

Review

A Comprehensive Meta-Analytical Review Comparing the Mannheim Peritonitis Index (MPI) and POSSUM Scoring Systems in Predicting Outcomes of Secondary Peritonitis

Arjun C, MS¹ 

¹ general Surgery, DMMC Wayanad

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Background

Secondary perforation peritonitis represents one of the most formidable and frequently Secondary perforation peritonitis is a serious and common surgical emergency worldwide, marked by severe illness, high rates of complications, and significant risk of death. high morbidity, and significant mortality. Even though source control, critical care resuscitation, and targeted antimicrobial therapy have all improved, death rates are still very different, ranging from 10% to over 30% depending on the patient's physiological reserves and the cause of the perforation. For surgical planning, patient counselling, and institutional auditing, it is important to have accurate and repeatable risk stratification. This meta-analytical review assesses, contrasts, and integrates the predictive accuracy of the disease-specific Mannheim Peritonitis Index (MPI) with the physiology-based POSSUM (Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity) scoring systems.

Methods

A systematic review and meta-analysis of 40 original articles comparing MPI and POSSUM (including its Portsmouth modification, p-POSSUM, and the colorectal variant, CR-POSSUM) in patients undergoing emergency laparotomy for secondary perforation peritonitis was conducted in accordance with PRISMA guidelines. We gathered and organized data on sensitivity, specificity, observed-to-expected (O/E) mortality ratios, and the Area Under the Receiver Operating Characteristic Curve (AUC) for both mortality and morbidity.

The results showed that both scoring systems were excellent at predicting postoperative outcomes. The combined analysis showed that POSSUM and p-POSSUM were better at predicting death overall (mean AUC 0.88 to 0.94) than the MPI (mean AUC 0.75 to 0.89). POSSUM also showed an unmatched ability to predict postoperative morbidity, which is something that MPI doesn't do as well. Classic POSSUM, on the other hand, always tended to overestimate death rates in the highest-risk groups (O/E ratio < 1). The p-POSSUM equation fixed this problem for the most part. On the other hand, the MPI showed great specificity (85% to 97%) and was easy to calculate during surgery, making it a very useful tool in emergency situations.

Conclusions

POSSUM and p-POSSUM are statistically better at predicting overall surgical morbidity and mortality, but their complicated math makes them less useful at the bedside in places where resources are limited. The MPI is still a very specific and easy-to-use tool, and hospitals should consider using a mix of methods that use the Mannheim Peritonitis Index (MPI) for making immediate surgical decisions and the p-POSSUM for reviewing and improving surgical quality later on. Real-time surgical decision-making and the p-POSSUM are used for retrospective quality assurance and surgical auditing.

1. INTRODUCTION

1.1. BURDEN OF SECONDARY PERITONITIS

Secondary peritonitis is a life-threatening surgical emergency associated with high morbidity and mortality. The Burden of Secondary Peritonitis Secondary peritonitis is a life-threatening surgical condition characterized by the compromise of the gastrointestinal or genitourinary tract, resulting in the introduction of endogenous microbes and chemical irritants into the previously sterile peritoneal cavity. It is still a major cause of surgical emergencies that aren't caused by trauma all over the world.¹⁻⁸ The pathophysiological cascade that starts with this spillage is very deep. Localized mesothelial inflammation swiftly advances to Systemic Inflammatory Response Syndrome (SIRS). If source control is delayed or inadequate, it will inevitably lead to severe sepsis, septic shock, and Multiple Organ Dysfunction Syndrome (MODS). So, even though modern times have strong broad-spectrum antibiotics, advanced intensive care units, and better surgical methods (like damage control laparotomy and open abdomen management), the death rate from secondary peritonitis is still too high.^{9,10}

1.2. NEED FOR RISK STRATIFICATION

Accurate prognostic scoring is essential for clinical decision-making and auditing.

The treatment of peritonitis is complicated and takes a lot of resources. Not all patients have the same physiological reserve to deal with the initial injury or the surgery that follows. So, it's very important to find patients who are at a high risk of bad outcomes for a number of reasons: Clinical Decision Making: High-risk patients may need more aggressive preoperative resuscitation, damage-control surgery instead of definitive anastomosis, and planned re-laparotomies. Patient Counseling: Giving families objective, data-driven prognostic information. Resource Allocation: Effectively triaging patients to Intensive Care Units (ICUs) after surgery. Surgical Auditing: Risk-adjusted data is needed to compare the quality of surgical care across different institutions or surgeons. It is scientifically invalid to compare raw mortality rates without taking into account the baseline physiological severity of the patient cohort.

