The novel derived preoperative-POSSUM score as a predictor of surgical patients' allocation to an elective postoperative ICU ordered by anesthesiologists at Cairo University Hospital

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Background
Anesthesiologists depend on multiple factors to request a postoperative ICU bed after elective surgeries. This decision may be based on the risk of surgery and comorbidities. Some surgeries may be postponed, or some patients may be exposed to unnecessary ICU admission. So, this aroused the need for certain scores upon which anesthesiologist could build their request for ICU admission.
Aim
To evaluate the accuracy of the pre-Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) score as a predictor for the need for postoperative ICU.
Patients and methods
This study calculated the POSSUM score preoperatively (pre-POSSUM) for 308 patients who underwent elective general surgeries at Kasr Alainy Hospital, a leading tertiary care hospital in Cairo, Egypt.
Results
Our study showed the possibility of having a cutoff value of pre-POSSUM score that could predict patients who would benefit most from a postoperative ICU stay. The best cutoff value for the estimated morbidity percent was 19.545, with 100% sensitivity and 64.3% specificity. Moreover, the estimated mortality percent at a cutoff value of 3.375 showed 100% sensitivity and 62% specificity.
Conclusion
The pre-POSSUM could be used as a reliable tool for the allocation of patients after elective general surgeries, identify those who require intensive postoperative care, and use the cutoff values shown in a study to help to triage patients after elective surgeries.

Keywords:
ICU ordered by anesthesiologists, POSSUM score, surgical patients

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Introduction

Determination of the criteria for requesting a postoperative ICU bed for patients assigned to different elective surgeries varies widely. Some anesthesiologists may request a postoperative ICU bed depending on the risk of surgery; some may build his/her request upon the age of the patient or associated comorbidities, past medical, surgical history, abnormal preoperative laboratory results; and others may request based on serious unplanned intraoperative events faced by patients that require postoperative monitoring in the ICU [1].

Besides, routine ICU admission after elective surgeries is being questioned owing to limited resources, the number of ICU beds, and health care providers [2].

Moreover, the need for postoperative ICU may also be misunderstood with just the need for postoperative monitoring in the so-called intermediate care unit. Some patients may only require early monitoring for early correction of postoperative derangements such as hypothermia, fluid, and electrolyte imbalances, in specialty wards acquainted with highly trained nursing staff and monitoring devices that allow for longer and more economic observation of patients [1].

Furthermore, ICU admission may paradoxically affect the postoperative outcome by increasing the risk of hospital-acquired infections, late mobilization, over sedation, and stress-related to an ICU stay [3].

Therefore, the lack of evident criteria for requesting a postoperative ICU bed may lead to either postponing

surgery until an ICU bed is available or on the other side exposing the patient's life to danger owing to unawareness of the need for postoperative care [2].

Furthermore, it is vital to identify severely ill patients who are at high risk of developing actual or imagined life-threatening health conditions. Any pathogenic disease that causes physiological fragility and results in disability or death within minutes or hours is referred to as acute illness. Several severely sick patients need to remain in an ICU for a long time before they recuperate, which is associated with high morbidity and cost use. Individuals with potential serious physiological instabilities who require technical and/or artificial life support are monitored and cared for in the ICU. Consequently, with the increasing demand for secure and efficient medical provision, cost-effective analysis is compulsory to avoid the dissipation of the limited resources [4].

Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) was devised to assess surgical outcomes. The POSSUM score was developed to predict morbidity and mortality and allow for rapid use and application for elective health care systems [5].

The currently available POSSUM score uses operative parameters such as blood loss and peritoneal soiling as estimated postoperatively. Yet, we think that anticipating these data by a qualified surgeon will help in developing a derived preoperative-POSSUM score (pre-POSSUM), that is, modified POSSUM, which will be closely matched with the patient's POSSUM score. Hence, such a new score could predict preoperatively the need for postoperative ICU.

Using such scores may contribute to ICU triaging by categorizing patients into those who just need postoperative monitoring and those who require ICU care, which aids at reserving resources to those who are in serious need of ICU admission.

Patients and methods

The study was conducted after taking approval of the ethics and research committee of the Anesthesia Department, Faculty of Medicine, Cairo University.

It was conducted at the general surgery theater, Kasr Alainy Hospital, Cairo University. Our study was conducted prospectively from July 2020 till December 2020.

