitney U test, compared continuous variables.

ROC curves were used to judge how well the MPI separates survivors from non-survivors. The area under the curve was reported with 95% confidence intervals, and the Youden index identified the cutoff that best-balanced sensitivity and specificity.

Logistic regression was used to find independent predictors of death. Variables significant on univariate testing ($p<0.1$) entered the multivariate model. A p value below 0.05 was taken as significant.

RESULTS

DEMOGRAPHIC PROFILE

Demographic characteristics of the study population (n = 50)

Variable	Number	Percentage
Age groups		
18-30 years	8	16.0

31-45 years	14	28.0
46-60 years	18	36.0
Over 60 years	10	20.0
Gender		
Male	34	68.0
Female	16	32.0
Comorbidities		
Diabetes mellitus	12	24.0
Hypertension	8	16.0
Chronic kidney disease	4	8.0
Malignancy	6	12.0

The mean age was 48.6 years (SD 15.2), and most patients (36%) were aged 4660. The male-to-female ratio was 2.1:1.

AETIOLOGY OF PERITONITIS

Aetiology of secondary peritonitis (n = 50)

Cause	Number	Percentage
Duodenal ulcer perforation	18	36.0
Appendicular perforation	10	20.0
Ileal perforation	8	16.0
Gastric ulcer perforation	6	12.0
Large bowel perforation	4	8.0
Traumatic perforation	3	6.0
Postoperative anastomotic leak	1	2.0

Duodenal ulcer perforation was the commonest cause (36%), followed by appendicular perforation (20%).

MPI SCORE DISTRIBUTION

Distribution of MPI scores in the study population.

The mean MPI was 24.8 (SD 9.6, range 8–47). Scores were grouped as low risk (below 21), moderate risk (21–29), and high risk (30 and above).

MPI score categories (n = 50)

MPI category	Score range	Number	Percentage
Low risk	Below 21	16	32.0
Moderate risk	21-29	22	44.0
High risk	30 and above	12	24.0

MORTALITY ANALYSIS

Overall 30-day mortality was 18% (9 of 50 patients). Death rates differed significantly across the MPI categories ($p < 0.001$).

Mortality by MPI category

MPI category	Total	Deaths	Mortality
Below 21	16	0	0%
21-29	22	2	9.1%
30 and above	12	7	58.3%
Total	50	9	18.0%

ROC CURVE ANALYSIS

ROC curve for the MPI in predicting mortality.

The MPI discriminated well for mortality, with an area under the curve of 0.89 (95% CI 0.79-0.99).

Diagnostic performance at different MPI cutoffs

Cutoff	Sensitivity	Specificity	PPV	NPV
22	100.0%	58.5%	34.6%	100.0%

24	100.0%	68.3%	40.9%	100.0%
26	88.9%	82.9%	53.3%	97.1%
28	77.8%	87.8%	58.3%	94.7%
30	77.8%	92.7%	70.0%	95.0%

By the Youden index, the best cutoff was an MPI of 26, with 88.9% sensitivity and 82.9% specificity.

POSTOPERATIVE COMPLICATIONS

Postoperative complications (n = 50)

Complication	Number	Percentage
Wound infection	14	28.0
Respiratory complications	10	20.0
Sepsis	8	16.0
Acute kidney injury	6	12.0
Anastomotic leak	3	6.0
Burst abdomen	2	4.0
Need for relaparotomy	4	8.0

The overall complication rate was 46%; 23 patients had at least one complication, and wound infection was the most frequent (28%).

MPI AND COMPLICATIONS

Complication rate by MPI category.

Complication rates climbed steadily across the MPI categories. Patients with an MPI above 26 had far more complications than those below it (68.4% versus 25.8%, $p < 0.001$).

Survivors versus non-survivors

Variable	Survivors (n = 41)	Non-survivors (n = 9)	p value
Mean age (years)	46.2 (14.8)	59.4 (12.1)	0.015
Male sex	29 (70.7%)	5 (55.6%)	0.377
Mean MPI	22.1 (7.8)	37.2 (6.4)	<0.001
Duration > 24 h	18 (43.9%)	8 (88.9%)	0.016
Organ failure	4 (9.8%)	7 (77.8%)	<0.001
Diffuse peritonitis	22 (53.7%)	9 (100%)	0.008
Faecal exudate	6 (14.6%)	6 (66.7%)	0.002

HOSPITAL STAY

The mean hospital stay was 12.4 days (SD 6.8), and it lengthened with higher MPI scores: 8.6 days for an MPI below 21, 13.2 days for 21-29, and 18.4 days for 30 and above ($p < 0.001$).

DISCUSSION

This study looked at how the Mannheim Peritonitis Index performed in 50 patients with secondary peritonitis. The findings back its use as a prognostic tool in this setting.