1.3. EVOLUTION OF SCORING SYSTEMS

MPI and POSSUM are widely used scoring systems. Evolution of Surgical Scoring Systems To address the need for objective risk adjustment, numerous scoring systems have been developed over the past four decades. The Acute Physiology and Chronic Health Evaluation (APACHE) II score is widely used, but it was made for intensive care units and often needs 24 hours of data collection, which makes it less useful for emergency preoperative surgical triage. In the case of abdominal sepsis, the Mannheim Peritonitis Index (MPI) and the POSSUM system have been the most thoroughly studied and used in practice.¹⁻¹⁰ The MPI was created just for peritonitis, using both clinical and intraoperative data. POSSUM, on the other hand, was made as a

general physiological and operative severity score for all types of surgery. This review brings together data from 40 original research articles to give a clear comparison of the MPI and POSSUM systems in the case of secondary perforation peritonitis.

A DETAILED LOOK AT THE SCORING SYSTEMS

The Mannheim Peritonitis Index (MPI) The MPI was made by Wacha and Linder at the University of Mannheim in Germany in 1987 [Table 1]. It was made to predict the risk of death in people with peritonitis. The researchers looked at 20 possible risk factors in a retrospective cohort and used discriminant analysis to find eight independent prognostic variables. The MPI is great because it is so simple. It doesn't need complicated lab tests or monitoring of physiological functions, which makes it perfect for emergency situations and places with few resources.¹¹⁻²⁰

Patients are usually put into three risk groups based on their scores: Score < 21: Mild risk (Mortality < 5%) Score 21 - 29: Moderate risk (Mortality 15% - 25%) Score > 29: Severe risk (Mortality > 50%) 2.2 The POSSUM Scoring System Copeland et al. came up with the POSSUM Scoring System in 1991. It stands for the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity.[Table 2]

POSSUM is not disease-specific like the MPI. Instead, it is a general surgical auditing tool that can predict both mortality and morbidity for a wide range of surgical procedures. It does this by looking at 12 physiological variables (assessed before surgery) and 6 operative variables (assessed during surgery). Each variable is graded exponentially (1, 2, 4, or 8) based on how far it is from the normal physiological range.

The predicted risk of mortality (R) and morbidity are calculated using sophisticated logistic regression equations.

The predicted risk of morbidity (R1) was calculated using the POSSUM classic equation for mortality as follows: $\ln [R/(1 - R)] = -7.04 + (0.13 \times \text{physiological score}) + (0.16 \times \text{operative severity score})$

The Portsmouth Modification (p-POSSUM) Early validations of the POSSUM scoring system consistently revealed a critical flaw: while it accurately ranked patients by risk, it frequently overestimated the absolute mortality rate, particularly in low-risk patients. This phenomenon, often referred to as the "POSSUM effect," prompted the creation of the Portsmouth POSSUM (p-POSSUM) by Whiteley and Prytherch in 1996. The p-POSSUM system employs the identical 18 variables (12 physiological, 6 operative) but utilizes a modified logistic regression equation with a distinct intercept and weighting to yield a more accurately calibrated prediction of mortality:

$\ln [R/(1 - R)] = -9.37 + (0.19 \times \text{physiological score}) + (0.15 \times \text{operative severity score})$

Table 1. Mannheim Peritonitis Index (MPI)

Risk Factor / Clinical Variable	Condition	Score
Age	> 50 years	5
Sex	Female	5
Organ Failure	Presence of respiratory, renal, cardiovascular, or intestinal failure	7
Malignancy	Presence of malignancy	4
Duration of Peritonitis	Preoperative duration > 24 hours	4
Origin of Sepsis	Non-colonic origin	4
Extent of Spread	Diffuse generalized peritonitis	6
Character of Exudate	Clear	0
	Purulent	6
	Fecal	12
Maximum Possible Score		47

Table 2. POSSUM Physiological Variables (PS)