Inclusion criteria included all adult patients who were scheduled for an elective general surgical operation during the study period.

Exclusion criteria included patients who were operated on an emergency basis, patients already in ICU, patients who were scheduled for day surgery, and patients who were scheduled for cardiac and neurosurgical surgery.

Study protocol

This study was conducted at Kasr Alainy Hospital, a leading tertiary care hospital in Cairo, Egypt. The anesthesiologist, who was in charge of preoperative assessment at each unit, assessed patients who were scheduled for elective surgery and was blind to the study.

The items of the POSSUM score were collected in a data sheet preoperatively. The operative severity part of the POSSUM score was fulfilled preoperatively (grade of surgery, expected blood loss, presence of contamination, and presence of malignancy) by asking the operating surgeon about the expected blood loss or expected contamination and soiling and grade of metastasis.

Simplified Acute Physiology score (SAPS) II was calculated in the first 24 h for patients who were admitted to the ICU. The SAPS II score is made of 12 physiological variables and three disease-related variables. The worst physiological variables were collected within the first 24 h of ICU admission. The 'worst' measurement was defined as the measure that correlated to the highest number of points [6].

For patients who were admitted to postoperative ICU, data such as days of mechanical ventilation, the use of inotropic support, days of ICU stay, and 30-day mortality were recorded.

Patients allocated postoperatively to the ward were traced for the occurrence of adverse events requiring ICU admission and days of in-hospital stay.

The decision of which level of care was needed postoperatively (intensive care, intermediate care, or ward) was according to the discretion of the attending anesthetist.

Therefore, in this study, we traced those patients for whom a preoperative decision for requesting a postoperative ICU was made according to the clinical experience of the attending senior

anesthesiologist, and their pre-POSSUM score (the modified POSSUM) was calculated to see the validity of the score and see if this score can be easily applied in our practice.

The criteria of necessary admission to the ICU were as follows:

(1) Patients admitted to the ICU had one of the following criteria:
SAPS II score more than or equal to 13 (cutoff point) during the first 24 h postoperatively [sensitivity: 70.5%, specificity: 63.1%, the area under the receiver operating curve (AUC ROC): 0.778, 95% confidence interval (CI)=0.65–0.90] [7]:
A critically ill patient requiring life support for organ failure, intensive monitoring, and therapies only provided in the ICU environment. Life support including invasive ventilation, continuous renal replacement therapies, invasive hemodynamic monitoring to direct aggressive hemodynamic interventions, extracorporeal membrane oxygenation, intra-aortic balloon pumps, and other situations requiring critical care (e.g. patients with severe hypoxemia or in shock).Individuals with a much lesser chance of recovery and who would prefer to undergo intensive care treatments but not chest compressions in the event of cardiogenic shock, as indicated before (e.g. individuals with metastatic cancer who are in need of vasodilators and have breathing problem owing to pneumonia or septic shock).Individuals with organ failure who require ongoing monitoring and/or treatments (e.g. noninvasive breathing) or who, in the medical assessment of the delegating task therapist, might be maintained at a reduced quality of care than the ICU (e.g. individuals with respiratory failure accepting periodic noninvasive support, individuals who need careful supervision for danger of worsening, or who need much postoperative treatment). If initial therapy did nothing to prevent worsening or the facility lacked intermediate medical unit capabilities, these individuals might have to be transferred to the ICU.Individuals who may not want to be included or resurrected, but who have a lesser chance of recovery/survival (e.g. individuals with chronic brain metastases). These individuals may be evaluated for ICU in unusual circumstances if the hospital does not provide intermediate medical unit capabilities.
However, patients with ICU length of stay less than 24 h were considered not in a true need for ICU admission.
(2) For patients discharged to ward postoperatively and who turned out to be in a need for postoperative ICU admission due to organ failure and the need for inotropic support, data were collected and analyzed by the study's investigators.

Measurement tools

(1) For patients indicated for elective surgeries, we calculated their derived preoperative-POSSUM score (the modified POSSUM).
(2) SAPS II score was calculated for admitted to the ICU within the first 24 h postoperatively.
(3) The preoperative request of ICU and the reasons.
(4) The postoperative level of care as assigned by the attending anesthetist and the reason.
(5) Patients who were admitted to ICU: days of ICU stay, the need for vasoactive drugs, days of mechanical ventilation, and the outcome.
(6) Patients who needed admission to ICU within 48 h postoperatively.