The make-up of our patients matched what is usually seen in peritonitis. The male predominance (68%) fits earlier reports, which put it down to higher rates of peptic ulcer disease and traumatic perforation in men. The mean age of 48.6 years sits with the middle-aged groups commonly affected by both peptic and appendicular disease.

Duodenal ulcer perforation led the list (36%), in keeping with the high prevalence of peptic ulcer disease in our region. This differs from Western series, where appendicular and colonic disease are more common, and the contrast is itself an argument for doing local validation.

Our overall mortality of 18% sits within the 6% to 60% reported for secondary peritonitis. That wide spread in the literature reflects very different patient groups, healthcare resources, and definitions of severity.

The ROC analysis gave an AUC of 0.89, which points to strong discrimination for mortality and compares well with other validation work. Notash *et al.* reported an AUC of 0.82, and Sharma *et al.* found 0.91 in their cohort.

We settled on an optimal cutoff of 26, close to the 26-29 range generally used. At this value sensitivity was 88.9% and specificity 82.9%.

The high negative predictive value (97.1%) is what makes the MPI useful for spotting low-risk patients, who may not need intensive care.

The stepwise rise in mortality across categories (0% below 21, 9.1% for 21-29, and 58.3% for 30 and above) repeats the pattern from the original Mannheim cohort, and that consistency across populations is reassuring.

Beyond mortality, the MPI tracked postoperative complications. Patients scoring above 26 had nearly three times the complication rate of those below, which extends the score's usefulness to morbidity and to planning perioperative care.

Some components separated survivors from non-survivors more sharply than others. Organ failure, diffuse peritonitis, and faecal exudate had the strongest links with death, which fits what is known about the drivers of severe peritonitis.

A duration of peritonitis beyond 24 hours was much more common in those who died (88.9% versus 43.9%). This is a reminder of the value of early surgery and supports keeping time as a weighted item in the score.

Set against other systems, APACHE II offers similar accuracy but needs extensive laboratory data that are often unavailable at presentation, while POSSUM was built for general surgical patients and may miss peritonitis-specific factors. The MPI sits between simplicity and accuracy, which is what makes it workable in the emergency setting.

The study has limits. It was done at a single centre with a fairly small sample. The prospective design and consecutive enrolment help its internal validity, but multicentre work would improve generalisability. We could not assess inter-observer reliability of the scoring, though the objective nature of most items probably keeps variation low.

CLINICAL APPLICATIONS

Scoring the MPI takes about two minutes and needs no special equipment. It can be done in theatre, so risk can be graded straight away. Patients with an MPI above 26 may do better with planned intensive care admission, aggressive fluid resuscitation, and close watching for complications.

Figure shows the intraoperative findings in one of our patients with a gastric antral perforation.

Intraoperative photograph of a gastric antral perforation. An open exploratory laparotomy exposes the abdominal cavity through a midline incision. The gastric antrum lies in the centre with a full-thickness perforation and everted, oedematous margins, and the surrounding serosa is hyperaemic and inflamed. The greater omentum (upper field) is congested and oedematous, reflecting its response to peritoneal contamination, while the adjacent bowel loops remain viable.

CONCLUSIONS

The Mannheim Peritonitis Index predicts both mortality and morbidity reliably in secondary peritonitis. In our 50 patients it discriminated well, with an AUC of 0.89, and a cutoff of 26 gave the best balance of sensitivity (88.9%) and specificity (82.9%) for mortality.

The score can be worked out in theatre without special investigations, which suits resource-limited settings. Patients with an MPI above 26 need intensive postoperative monitoring, given their much higher risk of death and complications. We recommend scoring the MPI routinely in every patient undergoing emergency laparotomy for secondary peritonitis, to guide the intensity of postoperative care and the use of resources.

LIST OF ABBREVIATIONS

AKI: Acute kidney injury; APACHE: Acute Physiology and Chronic Health Evaluation; AUC: Area under the curve; CI: Confidence interval; MPI: Mannheim Peritonitis Index; NPV: Negative predictive value; POSSUM: Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity; PPV: Positive predictive value; ROC: Receiver operating characteristic; SD: Standard deviation; SPSS: Statistical Package for the Social Sciences.

DECLARATIONS

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Institutional Ethics Committee of Government medical college and hospital, Chidambaram, Tamil Nadu. All procedures were carried out in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments. Written informed consent to participate was obtained from every patient, or from the next of kin where the patient was unable to consent.

CONSENT FOR PUBLICATION

Written informed consent for publication of clinical details and accompanying images was obtained from the patient. A copy of the consent form is available for review by the Editor of this journal.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTIONS

NJS conceived and designed the study and supervised all clinical aspects. V enrolled patients, collected data, and scored the Mannheim Peritonitis Index intraoperatively. J performed the statistical analysis and interpreted the results. V drafted the manuscript. NJS and J critically revised the manuscript for important intellectual content.
All authors read and approved the final version of the manuscript.

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