Physiological Variable	Score: 1	Score: 2	Score: 4	Score: 8
Age (years)	< 60	61 – 70	71 – 80	> 80
Cardiac Signs	Normal	On cardiac drugs (e.g., diuretics, digoxin); Borderline cardiomegaly	Peripheral edema; Warfarin therapy	Raised JVP; Cardiomegaly
Respiratory Signs	Normal	Dyspnea on exertion; Mild COPD	Limiting dyspnea; Moderate COPD	Dyspnea at rest; Pulmonary fibrosis/consolidation
Systolic BP (mmHg)	110 – 130	131 – 170 or 100 – 109	> 170 or 90 – 99	< 90
Pulse Rate (beats/min)	50 – 80	81 – 100 or 40 – 49	101 – 120 or < 40	> 120
Glasgow Coma Scale	15	12 – 14	9 – 11	< 9
Serum Urea (mmol/L)	< 7.5	7.6 – 10.0	10.1 – 15.0	> 15.0
Serum Sodium (mmol/L)	> 136	131 – 135	126 – 130	< 126
Serum Potassium (mmol/L)	3.5 – 5.0	3.2 – 3.4 or 5.1 – 5.3	2.9 – 3.1 or 5.4 – 5.9	< 2.9 or > 5.9
Hemoglobin (g/dL)	11.5 – 16.9	10.0 – 11.4 or 17.0 – 18.0	8.5 – 9.9 or > 18.0	< 8.5
White Cell Count ($\times 10^9/L$)	4.0 – 10.0	10.1 – 20.0 or 3.1 – 3.9	> 20.0 or < 3.0	–
Electrocardiogram (ECG)	Normal	–	Atrial fibrillation (rate 60–90)	Any other abnormal rhythm; >5 ectopics/min; Q waves; ST/T changes

2. METHODS

2.1. SEARCH STRATEGY

Databases searched included PubMed, Embase, Cochrane, and Scopus. This meta-analytical review synthesized data from 40 peer-reviewed, original research articles identified through major medical databases, including PubMed/MEDLINE, Embase, Cochrane Library, and Scopus. The search strategy utilized Boolean operators combining keywords: (“Mannheim Peritonitis Index” OR “MPI”) AND (“POSSUM” OR “p-POSSUM” OR “CR-POSSUM”) AND (“secondary peritonitis” OR “perforation peritonitis” OR “emergency laparotomy”) AND (“mortality” OR “morbidity”).

2.2. INCLUSION AND EXCLUSION CRITERIA

Only original studies with ≥ 30 patients were included. Inclusion and Exclusion Criteria articles were selected based on the following strict inclusion criteria: Original prospective or retrospective cohort studies. Patient cohorts consisting primarily of adults undergoing surgical intervention for secondary peritonitis. Studies that calculated and reported outcomes using either MPI, POSSUM, p-POSSUM, or a direct comparison of these systems. Studies reporting quantifiable clinical outcomes, specifically observed mortality and/or observed morbidity. Exclusion criteria included case reports, studies focusing exclusively on primary spontaneous peritonitis or peritoneal dialysis-related peritonitis,

Table 3. Patient Demographics and Peritonitis Etiology by Region

Economic Region	Typical Locations	Primary Etiologies of Peritonitis	Patient Demographics & Comorbidities
Low- and Middle-Income	India, Nepal, Middle East	Late-presenting gastroduodenal ulcer perforations, typhoid ileal perforations, neglected appendicitis	Implicitly younger populations, often with fewer chronic baseline comorbidities
High-Income	UK, Germany, USA	Lower gastrointestinal perforations (diverticular perforation, ischemic colitis, anastomotic leaks)	Older populations with higher prevalence of chronic cardiovascular and respiratory diseases

and studies with a sample size of fewer than 30 patients to prevent small-study statistical bias.

2.3. DATA EXTRACTION AND ANALYSIS

AUC and O/E ratios were analyzed. Data Extraction and Statistical Synthesis data extraction was performed systematically. The extracted variables comprised the author, year of publication, study design, geographical location, sample size, primary etiology of the peritonitis, mean MPI scores, mean POSSUM/p-POSSUM scores, observed mortality rates, and predicted mortality rates. To assess the discriminative capability of the scoring systems, the Area Under the Receiver Operating Characteristic (ROC) Curve (AUC) was analyzed. AUC of 1.0 means the test is perfect, and AUC of 0.5 means the test doesn't tell you anything useful. The Observed-to-Expected (O/E) ratio was used to check the calibration. A ratio of 1.0 means that the calibration is perfect.

3. RESULTS

3.1. STUDY CHARACTERISTICS

The 40 studies reviewed included patients from a wide range of geographic and socioeconomic backgrounds [table 3], offering a comprehensive representation of global peritonitis presentations.¹⁻⁴⁰

3.2. PERFORMANCE OF THE MANNHEIM PERITONITIS INDEX (MPI)

Across the reviewed literature, the MPI demonstrated consistent and reliable performance in predicting mortality, confirming its validity as a robust, disease-specific prognostic tool. [table 4]

A notable limitation of the MPI is its inability to incorporate physiological reserve. For example, a young patient with delayed fecal perforation may receive a similar score to an octogenarian with severe COPD and an early purulent perforation, despite markedly different capacities to withstand surgical stress.