Primary outcome

(1) The accuracy of the pre-POSSUM score as a predictor for patients triaging postoperatively and identification of those who need a postoperative ICU bed were the primary outcome.

Secondary outcome(s)

The following were the secondary outcomes:

(1) Incidence of preordering ICU in surgical patients.
(2) The reason for preordering ICU in surgical patients.
(3) The true incidence of patients needing postoperative ICU.
(4) Correlation between pre-possum score and SAPS II score in the first 24 h in ICU.
(5) To evaluate the relation of the derived pre-POSSUM score with the POSSUM score.

Statistical analysis

Sample size

The sample size was calculated using MedCalc Software, version 14 (MedCalc Software Bvba, Ostend, Belgium) to detect AUC of 0.75, setting the null hypothesis AUC at 0.50, and taking into consideration that the incidence of the true need for ICU admission was 3%, we calculated a minimum

number of 295 patients (with at least 9 truly needed postoperative ICU) at a study power of 80% and an alpha error of 0.05.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS), version 26 was used to encode and enter data (IBM Corp., Armonk, New York, USA). In quantitative data, average, SDs, medians, minimum, and maximum were used, whereas categorical variables were summarized using frequencies (count) and frequency distribution (%).

The nonparametric Mann–Whitney test was used to make the comparison among ordinal data [8]. The Spearman correlation ratio was used to calculate relationships among numerical variables [9]. The optimal cutoff estimate of important parameters for the identification of Hospitalization was determined using a ROC curve and AUC analysis. Statistical significance was defined as a *P* value of less than 0.05.

Mean and SD were used in symmetrically distributed data. Median and range were used in skewed data. The data in our study showed symmetrical distribution.

Consent statement

The study was conducted after taking approval of the ethics, research committee of the Anesthesia Department, Faculty of Medicine, Cairo University and a written informed consent from the patients.

Results

The pre-POSSUM score was calculated for 308 patients, who underwent 'elective' general surgeries and were eligible for effective analysis according to the inclusion criteria. Their ages were categorized as less than or equal to 60 (67.5%) years, 61–70 (20.5%) years, and more than or ewual to 70 (12.0%) years.

