

# Validity of P-POSSUM in adult cancer surgery (PACS)

Sudipta Mukherjee, Ankit Kedia, Jyotsna Goswami, Arunangshu Chakraborty

Department of Anaesthesia, Critical Care and Pain, Tata Medical Center, Kolkata, West Bengal, India

## Abstract

**Background and Aims:** Objective prediction of postoperative morbidity and mortality can help clinicians for appropriate resource allocation and counseling of patients and their kin. Among different scoring systems, “Portsmouth- Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity” (P-POSSUM) includes both preoperative and intraoperative parameters for postoperative risk prediction. The aim of this study was to investigate the validity of morbidity prediction by P-POSSUM in patients requiring intensive care after undergoing major surgeries for gastrointestinal and gynecological malignancies.

**Material and Methods:** All adult patients (>18 years) undergoing gastrointestinal and gynecological cancer surgeries who were shifted to intensive care unit (ICU) or high dependency unit (HDU) for postoperative care were included and P-POSSUM was measured. Postoperative complications were graded as per Clavien–Dindo (CD) grading and have been compared with predicted complications as per P-POSSUM.

**Results:** 143 patients were included in the study and the median P-POSSUM score was 35. The mean predicted morbidity was 55.28% (SD 25.54%) and the observed complications were 45.45%, which shows P-POSSUM has over predicted morbidity. At P-POSSUM values 60 and above, the incidence of major complications was 22.22%, compared to 6.25% for the rest (Odds ratio 4.286).

**Conclusion:** P-POSSUM is not a reliable predictor of postoperative morbidity for patients undergoing major gynecological and gastrointestinal surgeries for cancer in our institution. But there is a significant incidence of major complications with P-POSSUM morbidity prediction score 60 or higher leading to the need for more stringent assessment and monitoring in that subgroup.

**Keywords:** Malignancy, postoperative care, postoperative complications, postoperative morbidity

## Introduction

Mortality and morbidity are important yardsticks of measuring the surgical outcomes. Various attempts have been made to predict the postoperative outcome after major surgeries so that decision-making regarding the feasibility of the surgery, resource allocation, counseling patients or their kin, and comparing the performance of different surgical teams can be made more systematically. Scoring systems like American Society of Anesthesiologists Physical Status (ASA-PS) Classification, Revised Cardiac Risk Index (RCRI), and National Surgical Quality Improvement Program (NSQIP) were developed

based on the preoperative health status of the patient and nature of the proposed surgery. However, these scoring systems did not account for the intraoperative events, which are crucial determinants of postoperative outcomes as well. Scoring systems like Portsmouth-Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (P-POSSUM) and Surgical Apgar score (SAS) account for intraoperative events. But SAS does not include preoperative status of the patient making it apparently less representative of postoperative course.

Copeland *et al.* first described POSSUM in 1991 as a scoring system for surgical audit.<sup>[1]</sup> It was found to over predict

Address for correspondence: Dr. Sudipta Mukherjee,  
Tata Medical Center, 14, Major Arterial Road (EW), Newtown,  
Rajarhat, Kolkata - 700 160, West Bengal, India.  
E-mail: sudipta.nrs@gmail.com

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death, especially amongst the low-risk patients. This led to the modification of the logistic regression and the development of the P-POSSUM.<sup>[2]</sup> P-POSSUM seems to reflect mortality risk better than POSSUM.<sup>[3]</sup> However, this group did not modify the morbidity prediction model. Various studies have validated P-POSSUM or one of its variants in general surgery, laparotomy, or in high-risk patients for the prediction of mortality;<sup>[4,5]</sup> but there is not enough data for the prediction of morbidity with P-POSSUM. In one study involving 92 laryngectomies, morbidity predicted by POSSUM was found to have poor correlation with bed occupancy.<sup>[6]</sup>

In this observational study, we investigated the validity of morbidity prediction by P-POSSUM in patients requiring ICU and HDU care after undergoing major surgeries for gastrointestinal and gynecological malignancies at our institution.

