Section: Surgical Oncology

Original Research Article

THE P-POSSUM SCORING SYSTEM IN PREDICTING POSTOPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING SURGERY FOR GASTRIC AND ESOPHAGOGASTRIC JUNCTION CANCER

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Received *: 29/07/2026*
Received in revised form *: 02/09/2026*
Accepted *: 14/09/2026*

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DOI: 10.70034/ijmedph.2026.3.877

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 5686-5692

ABSTRACT

Background: Preoperative risk assessment and careful patient selection improve postoperative outcomes in D2 gastrectomy. P-POSSUM is a scoring system that estimates the risk of postoperative morbidity and mortality using perioperative parameters. This study evaluated the accuracy of P-POSSUM in predicting the risk of mortality and morbidity in patients undergoing D2 gastrectomy.

Materials and Methods: We collected perioperative patient data for P-POSSUM score analysed retrospectively from a prospectively maintained database. P-POSSUM estimated risk of postoperative morbidity and mortality was calculated using an online calculator. Patients were categorised into low (<3.3%), intermediate (3.3-6.3%), and high (>6.3%) risk groups for 30-day mortality, as well as low (<55%), intermediate (55-70%), and high (>70%) risk groups for 30-day morbidity. The observed and expected events for each group were compared and analysed.

Results: A total of 185 eligible patients were evaluated, of whom 144 met the inclusion criteria. Postoperative complications were observed in 83 (57.6%) patients, among whom 26 (32%) had major complications (Clavien-Dindo grade ≥ III) and 57 (68%) had minor complications (Clavien-Dindo grade I-II). The 30-day mortality rate was 3.5% (n=5). P-POSSUM predicted a mortality rate twice as high as the observed rate. However, the predicted overall morbidity by P-POSSUM closely matched the observed rate (observed-to-expected ratio = 0.9).

Conclusion: P-POSSUM is unsuitable for predicting postoperative mortality risk in gastrectomy patients. While it may aid in morbidity prediction, accuracy improvement and validation in diverse populations and surgical subtypes are necessary.

Keywords: P-POSSUM, Gastrectomy, Stomach Neoplasms, Postoperative Complications, Risk Assessment.

INTRODUCTION

Gastrectomy with D2 Lymphadenectomy is the standard surgical option for resectable gastric cancer. However, it is associated with a postoperative morbidity rate of 9-46% and a mortality rate of 4.1%.[1] Predicting postoperative morbidity and mortality would help decide the treatment (surgery/extent of surgery/non-surgical/alternate treatment options). It can assist surgeons in planning the surgery better and taking necessary precautions to minimise the risk of complications. Preoperative risk stratification can aid in quality improvement and benchmarking efforts. By comparing outcomes between patients at different levels of risk, surgical teams can identify areas for improvement and implement interventions to enhance patient outcomes.

For the assessment of the postoperative risk of mortality and morbidity, many scoring systems have

been developed,[2,3] such as the P-POSSUM Score (Portsmouth-Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity)4, ACS NSQIP (American College of Surgeons National Surgical Quality Improvement Program) Surgical Risk Calculator,[5] and the Cologne Risk Score.[6] Among these, the P-POSSUM score is easy to calculate, which estimates the risk of overall morbidity and mortality and gives a value in percentage.

The POSSUM score was developed in 1991 by Copeland et al. and was used to predict postoperative morbidity and mortality.[7] It uses twelve physiological and six operative parameters and estimates the risk of postoperative morbidity and mortality. It has been studied that the POSSUM score tends to overestimate mortality in low-risk patients and underestimate the risk of mortality in elderly patients and emergency patients. Therefore, the predictor equation was modified using a standardised technique for logistic regression, and the P-POSSUM (Portsmouth-POSSUM) scoring system was developed.[8] The P-POSSUM score can be calculated using an online calculator, which gives a predicted value in proportion to the risk of morbidity and mortality. The lowest risk of mortality is 0.2%, the lowest risk of morbidity is 5.5%, and the highest risk of morbidity and mortality is 100%.[9]

As a risk predictor and auditing tool, p-POSSUM is widely used in general surgery, except for trauma. It has undergone various modifications for specific types of surgeries like colorectal, vascular, hepatobiliary, and orthopaedic surgery.[8,10] Some studies have concluded that P-POSSUM is a better predictor of mortality in gastroesophageal cancer than POSSUM.[11] However, other studies, including a review article that analysed ten studies, found that P-POSSUM is a poor predictor of postoperative mortality.[8,12] Given the varied conclusions, we used the P-POSSUM model to assess the risk of morbidity and mortality in South Asian gastric cancer patients undergoing gastrectomy with D2 Lymphadenectomy to evaluate its applicability.