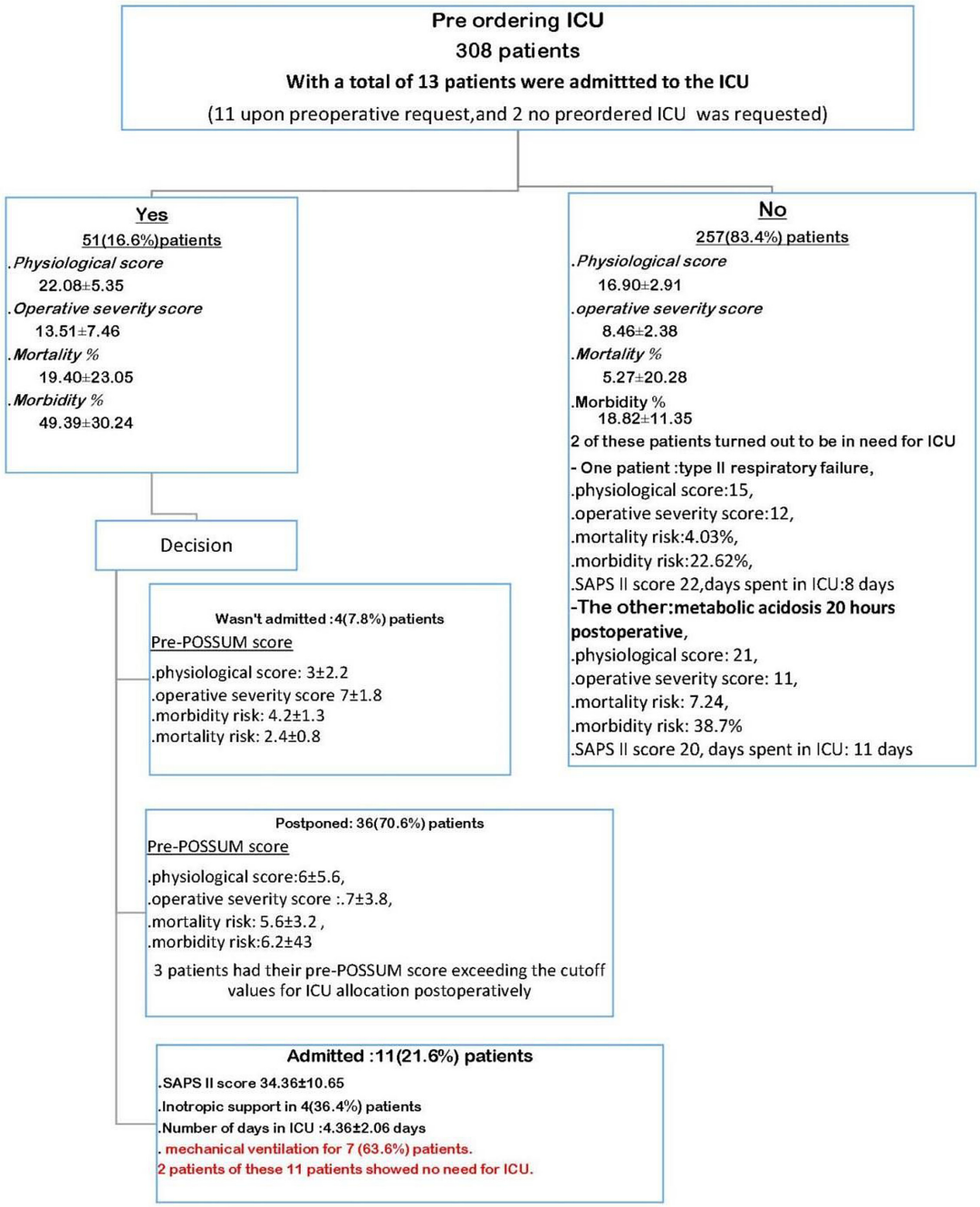
Our study included 308 patients. We calculated the pre-POSSUM score for all of these 308 patients, although ICU bed was requested for only 51 patients. The large number (308 patients) was because preordering ICU bed is always requested for a minor number of all the patients undergoing elective surgeries, so we had to include a large number of patients to pick those for which an ICU bed was requested preoperatively by the senior attending anesthesiologists.

Of 308 patients, 11 were admitted to the ICU according to a preoperative decision by the attending senior anesthesiologist; nine of these 11 patients truly needed postoperative ICU and two patients did not need ICU admission as they spent less than 24 h in the ICU, and required no mechanical ventilation nor inotropic support. Moreover, two patients who were discharged to the ward and for which no postoperative ICU was requested by the senior anesthesiologist turned out to be in true need of postoperative ICU (Fig. 1). Therefore, this yielded a net of 13 patients who were admitted to the ICU; nine patients were admitted upon preoperative request, two patients were admitted according to preoperative request but showed no need for ICU, and another two patients were admitted later on for which no ICU was requested preoperatively (one of them had type II respiratory failure 16 h postoperatively; the pre-POSSUM score showed the following: physiological score: 15, operative severity score: 12, mortality risk: 4.03%, morbidity risk: 22.62%, SAPS II score 22, days spent in ICU: 8 days. The other one experienced metabolic acidosis 20 h postoperatively; the pre-POSSUM score showed the following: physiological score: 21, operative severity score: 11, mortality risk: 7.24, morbidity risk: 38.7% SAPS II score 20, days spent in ICU: 11 days).

A postoperative ICU bed was requested for 51 (16.6%) of 308 patients. Of these 51 patients, 36 (70.6%) patients had their surgeries postponed, so 272 patients underwent operations. Unfortunately, there were no ICU beds available at their operative date, so their surgeries were postponed until the availability of ICU beds; their pre-POSSUM score revealed the following: physiological score: 6±5.6, operative severity score: 7±3.8, mortality risk: 5.6±3.2, and morbidity risk: 6.2±43. These patients were postponed for more than 7 days. We failed to follow them beyond these 7 days to investigate whether they underwent their surgeries or had experienced adverse events postoperatively. Of these 36 patients, only three patients had their pre-POSSUM score exceeding the cutoff values for ICU allocation postoperatively.