## Material and Methods

After getting clearance from Institutional Review Board (IRB), all adult patients (>18 years) undergoing gastrointestinal and gynecological cancer surgeries between October 2017 and February 2018, who were shifted to ICU or HDU for postoperative care in our institute were included in this prospective observational study. The patients for whom the P-POSSUM score could not be estimated were excluded from the study. Data from 143 patients undergoing surgeries within the stipulated time period were collected and followed up for 30 days by the surgical team. Need for consent from patients or their kin had been waived off by IRB as all the data had been collected from the patient's file and documents; and no direct interaction with the patient was made.

P-POSSUM score and predicted morbidity was calculated based on the 12 preoperative and 6 intraoperative parameters for a given patient [Figure 1]. The clinical parameters from the nursing chart in the immediate preoperative period, the latest available biochemical parameters, and ECG were used to calculate the physiological score. The operative score was calculated based on intraoperative events and findings. The combination of the two scores was used to estimate the predicted morbidity according to the equation suggested by Prytherch *et al.*<sup>[3]</sup> The incidence of postoperative complications was recorded and graded as per Clavien–Dindo (CD) classification [Figure 2]. These data were collected by the respective surgical team based on their 30 days follow-up in the postoperative period; they were blinded about the predicted P-POSSUM morbidity assessment for the respective patient. CD score of 1 or above has implied the incidence of any complication while a CD score of 3 or higher was considered as a major complication. The predicted morbidity as per

P-POSSUM was been compared with actual morbidity measured by Clavien–Dindo (CD) grade.

## Results

We collected data from a total of 143 patients out of which 81 were submitted to gastrointestinal cancer surgeries and 62 patients underwent surgeries for gynecological cancers. The P-POSSUM scores were normally distributed ranging from 20 to 55 for the patients included. The median P-POSSUM score was 35. The mean predicted morbidity was 55.28% (SD 25.54%). The observed incidence of any complication as per CD classification was 45.45%. So it was over predicting morbidity in our observation. The correlation coefficient between the predicted morbidity and observed complication was 0.24. The patients were categorized in deciles based on their predicted postoperative morbidity percentage as predicted from P-POSSUM score [Table 1]. Receiver operating characteristic curves (ROC) [Figure 3] were drawn for the incidence of any complication and major complication. A cut off value of 50 for “predicted morbidity” had the highest sensitivity and specificity of 69% and 54%, respectively for predicting the incidence of “any complication”. A cut off value of 60 for “predicted morbidity” had the highest sensitivity and specificity of 73% and 60%, respectively for predicting the incidence of “major complication”.

The incidence of “any complication” in patients with P-POSSUM predicted morbidity ranging between 20 and 70 percent ( $n = 81$ ) matched with the predicted outcome [Figure 4]. The departments performed better than expected outcomes when the P-POSSUM predicted morbidity was more than 70%. This group has included about 33% of the sample size. The incidence of actual complication in patients with P-POSSUM predicted morbidity is less than 20%’ was more than what was predicted.

The incidence of major complications was 13.29% and no mortality was observed during the 30-day follow-up period. The correlation coefficient of observed major complications with predicted morbidity was 0.15. It was also noted that 14 out of 19 major postoperative complications were clustered in the group of patients for whom the P-POSSUM value was more than 60. The incidence of major complications was 22.22% in this subgroup of patients, compared to 6.25% for the rest. Considering type 1 error <0.05 and power of the study >80%, the odds ratio of having a major complication in this sub-group (P-POSSUM predicted morbidity score more than 60) was 4.286 compared to the patients with P-POSSUM predicted morbidity score less than 60 (Chi-square statistic is 7.8041,  $P$  value 0.005;