MATERIALS AND METHODS

We retrospectively analysed data from our Institute's prospectively maintained Surgical Oncology database. Patients with gastric and gastroesophageal junction cancers who underwent Open radical gastrectomy with D2 dissection with curative intent from May 2016 to March 2023 were included in the study. Patients with incomplete data for calculating the P-POSSUM score were excluded.

Workup and treatment protocol: The initial workup involved upper gastrointestinal endoscopy with biopsy, followed by Contrast-enhanced CT Thorax abdomen and pelvis to diagnose and stage the disease for treatment planning. Patients with clinical T4 disease or bulky multi-station nodes were considered for perioperative chemotherapy, while those with T1, T2, T3 stage, and N0 or single station N1 were considered for upfront surgery.

Patient demographic details, preoperative indices such as the American Society of Anesthesiologists (ASA) score, co-morbidities, nutritional status (BMI, Hemoglobin, and Serum Albumin levels), and neoadjuvant therapy details were retrieved. The patient's nutritional status and comorbidities were optimised before surgery.

Surgical procedure and perioperative management: The type of gastrectomy was based on the location of the primary tumor. A Subtotal gastrectomy was performed on distal tumors. Total gastrectomy was done for tumors with diffuse involvement of the stomach, tumors involving the body of the stomach, large proximal tumors, or proximal tumors with bulky nodal disease. Proximal gastrectomy was performed for an early-stage proximal tumor (T1/2, N0). D2 lymphadenectomy was done according to the Japanese gastric cancer guidelines.[13] For analysis, proximal gastrectomy and subtotal gastrectomy were combined and termed partial gastrectomy.

Postoperative Morbidity and Mortality: All complications during the post-operative period, either surgical or non-surgical, were recorded and graded according to the Clavien-Dindo classification for 30 days.[14] Clavien-Dindo grades I and II were classified as minor complications, and grades ≥III were considered major complications. Postoperative complications such as surgical site infection, atelectasis, pleural effusion, paralytic ileus, anastomotic leak, duodenal stump blowout, delayed gastric emptying, and any other complications were noted and managed according to the institutional policy. Post-operative mortality is defined as all deaths within 30 days of surgery. The P-POSSUM score with an estimated risk of morbidity and mortality was calculated for each patient using an Online calculator (www.riskprediction.org.uk)9. Based on the P-POSSUM score, patients were categorised into three risk range groups: low, intermediate, and high risk. [Table 1, 2; Figure 1]

Table 1: Grading of postoperative complications.

Clavien-Dindo grade	Partial Gastrectomy (n=102)	Total Gastrectomy (n=42)
Grade I	08 (7.8%)	05 (12%)
Grade II	33 (32%)	11 (26%)
Grade IIIa	01 (0.9%)	06 (14.2%)
Grade IIIb	08 (7.8%)	03 (7.1%)
Grade IVa	01 (0.9%)	01 (2.4%)
Grade IVb	00	00
Grade V	03 (2.9%)	02 (4.8%)

Table 2: Results of P- POSSUM expected morbidity compared to observed morbidity.

P-POSSUM Morbidity risk categorization (%)	Number of patients (n)	Mean predicted risk of morbidity (%)	Observed morbidity		Observed total morbidity (n)	Expected morbidity (n)	O: E ratio	Chi2 value-3.9 p-Value-0.14
			Minor	major				
Low risk < 55	49	48.2	16	14	30	24.1	1.2	
Intermediate Risk 55-70	52	63.9	21	06	27	33.2	0.8	
High Risk > 70	43	80.2	20	06	26	33.6	0.7	
Total	144	63.2	57	26	83	91	0.9	

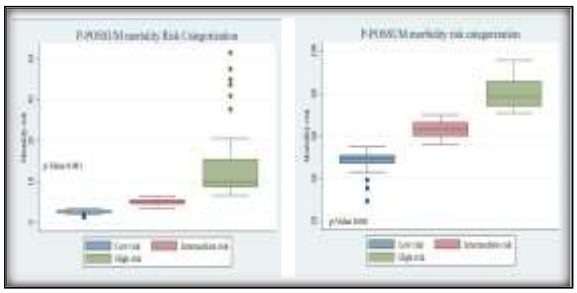

Figure 1: Box-and-whisker plot showing the distribution pattern of P-POSSUM predicted risk of mortality and morbidity in each risk groups.