Another four (7.8%) of 51 patients had their surgeries done and were discharged from the PACU without the need for postoperative intensive care. ICU bed was ordered preoperatively for these four patients by the attending senior anesthesiologist based on his/her clinical decision; their pre-POSSUM score revealed the following: physiological score: 3±2.2, operative severity score 7±1.8, morbidity risk: 4.2±1.3, and mortality risk: 2.4±0.8. However, the decision was changed at the end of their operation. There was no mortality reported in these four patients, and they were

Figure 1



Flowchart for the distribution of patients according pre-determined ICU admissions.

discharged from the hospital without any adverse events.

As for 11 (21.6%) of 51 patients who were admitted to ICU, four (36.4%) required inotropic support. The number of days spent in the ICU was 4.36±2.06 days. Of the 11 patients who had been admitted to the ICU, seven (63.6%) patients required mechanical ventilation. As for those who were admitted in the ICU, we calculated their SAPS II score during the first 24 h postoperative and it was 34.36±10.64 points.

The physiological part of the pre-POSSUM (the modified POSSUM) score presented in Table 1 shows the distribution of patients in each variable, whereas the variables of the operative severity part of the pre-POSSUM score are shown in Table 2.

The total points (the sum) of the physiological part of the pre-POSSUM score were 17.76±3.93, and for the operative severity part were 9.30±4.16. The mortality percent was 7.61±21.38% and the morbidity percent was 23.8±19.65%.

Table 1 Physiological part of the POSSUM score

	Physiological variables	*n* (%)
	≤60	208 (67.5)
Age	61–70	63 (20.5)
	≥70	37 (12.0)
	No failure	222 (72.1)
Cardiac signs	Diuretic, digoxin, anti-anginal or antihypertensive therapy	72 (23.4)
	Peripheral edema or warfarin therapy	13 (4.2)
	Raised central venous pressure or cardiomegaly	1 (0.3)
	No dyspnea	223 (72.4)
	Dyspnea on exertion, mild obstructive airway disease	75 (24.4)
Respiratory signs	Limiting dyspnea (one flight) or moderate obstructive airway disease	10 (3.2)
	Dyspnea a rest(rate≥30/min), fibrosis, consolidation	0
	110–130	108 (35.1)
SBP	131–170 or 100–109	190 (61.7)
	≥171 or 90–99	9 (2.9)
	≤89	1 (0.3)
	50–80	162 (52.6)
Pulse	81–100 or 40–49	137 (44.5)
	101–120	5 (1.6)
	≥121 or ≤39	4 (1.3)
	15	304 (98.7)
GCS	12–14	4 (1.3)
	9–11	0
	≤8	0
	≤7.5	266 (86.4)
Urea (mmol/l)	7.6–10	42 (13.6)
	10.1–15.0	0
	≥15.1	0
	≥136	214 (69.5)
Sodium (mmol/l)	131–135	88 (28.6)
	126–130	6 (1.9)
	≤125	0
	3.5–5.5	252 (81.8)
Potassium (mmol/l)	3.2–3.4 or 5.1–5.3	47 (15.3)
	2.9–3.1 or 5.4–5.9	9 (2.9)
	≤2.8 or ≥6.0	0
	13–16	109 (35.4)
Hemoglobin (g/dl)	16.1–17.0 or 11.5–12.9	84 (27.3)
	10.0–11.4 or 17.1–18	97 (31.5)
	≤9.9 or ≥18.1	18 (5.8)
White cell count (10^9cells/l)	4–10	236 (76.6)
	10.1–20 or 3.1–3.9	66 (21.4)
	≥20.1 or ≤3	6 (1.9)
	Normal	288 (93.5)
ECG	Atrial fibrillation (rate 60–90)	3 (0.9)
	Any abnormal rhythm or ≥5 ectopics/minute or Q waves or ST/T wave changes	17 (5.5)

GCS, Glasgow coma scale; SBP, systolic blood pressure.

Analysis of ROC curves (Fig. 2) of variables of the pre-POSSUM score for all patients undergone operations (272) and patients who are in a true need for postoperative ICU revealed the good discriminative ability of pre-POSSUM to determine the need for an ICU bed (Table 3).

Sensitivity of the operative severity score of the pre-POSSUM score to detect the true need for postoperative ICU was 81.8% at a cutoff value of 9.5 (AUC=0.755, *P*=0.004, 95% CI=0.58–0.925, with a specificity 67.3%).