Score	1	2	4	8
Age (years)	≤60	61~70	≥71	—
Cardiac sign	Normal	Cardiac drug or steroid	Edema:Warfarin	JVP*
CXR <sup>†</sup>	Normal	—	Borderline cardiomegaly	Cardiomegaly
Respiratory sign	Normal	SOB <sup>‡</sup> exertion	SOB stasis	SOB at rest
CXR	Normal	Mild COAD <sup>§</sup>	Mod COAD	Any other change
Blood pressure				
Systolic	110~130	131~170	≥171	—
		100~109	90~99	≤89
Pulse	50~80	81~100 or 40~49	101~120	≥121≤39
Hemoglobin	13.0~16.0	11.5~12.9 or 16.1~17.0	10.0~11.4 or 17.1~18.0	≤9.9≥18.1
Coma score	15	12~14	9~11	≤8
WBC <sup>  </sup> count (×10 <sup>3</sup> /ml)	4.0~10.0	10.1~20.0 or 3.1~3.9	≥20.1≤3	—
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	≤2.8≥6
Urea (mmol/L)	<7.5	7.6~10	10.1~15	≥15.1
Sodium (mmol/L)	>136	131~135	126~130	<125
ECG <sup>¶</sup>	Normal	—	Atrial fibrillation (60~90)	Any other change

Score	1	2	4	8
Operative magnitude*	Minor	Intermediate	Major	Major+
No. of operation within 30 days	1	2	2	>2
Blood loss per operation (ml)	<100	100~500	501~999	>1,000
Peritoneal contamination	No	Serious	Local pus	Free bowel content, pus or blood
Presence of malignancy	No	Primary cancer only	Node metastases	Distant metastases
Timing of operation	Elective		Emergency resuscitation possible, operation <24 h	Emergency immediate, operation <2 h

**Figure 1:** Portsmouth-Physiological and Operative severity for the enumeration of mortality and morbidity (P-POSSUM). Both POSSUM and P-POSSUMb scores depend on the 12 preoperative parameters and 6 intraoperative parameters (adopted from reference 1)

Grade	
1	<b>Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions.</b> Acceptable therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside.
2	Requiring pharmacological treatment with drugs other than such allowed for grade 1 complications. Blood transfusions, antibiotics and total parenteral nutrition are also included.
3	Requiring surgical, endoscopic or radiological intervention
3a	Intervention under regional/local anesthesia
3b	Intervention under general anesthesia
4	Life-threatening complication requiring intensive care/intensive care unit management
4a	Single organ dysfunction
4b	Multi-organ dysfunction
5	Patient demise

**Figure 2:** Clavien–Dindo (CD) grading: It comprises of grade 0 to 5 with increasing grade indicates more severe complication. CD score of 1 and 2 implies minor complications while a CD grade of 3 or higher was considered as a major complication

Chi-square statistic with Yates correction is 6.4793, *P* value 0.01) [Table 2].

## Discussion

The equations of POSSUM scores were devised in 1991 from a retrospective and prospective logistic regression analysis of postoperative outcomes. It was primarily used to compare the quality of clinical care provided by various health institutions across the globe taking into account of the physiological status of the patients and the nature of the surgeries. The

scoring system was later modified in 1998 by Prytherch and colleagues, as it was over predicted mortality in low-risk patients. This new scoring system was called P-POSSUM.<sup>[3]</sup>

A number of studies tested P-POSSUM as a predictor of postoperative outcomes in different surgical specialties. Many of them concluded that the score is a valid predictor of mortality.<sup>[7-12]</sup> These results made it a reliable tool to influence the clinical decision like performing the surgery, counseling the patient and relatives, allocation of resources, etc. The accuracy of the morbidity prediction has not been as extensively tested and also has yielded variable results. It must, however, be noted that the correlation of the actual postoperative outcomes with the outcome predicted by P-POSSUM merely indicates that the performance of the unit doing the study is similar to the performance of the unit that derived the regression equation of the scoring system, as multiple study groups reported that both did not correlate.<sup>[13,14]</sup>