Statistical Analysis: Categorical data were expressed as frequency and percentages, while continuous variables were expressed as means with standard deviations or as medians with interquartile range (IQR), as appropriate. We calculated each group's expected morbidity and mortality by multiplying the number of operations by the mean risk. We then tabulated the observed Morbidity and Mortality in each group and used the chi-square test to detect any differences between expected and observed rates of Morbidity and Mortality. The p-value < 0.05 was considered as significant.

RESULTS

Among the 185 patients with gastric cancer who underwent curative gastrectomy with D2 Lymphadenectomy from May 2016 to March 2023, 144 patients met the inclusion criteria, depicted in Figure 2. The clinicopathological data of these patients are enumerated in Table 3. The population's median age was 58 years, and neoadjuvant chemotherapy was received by 36% of patients, and the most common procedure was subtotal gastrectomy (64 %).

Figure 2: Flow chart showing details of risk groups.

Table 3: Demographic details and major complications.

Variable	Numbers (percentage)	Major complications	p-Value
Age			
<=50 years	36 (25%)	03 (8.3%)	0.08
>50 years	108(75%)	23 (21.3%)	
Gender			
M	98 (68%)	21 (21.4%)	0.12
F	46 (32%)	5 (10.8%)	
BMI Group (n=134)			
<18.5	28 (20.8%)	4 (17.2%)	
18.5-24.9	71 (53%)	11(15.5%)	0.76
25-29.9	30 (22.3%)	7 (23.3%)	
≥30	05 (3.7%)	1 (20%)	
Hb			
<10 mg/dl	41(26%)	2 (7.8%)	
10-12 mg/dl	54 (37.5%)	7 (9.3%)	0.003
>12 mg/dl	49 (34%)	17 (34.6%)	
Albumin level (n=140)			
<3.5 gm/dl	70(50%)	12(17.1%)	
>3.5 gm/dl	70 (50%)	13 (18.5%)	0.75
Comorbidities			
None	96 (66.6%)	11 (11.4%)	
Single	31 (21.5%)	7 (22.5%)	0.002
Multiple	17 (11.8%)	8 (47%)	
Pathological Stage			
I	24 (16.6%)	04 (16.6%)	
II	36(25%)	03 (8.3%)	0.31
III	75 (52%)	17 (22.6%)	
IV	9 (6.2%)	02 (22.2%)	
Type of Gastrectomy			

Partial Gastrectomy Total Gastrectomy	102 (70.8%) 42 (29.2%)	14 (13.7%) 12 (27.3%)	0.05
Chemotherapy details Upfront surgery Perioperative chemotherapy	 93 (64.5%) 51 (35.5%)	 14 (15%) 12 (23.5%)	 0.2
Duration of surgery <4hours >4hours	 50 (34.7%) 94 (65.3%)	 11 (22%) 15 (15.9%)	 0.3
Blood loss < =250 ml >250 ml	 79 (54.8%) 65 (45.1%)	 11 (14%) 15 (23%)	 0.15

All patients underwent D2 Lymphadenectomy, and nine underwent extended resections of involved surrounding organs to achieve R0 resection. Mesocolon was excised in five patients, pancreatic capsule was excised in two, distal pancreaticosplenectomy with excision of the cuff of left hemidiaphragm, and transverse colectomy was done in one patient each.

The mean operative duration was 288 minutes (SD-85), and the mean blood loss was 330 ml (SD-236).

The median postoperative ICU stay was one day (Range 1-29 days), with 33.64% of patients requiring postoperative elective ventilation. We observed postoperative complications in 58 % (n=83) of patients, among whom 32% (n = 26) had major complications. Surgical site infection was the most common complication (n=27), followed by respiratory complications (n=26). The mean hospital stay was 12 days (SD-7.7), details shown in Table 3 and [Table 4].