Sensitivity of the estimated mortality of the pre-POSSUM score to detect the true need for postoperative ICU was 100% at a cut-off value of 3.375 (AUC=0.833, *P*<0.001, 95% CI=0.750–0.917, with a specificity 62%).

Table 2 Operative severity part of the POSSUM score

Operative severity variables	*n* (%)
Operative severity	
Minor	71 (23.1)
Moderate	147 (47.7)
Major	72 (23.4)
Major +	18 (5.8)
Number of procedures	
1	294 (95.5)
2	11 (3.6)
2	3 (1.0)
≥2	0
Total blood loss	
≤100	133 (43.2)
101–500	117 (38.0)
501–999	45 (14.6)
≥1000	13 (4.2)
Peritoneal soiling	
None	269 (87.3)
Minor (serous fluid)	31 (10.1)
Local pus	7 (2.3)
Free bowel content	1 (0.3)
Malignancy	
None	259 (84.1)
Primary cancer only	20 (6.5)
Nodal metastasis	28 (9.1)
Distant metastasis	1 (0.3)
Mode of surgery	
Elective	308 (100)
Urgent	0
Emergency	0

Sensitivity of the estimated morbidity of the pre-POSSUM score to detect the true need for postoperative ICU was 100% at a cut-off value of 19.545 (AUC=0.833, $P<0.001$, 95% CI=0.750–0.917, with a specificity 64.3%).

However, the physiological score was not sensitive in predicting the postoperative need for an ICU.

Discussion

Individuals who need surgery are frequently admitted to high-dependency units. Because resources are limited and there are no widely acknowledged entry standards, individuals must be prioritized. We aimed in our study to have certain criteria upon which we could build our request for a postoperative ICU stay to avoid the complications of unnecessary ICU admission, to avoid missing those patients who require postoperative ICU, and save ICU beds and resources for those who need the most.

In our study, we calculated the POSSUM score preoperatively (pre-POSSUM) (modified POSSUM) for 308 patients who underwent elective general surgeries. A large number of patients were included in our study to pick those for which an ICU bed was requested preoperatively, as this request is usually for a minority of the total patients undergoing elective surgeries. Just two patients out of 257 for which no ICU bed was ordered preoperatively by the senior anesthesiologists, turned out to need ICU one suffered from type II respiratory failure and the other had metabolic acidosis. However, their pre-POSSUM score was exceeding the cutoff values that we concluded in our study. Therefore, if the ICU request was based on their pre-POSSUM score, we would not have missed those two patients, and they would have been admitted early to the ICU.

Of the 51 patients for whom ICU bed was requested preoperatively, 36 patients had postponement of surgery, and only three patients of these patients had their pre-POSSUM score exceeding the cutoff values estimated in our study, so we assume that 33 out of these 36 patients would have had their surgeries done without the need for postoperative ICU and we could have avoided postponing their surgeries if the pre-POSSUM score was applied preoperatively.

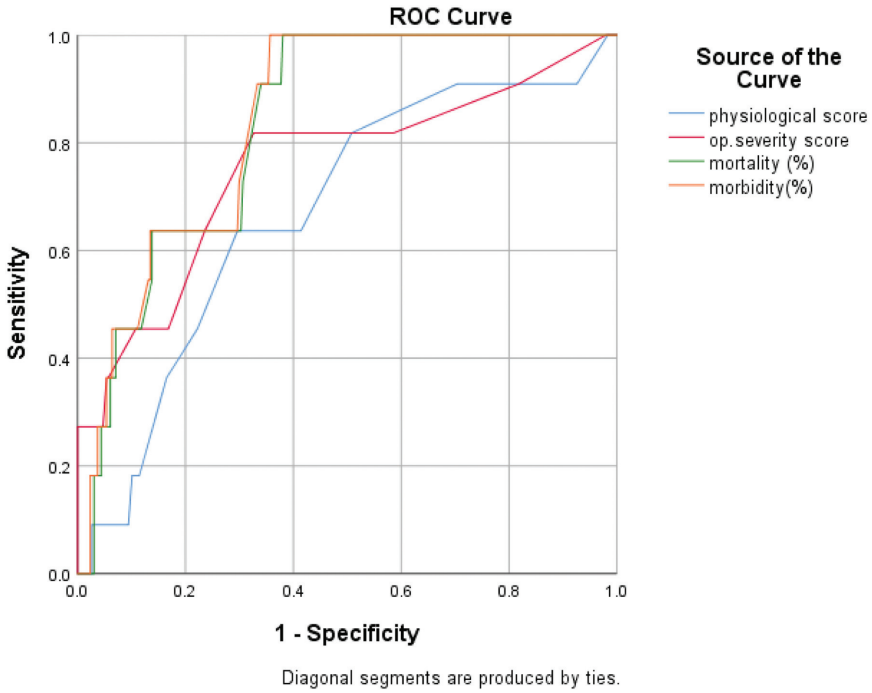
Of the 51 patients for whom an ICU bed was requested preoperatively, four patients had their surgeries done and the decision for postoperative ICU bed was changed postoperatively by the attending senior anesthesiologist. Their pre-POSSUM score had values less than the cutoff values estimated in our study. Therefore, if the pre-POSSUM score was calculated for these patients preoperatively, no ICU bed would have been requested, and this bed would have been reserved for other patients.