3.3. PERFORMANCE OF POSSUM AND P-POSSUM

The physiologically comprehensive structure of the POSSUM systems resulted in superior statistical metrics across nearly all comparative studies. [table 5]

Unlike the MPI, classic POSSUM was designed to predict postoperative morbidity as well as mortality. The MPI did not demonstrate strong correlation with non-fatal systemic complications.

3.4. DIRECT COMPARATIVE OUTCOMES

In studies where both MPI and POSSUM were applied to the same patient cohorts, a consistent pattern emerged regarding their practical trade-offs. [Table 6]

The MPI offers simplicity and intraoperative practicality, while POSSUM and p-POSSUM provide deeper physiological risk stratification and superior predictive precision.

4. DISCUSSION

4.1. CLINICAL IMPLICATIONS

To treat secondary peritonitis, doctors need to find the right balance between aggressive resuscitation, precise surgery, and careful critical care. The foundation of this multidisciplinary approach is accurate prognostication. The comprehensive synthesis of these 40 articles reveals that the pursuit of the "perfect" surgical scoring system represents a fundamental trade-off between statistical accuracy and bedside clinical utility.

The Case for the Mannheim Peritonitis Index The enduring popularity of the MPI, nearly four decades after its inception, is a testament to its pragmatism. In the chaotic setting of an emergency laparotomy, especially in places where arterial blood gases, advanced electrocardiography, or comprehensive metabolic panels might not be available or might take a long time to get, it is impossible to fill out the POSSUM score correctly. The MPI gets around this problem by using age, a basic organ function test, and direct intraoperative visualization. The surgeon can quickly figure out the MPI score as soon as they open the abdomen by looking at the amount of fecal fluid, the severity of the peritonitis, and how long it has been since the symptoms started. But, as many authors in this review point out, the binary nature of the MPI's variables is a problem. "Organ failure" is treated as a single yes/no variable worth 7 points, failing to distinguish between a patient requiring low-dose vasopressors and a patient in complete anuric multi-organ failure on a ventilator.

The Supremacy of POSSUM for Auditing If the goal of the scoring system is retrospective institutional auditing

Table 4. Performance Metrics of the Mannheim Peritonitis Index (MPI)

Metric / Feature	Value / Finding	Clinical Notes
Discriminative Power (AUC)	0.75 – 0.89	Consistent and reliable performance for mortality prediction
Mortality (Score < 21)	0% – 5%	Strong predictive validity for low-risk category
Mortality (Score > 29)	> 50%	Exponentially elevated risk, particularly with delayed surgery (> 48 hours)
Pooled Sensitivity	~85%	Evaluated at a cut-off threshold of 26 points
Pooled Specificity	88% – 97%	Evaluated at a cut-off threshold of 26 points
Primary Limitation	Lacks physiological depth	Highly sensitive to disease duration but does not adequately account for severe pre-existing comorbidities

Table 5. Performance Metrics of POSSUM and p-POSSUM

Metric / Feature	Finding	Clinical Notes
Discriminative Power (AUC)	0.88 – 0.99	Near-perfect rank ordering; consistently superior to MPI in head-to-head studies (e.g., Nachiappan 2016; Pathak et al. 2023; Sharma & Singh 2024)
Calibration (Classic POSSUM)	Over-predicts mortality	Predicted mortality 30–40% vs. actual 15–20% (O/E ratio < 1.0)
Calibration (p-POSSUM)	Highly accurate	Corrected over-prediction; O/E ratio approximates 1.0 in elective and emergency cohorts
Morbidity Prediction	Highly sensitive	Accurately predicts ICU admission, prolonged hospitalization, wound dehiscence, anastomotic leak, acute renal failure, and ventilator dependence

Table 6. Direct Clinical Comparison (MPI vs. POSSUM)

Feature	Mannheim Peritonitis Index (MPI)	POSSUM / p-POSSUM
Primary Focus	Local peritoneal factors	Systemic physiological and operative factors
Key Predictive Variables	Character of exudate, duration of disease	Serum urea, Glasgow Coma Scale, respiratory status
Clinical Utility	Intraoperative “character of exudate” provides immediate tactile risk assessment valued by surgeons	Physiological variables provide essential systemic prognostic insight not captured by MPI

and quality assurance, the literature unequivocally supports the use of p-POSSUM. The 18 variables provide a detailed picture of the patient’s physiological state during surgery. This is especially important in modern surgical practice, where it is necessary to compare the performance of different surgical units. Unit A may be unfairly punished if its crude peritonitis death rate is 25% and Unit B’s is 12%. However, if p-POSSUM analysis shows that Unit A gets a lot of older patients with delayed presentations and serious physiological problems (SAPS, high urea, tachycardia), while Unit B treats younger, healthier patients, the risk-adjusted mortality might show that Unit A is actually doing better.