Table 4: Details of postoperative complications

Type of complications	**Frequency**	
	Partial Gastrectomy (n=102)	**Total Gastrectomy (n=42)**
Respiratory complications Pleural effusion Basal Atelectasis Hospital acquired pneumonia. Aspiration Pneumonitis Respiratory distress COPD exacerbation	12(11.7%) 04 03 03 01 01 00	14(33.3%) 07 03 00 01 01 02
Surgical site infections (SSI) Superficial SSI Deep SSI	18 (17.6%) 12 6	09(21.4%) 06 03
GI complications Colonic pseudo-obstruction Gastroparesis Gastric remnant ischemia GJ site edema Pelvic collection Colonic fistula Intestinal Obstruction GB perforation	18 (17.6%) 2 6 1 1 1 1 5 1	01 (2.4%) 00 00 00 00 00 00 01 00
Post-operative blood transfusion	17 (16.6%)	08 (19%)
Re-surgery Anastomotic leak Duodenal stump blowout Colonic fistula Adhesiolysis Paralytic ileus Deep SSI Gastric remnant ischemia GB perforation Liver injury	11 (10.7%) 02 03 1 1 1 1 1 1 00	04 (9.5%) 01 01 00 00 00 01 00 00 01
Readmission Anastomosis leak Gastroparesis Duodenal stump blow-out Paralytic ileus Pleural effusion SSI Jejunojejunostomy site edema	07 (6.8%) 00 2 1 1 00 2 1	02 (4.7%) 01 00 00 00 01 00 00
Duodenal stump leak	05 (4.9%)	01 (2.3%)
Anastomotic leak Esophagojejunostomy site leak Gastrojejunostomy site leak Colo colic anastomosis leak	02 (1.9%) NA 1 1	02 (4.7%) 02 NA 00

On univariate analysis, patients who underwent total gastrectomy had a higher rate of major complications than those who underwent partial gastrectomy (p-value 0.05). Patients with multiple comorbidities also showed an increased rate of major complications (p-value 0.002). Respiratory complications, such as pleural effusion requiring intercostal drainage under local anaesthesia and respiratory distress requiring intensive care unit monitoring, were more common in patients who underwent total gastrectomy. On the other hand, gastrointestinal complications such as intestinal obstruction, duodenal stump blowout, and gastroparesis were more frequent in patients who underwent partial gastrectomy. Rates of readmissions and reoperations were similar between patients who underwent partial and total gastrectomy." shown in detail in Table 4. Other variables, such as age, gender, BMI, serum albumin level, duration of surgery, median blood loss, stage of disease and neoadjuvant chemotherapy, did not influence the rate of postoperative complications.

The overall morbidity predicted by P-POSSUM was almost similar to the observed 30-day morbidity with an observed to-expected ratio of 0.9. P-POSSUM tended to Underestimate the Morbidity in low-risk groups and overestimate the morbidity in intermediate and high-risk groups, but this was not statistically significant (p-Value 0.14), as depicted in [Table 2].

Overall, the 30-day mortality rate was 3.5% (n = 5); mortality details are shown in Table 5. Among the four observed mortalities in the low-risk group, two patients died due to gastrojejunostomy leak and gastric remnant stump ischemia. The third death in the low-risk group was due to respiratory distress with suspected pulmonary thromboembolism. The Last patient had mortality due to the hematemesis post-surgery. Single mortality was observed in the high-risk group; he died due to aspiration following an oral Gastrografin study done to confirm the esophagojejunostomy anastomosis integrity.

Table 5: Details of Mortality

Sl /no	Cause of mortality	Postoperative Day
1	Aspiration pneumonitis	17
2	Respiratory Distress (suspected Pulmonary Thromboembolism)	06
3	Gastrojejunostomy leak	13
4	Gastric Fundus perforation	23
5	Upper Gastrointestinal Bleed	23

The P-POSSUM score predicted a two times higher overall mortality rate than the observed 30-day mortality rate. When looking at the individual risk groups, the observed mortality rate in the low-risk group was three times higher than the predicted mortality rate. In contrast, in the high-risk group, it was only 0.16 times the predicted mortality rate, with a p-value of 0.005. This suggests a significant discrepancy between the predicted and observed 30-day mortality rates, as shown in [Table 6].

Table 6: Results of P- POSSUM expected mortality compared to observed mortality.

P-POSSUM Mortality risk (%)	Number of patients (n)	Mean predicted risk of mortality (%)	Expected mortality (n)	Observed 30-day mortality (n)	O: E ratio	Chi2 Value-10.2
Low risk < 3.3%	49	2.6	1.2	4	3.3	
Intermediate Risk 3.3-6.3%	52	5	2.6	0	0	
High Risk > 6.3%	43	13.8	5.9	1	0.16	P-Value-0.005
Total	144	7.1	10.2	5	0.49	