The main finding in our study showed that using the morbidity percent as estimated by the pre-POSSUM score has high sensitivity and specificity and could be used as a cutoff value for triaging patients and to a lesser extent the estimated mortality percent.

There was a statistically significant correlation between the true need for admission to the ICU and the mortality percentage, morbidity percentage, and operative severity part of the pre-POSSUM ($P<0.001$, <0.001, and 0.004 respectively). However, there was no statistically significant correlation between the true need for postoperative ICU and the physiological score ($P=0.052$).

Pinho *et al.* [10] conducted a cross-sectional prospective observational study, including a total of

Figure 2



ROC curve for detection of the need for ICU. ROC, receiver operating characteristic.

Table 3 Data of components of the pre-POSSUM score

Area under the curve	Lower bound	Upper bound	*P* value	95% confidence interval		
				Cut off	Sensitivity %	Specificity %
Physiological score	0.673	0.052	0.514	0.831	–	–	–
Operative severity score	0.755	0.004	0.584	0.925	9.5	81.8	67.3
Mortality (%)	0.833	<0.001	0.750	0.917	3.375	100	62
Morbidity (%)	0.841	<0.001	0.760	0.923	19.545	100	64.3

358 patients undergoing colorectal surgery during a 2-year period. POSSUM, namely, CR- POSSUM (colorectal-POSSUM), was calculated for these patients and was associated with the clinical decision to admit a patient to the high-dependency units/ICUs immediately after surgery. CR-POSSUM alone showed a better discriminative ability. This study showed that CR-POSSUM was strongly associated with immediate ICU admission (AUC 0.78, *P*=0.034, 95% CI 0.714–0.846) with a ≥9.16 cut-off point (sensitivity: 62.5%; specificity: 75.2%). These results were excellent compared with the results of our study. However, a drawback of the study by Pinho *et al.* [10] was that their study was confined to colorectal surgeries, unlike our study, which included several general surgeries. Another drawback to their study was the use of the total CR-POSSUM score and not the detailed variables of the pre-POSSUM score, which we included in our study. Therefore, our study could be widely used for different general surgeries, not just the colorectal surgeries, and also we could benefit from the predictive cutoff values of the pre-POSSUM score which are included in our study and are closely associated with the true need for postoperative ICU.

In another study conducted by Ngulube *et al.* [11] at two central hospitals in Harare, 202 patients undergoing a variety of major general surgical operations were recruited. The AUC for POSSUM morbidity score was 0.775 (*P*<0.0001), agreeing with our study, which shows that the score has good discrimination for picking those who will get morbidity, but their study linked the POSSUM score with the just the postoperative morbidity. Moreover, their study was not designed to detect the true need for postoperative ICU admission and they did not seek for having cut- off values for the POSSUM score.However, in a study conducted by Manoharan and Vijayalakshmi [12] for evaluation of

POSSUM scoring system in patients undergoing laparotomy, the POSSUM morbidity equation could reasonably predict morbidity in high-risk groups, whereas the sensitivity fell in elective conditions, which was in agreement with our study. However, the POSSUM mortality equation overpredicted mortality, especially in low-risk groups, whereas the predictive value improved significantly when an exponential analysis was used. Their study showed that the POSSUM score is well correlated to the morbidity equation but a drawback was that it was not used to triage patients postoperatively according to the true need for postoperative ICU.