4.2. THE LIMITATIONS OF THE CURRENT LITERATURE

While this meta-analysis gives a clear picture, there are some problems with the source literature that need to be noted: Heterogeneity of Etiology: Perforation peritonitis is not a homogenous disease. A perforated duodenal ulcer (initially presenting as chemical peritonitis) exhibits a markedly distinct microbiological and physiological progression compared to a perforated diverticulum (manifesting as gross fecal peritonitis). Many of the 40 studies combined these causes, which may have made the scoring systems less accurate for specific diseases. Definition of Organ Failure: The definitions of respiratory, renal, and cardiovascular failure have changed a lot since the MPI was made in 1987 (for example, the Sepsis-3 guidelines were added in 2016). Many current studies utilize contemporary definitions of sepsis retroactively on older scoring systems,

Table 7. Comparative Performance of the Mannheim Peritonitis Index (MPI) and POSSUM/p-POSSUM in Peritonitis

Feature	Mannheim Peritonitis Index (MPI)	POSSUM	p-POSSUM
Primary Focus	Local peritoneal severity	Systemic physiological + operative severity	Modified mortality prediction model
Key Variables	Age, organ failure, malignancy, duration >24h, origin of sepsis, character of exudate	12 physiological + 6 operative variables (e.g., serum urea, GCS, respiratory status, blood loss)	Adjusted regression equation using POSSUM variables
Discriminative Power (AUC)	0.75 – 0.89	0.88 – 0.99	0.88 – 0.99
Mortality Prediction Accuracy	Good at extremes (<21 low risk; >29 high risk)	High discrimination but overestimates mortality	Highly accurate; corrected overestimation
Calibration (O/E Ratio)	Generally acceptable	<1.0 (over-predicts mortality)	≈1.0 (well calibrated)
Sensitivity (Cut-off ≈26)	~85%	Very high	Very high
Specificity	88% – 97%	High	High
Morbidity Prediction	Limited	Designed to predict postoperative morbidity	Less commonly used for morbidity
Strengths	Simple, quick, intraoperative utility	Excellent physiological depth; strong statistical performance	Improved mortality calibration
Limitations	Lacks physiological reserve assessment	Complex; time-consuming; mortality overestimation	Requires calculation model

potentially distorting validation outcomes. Subjectivity in Operative Variables: The POSSUM operative variables (e.g., “Operative Severity,” ranging from minor to major+) exhibit intrinsic subjectivity. A senior consultant surgeon may classify a procedure as “moderate,” whereas a junior resident may categorize it as “major,” resulting in inter-observer variability in score calculation.

5. CONCLUSION

Secondary peritonitis continues to pose a complex surgical challenge with significant consequences for patient survival. This comprehensive analysis of 40 clinical studies substantiates that objective risk stratification is not merely an academic endeavor, but a clinical imperative. The Mannheim Peritonitis Index and the POSSUM systems are both reliable, validated instruments; however, they fulfill distinct primary purposes. The p-POSSUM equation is the best way to predict both morbidity and mortality because it is statistically better and multidimensional. This makes it the best choice for surgical auditing, clinical governance, and academic research. However, just because it is mathematically better doesn’t mean it is always useful in the clinic. The MPI is still a very useful, very specific, and very easy-to-use prognostic index that can help doctors make quick decisions at the bedside. The international surgical community should now push for a dual-axis approach: using the MPI for quick, real-time surgical triage and intraoperative strategy, and adding p-POSSUM data to electronic medical records for thorough, risk-adjusted retrospective auditing. Artificial intelligence and machine learning models may soon fill this gap, making a new generation of dy-

namic, automated scoring systems that combine the depth of POSSUM with the speed of the MPI.

ETHICS APPROVAL

This study was given a non-human subject study by reviewing the database. A Review article.

DATA AVAILABILITY

Databases searched included PubMed, Embase, Cochrane, and Scopus. This meta-analytical review synthesized data from 40 peer-reviewed, original research articles identified through major medical databases, including PubMed/MEDLINE, Embase, Cochrane Library, and Scopus.

COMPETING INTERESTS

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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AUTHORS’ CONTRIBUTIONS

Single Author Dr Arjun Chinnappa collected the data, analysed, discussed and concluded.

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