The use of P-POSSUM as a risk prediction tool brings forth a number of practical challenges that can have a negative impact on clinical practice. It implies that the postoperative outcome for a given surgery on a given patient should be the same whether it is performed in a resource-limited setup in an underdeveloped country or a tertiary care set up in a developed country. This in turn unfairly raises the expectations from a resource-limited institution to provide a clinical service at par with an institution in a developed nation. It also has a negative implication on the tertiary hospitals where the actual outcomes are better than predicted

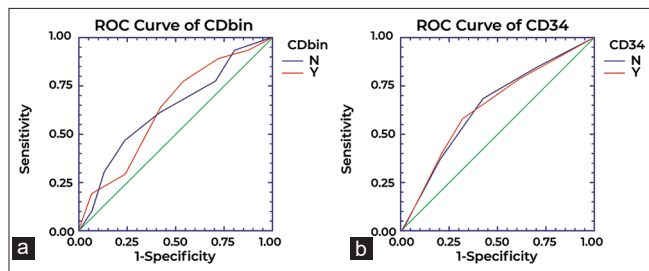
**Table 1: Actual complication rate (as per CD classification) in comparison with different range of predicted morbidity (as per P-POSSUM)**

POSSUM predicted morbidity	CD0	%	CD1	%	CD 2	%	CD3	%	CD4	%	CD5	%	n	Complication rate %
0-10	3	75.0	1	25.0	0	0.0	0	0.0	0	0.0	0	0.0	4	25.0
10-20	6	60.0	0	0.0	2	20.0	2	20.0	0	0.0	0	0.0	10	40.0
20-30	14	82.4	0	0.0	3	17.6	0	0.0	0	0.0	0	0.0	17	17.6
30-40	8	61.5	3	23.1	1	7.7	1	7.7	0	0.0	0	0.0	13	38.5
40-50	11	61.1	2	11.1	3	16.7	2	11.1	0	0.0	0	0.0	18	38.9
50-60	8	44.4	2	11.1	8	44.4	0	0.0	0	0.0	0	0.0	18	55.6
60-70	6	37.5	1	6.3	4	25.0	4	25.0	1	6.3	0	0.0	16	62.5
70-80	6	46.2	4	30.8	1	7.7	1	7.7	1	7.7	0	0.0	13	53.8
80-90	13	59.1	1	4.5	4	18.2	3	13.6	1	4.5	0	0.0	22	40.9
90-100	3	25.0	1	8.3	5	41.7	3	25.0	0	0.0	0	0.0	12	75.0
	78		15		31		16		3		0		143	

**Table 2: Incidence of major and minor complications with P-POSSUM cut off value of 60**

	Major complications (CD 3-5)	Minor complications (CD 1-2)	Total (CD 1-4)
Predicted morbidity >60%	14	49	63
Predicted morbidity <60%	5	75	80
Total	124	19	143

Odd's ratio - 4.286; Chi-square statistic is 7.8041, P value 0.005; Chi-square statistic with Yates correction is 6.4793, P value 0.01.