Another study conducted by Ramanathan *et al.* [13] showed that using POSSUM to identify high-risk patients before surgery is also not a reliable tool. ROC AUC was 0.62, which indicates a poor test. POSSUM overpredicts mortality in the fractured neck of the femur and should not be used as a comparative audit tool for this group of patients. Its role as a preoperative assessment tool is also limited. Unlike our study, this study was also confined to patients undergoing surgeries for fractured neck femur and did not link the score to the postoperative decision for ICU admission. In contrast to our study, their study used the POSSUM score as a whole not as individual variables.

Our study aimed at evaluating the accuracy of the pre-POSSUM score as a predictor for the need for postoperative ICU when used by anesthesiologists at Kasr Alainy University hospitals and find a cutoff value of pre-POSSUM score that could predict patients who would benefit most from a postoperative ICU.

Anesthesiologists at our institute requested a postoperative ICU bed based on several factors such as the patient having cardiac problems in the form of ischemic heart disease or abnormal rhythms in the ECG. Another major reason for their request was based on the surgery, being a major surgery as regarding duration or estimated blood loss and risk of the surgery itself.

Although the request for a postoperative ICU bed was for only 51 out of 308 patients, yet a large number of patients were postponed because there were no ICU beds available at the time of their surgery, whereas others for whom a postoperative ICU bed was requested were operated upon and discharged from the PACU without the further need for intensive care.

The majority of those who were admitted to the ICU needed intermediate care and monitoring rather than major organ support in the form of mechanical ventilation or inotropic support.

As a result of our study, we found that the morbidity percent as estimated by the pre-POSSUM score could help in triaging the patients postoperatively followed by the estimated mortality percent and then the operative severity score, with the least value for the physiological part.

Our study showed the possibility of having a cutoff value of pre-POSSUM score that could predict patients who would benefit most from a postoperative ICU.

Therefore, the anesthesiologists at our hospital could benefit from using such a score, being easily applied, as the score includes 12 routine measurements and laboratory findings, which do not require special arterial or venous samples, just preoperative available data and some readily available surgery-related data.

The pre-POSSUM score can be easily done using MDCalc Android App or online calculator https://www.mdcalc.com/possum-operative-morbidity-mortality-risk.

A limitation of our study was that part of the period of conducting this study was during the epidemic of COVID-19 in Egypt, and this may have resulted in requesting ICU beds postoperatively for a larger number of patients; however, it is of little contribution, as most of the study was conducted before the epidemic. Request for postoperative ICU in our institute is usually based on personal experience, which resulted in scarcity for ICU places. Therefore, we hypothesize that this raised the need for a triaging score with a cutoff value to identify the true ICU need. Another limitation was that it was a single-center study; however, our hospital is a leading tertiary care hospital in Cairo, Egypt. We also failed to follow patients who were postponed beyond 7 days to detect whether they underwent their surgeries or not or if they had experienced postoperative adverse events.

To the best of our knowledge, our study was the first study that used the pre-POSSUM score widely in several general surgery theaters, included individual variables of the pre-POSSUM score, and estimated cut-off values of the pre-POSSUM score that could be used for triaging patients postoperatively according to objective criteria and a scoring system for postoperative ICU, so we could avoid wasting our resources and save the ICU beds for those who require it to obtain maximum benefit.

We recommend adding further data to the physiological part of the pre-POSSUM score. These data, in our point of view, may enhance the significance of this part of the pre-POSSUM score, such as echocardiography findings as the resting ejection fraction. We also suggest adding the functional capacity expressed in terms of metabolic equivalent (METS). We also suggest adding the patients' coagulation profile to the laboratory data as it sometimes influences the decision of the type of anesthesia. We recommend this score to be studied on a larger scale, with a larger number of patients, and different surgical specialties like urology, obstetrics, and gynecology.

We recommend implementing the pre-POSSUM score as a triaging score for postoperative ICU admission in our institute.

Conclusion

The pre-POSSUM (modified POSSUM) score could be used as a reliable tool for the allocation of patients after elective general surgeries and identify those who require intensive postoperative care and use the cutoff values shown in our study to help to triage patients after elective surgeries.

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Conflicts of interest

There are no conflicts of interest.

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