DISCUSSION

This study evaluated the applicability of the P-POSSUM scoring system in predicting postoperative morbidity and mortality in curatively resected gastric cancer patients. We found that the predicted overall and observed morbidity were similar in the cohort. However, upon examining the individual groups, we found that it tended to overestimate the morbidity in low-risk groups and underestimate the risk in intermediate and high-risk groups. Nevertheless, this difference was not statistically significant, possibly due to the low sample size. The P-POSSUM-predicted mortality was two times higher than the overall 30-day mortality. In the low-risk group, the P-POSSUM scoring system underestimated the mortality, with the observed mortality being four times higher than predicted. In the high-risk group, the scoring system overestimated the mortality by six times. This difference in observed and predicted mortality was statistically significant, indicating that the P-POSSUM scoring system is not a good predictor of mortality risk in gastric cancer patients. As the P-POSSUM scores were categorized into risk groups instead of continuous variables, a specific cut-off score could not be generated.

Surgical management for resectable gastric cancer requires a delicate balance between achieving maximum locoregional control and minimising morbidity and mortality. The morbidity following radical gastrectomy depends on many factors15. The first factor is the extent of surgical resection, such as the extent of lymphadenectomy and the need for bursectomy and pancreaticosplenectomy. The Dutch trial and MRC trial have shown that D2 lymphadenectomy has a higher morbidity and

mortality rate than D1 lymphadenectomy.[16,17] The second factor is operative experience. Centres in Japan have shown less postoperative morbidity than Western centres directly attributed to the high-volume centres and expertise of the surgeon.[16,17] The third factor is the patient's nutritional condition, as poor nutritional status increases postoperative morbidity18. None of these factors are considered in the P-POSSUM scoring system.

The P-POSSUM scoring system does not consider the status of chemotherapy and radiotherapy in patients with malignancies. Neoadjuvant chemotherapy may lead to febrile neutropenia, diarrhoea, and vomiting, which may alter the patient's nutritional condition. Chemotoxicity during perioperative chemotherapy may cause grade III and IV toxicity, increase the Intensive care unit requirement, and increase the mortality risk.[19–21]

Another scoring system, O-POSSUM, is a dedicated tool for esophageal and gastric surgeries that predicts only mortality. However, the risk of morbidity is equally important, as timely adjuvant therapies are crucial for better oncological outcomes. Like P-POSSUM, O-POSSUM does not consider patient nutritional parameters and perioperative chemotherapy and radiotherapy status of the patient.[10]

Similar to our study, many studies, including a review article8, have found that P-POSSUM and O-POSSUM tend to overestimate mortality in patients undergoing esophagogastric surgery.[22,23] Still, P-POSSUM was found to be the least overestimating among them.[8,12] A study by Eichelmann et al. also found that P-POSSUM tends to overestimate the mortality while the observed morbidity rate was similar to the estimated morbidity,[24] [Table 7].

Table 7: Studies of P-POSSUM on postoperative mortality in patients undergoing Gastrectomy for gastric cancer.

Study	Year (country)	Patients (n)	P-POSSUM		O/E ratio	Comments
			Observed mortality (%)	Predicted mortality (%)		
Lamb et al,[22]	2008 (UK)	180	1.7	7.8	0.21	Overestimates the risk (p=0.006)
Gocmen et al,[23]	2004 (Turkey)	126	11.1	15.8	0.7	Overestimates risk (p = 0.002)
Hong et al,[11]	2015 (China)	510	2.7	2.5	1.08	Correct estimation (p = NS)
Eichelmann et al,[24]	2020 (Germany)	136	2.5	4.4	1.76	Overestimates the risk

The P-POSSUM scoring system is a nonspecific model developed from data on general surgical cases. To apply it to gastric cancer surgeries, the determining factors for calculating the operative severity score were similar for all our patients. All surgeries were considered major and elective, had no peritoneal contamination, and were malignant diseases with similar estimated blood loss. The model does not consider the type of gastrectomy, the extent of lymphadenectomy or the need for bursectomy and resection of adjacent organs, which are known to influence the postoperative course.[16,17] This highlights the need for a specific scoring system to predict the postoperative period in patients undergoing gastrectomy for gastric cancer.

The strength of this study is that it used a prospectively maintained Surgical Oncology database with detailed clinical and pathological data. The limitations are that the sample size was relatively small, which may limit the study's statistical power.

CONCLUSION

The P-POSSUM score is useful in predicting postoperative morbidity and mortality, but it is not specific to gastrectomy in patients with gastric cancer. This requires many modifications and validation for its use in different populations and surgical subtypes. This can help identify high-risk patients and optimise their perioperative care to reduce the risk of postoperative complications and improve oncological outcomes in gastric cancer.

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