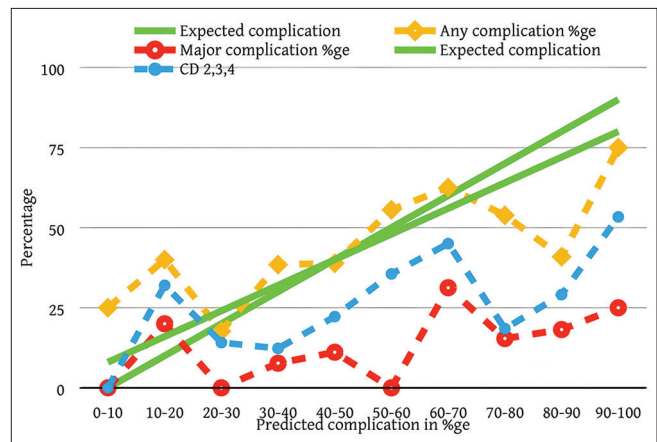


**Figure 3:** Receiver operating characteristic (ROC) curve for incidence of (a) any complication and (b) major complications. A cut off value of 50 for predicted morbidity had the highest sensitivity and specificity of 69% and 54%, respectively for predicting the incidence of “any complication”. A cut off Value of 60 for predicted morbidity had the highest sensitivity and specificity of 73% and 60%, respectively for predicting the incidence of ‘major complication’

outcomes. Their decision to perform the surgery may wrongly be questioned because of high “predicted morbidity and mortality” by P-POSSUM.

In this prospective audit performed for 143 patients who underwent major gastrointestinal or gynecological cancer surgery, the actual morbidity as estimated by the Clavien–Dindo classification system was 45.45% compared to 55.28% predicted by P-POSSUM. In a similar study observing patients undergoing surgeries for colorectal cancers, Carvalho-e-Carvalho *et al.* observed that their actual morbidity was 15.6% in contrast to expected morbidity of 39.2% as per P-POSSUM.<sup>[12]</sup>

We also observed that, in the case of “predicted morbidity” between 20% and 70% ( $n = 81$ ), the actual postoperative morbidity matched with the P-POSSUM predicted morbidity,



**Figure 4:** Graphical representation of relationship between actual (by CD score) and predicted (by P-POSSUM) morbidity of major oncosurgical patients. The actual postoperative outcome has matched with the P-POSSUM predicted morbidity for patients with predicted morbidity between 20% and 70% ( $n = 81$ ).

which is similar to studies by Hong *et al.* and Menon *et al.*<sup>[7,14]</sup> The patients with predicted morbidity more than 70% (as in high risk) had less postoperative complications and the patients with predicted P-POSSUM morbidity less than 20% had worse outcomes than what was predicted. These results indicated that greater attention is needed to improve outcomes in patients with low predicted risks. So P-POSSUM is not an accurate predictor of postoperative complications for the selected group of patients at both of the extremes.

In our study, we found that the incidence of major complications was four times higher in the patients with P-POSSUM score of more than 60. This led to a significant increase in

morbidity in that subgroup leading to ICU admission and longer ICU stay, more utilization of resources, cost, and less patient satisfaction. So P-POSSUM value of 60 can be used to identify surgical patients as “high risk” for postoperative complications in our group of cancer patients. Objective anticipation of the postoperative outcomes can help the clinical team to do more stringent monitoring and early identification of complications in this subgroup. Appropriate counseling of the family members will also ameliorate their emotional stress and dissatisfaction.

Our study has several limitations. The study included a selected subgroup of cancer patients. The findings need to be further strengthened by including a larger number of different surgical patient populations. So the result of our subgroup analysis with cut off of P-POSSUM value 60 needs to be validated further in future studies with a larger sample size. The subgroup analysis for individual specialty was not feasible due to the smaller sample size. Another limitation of the study was that we measured the actual incidence of complications by the Clavien–Dindo score, which defines postoperative complications differently than Copeland’s definition; although Clavien–Dindo classification includes a wider range of complications in addition to those mentioned in the study by Copeland *et al.*

## Conclusion

P-POSSUM is not a reliable predictor of postoperative morbidity for patients undergoing abdominal major gynecological and gastrointestinal surgeries for cancer in our institution. However, it remains an appropriate tool for auditing the performance of hospitals and departments within a hospital as it tries to eliminate bias caused by different natures of surgeries and preoperative clinical condition of the patients. A significant incidence of major complications was noted in patients where the P-POSSUM score is 60 or more. Thus, it may be appropriate to use this as a cut-off to counsel patients and relatives in terms of clinical and economical expectations.

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## Conflicts of interest

There are no conflicts of interest.

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