EVALUATION OF P-POSSUM SCORE FOR PREDICTION OF POSTOPERATIVE MORTALITY AFTER NON-ELECTIVE SURGERY IN MIDDLE EAST POPULATION

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Abstract

Background: There are different preoperative scoring systems which aim to classify the patient's risk before the surgery and decide the best treatment option for a specific patient. P-POSSUM score has been used in clinical practice for few years. The objective of this study was to find out whether there is any difference between predicted mortality from P-POSSUM score and observed mortality in Saudi patients.

Methods: This was a prospective observational study conducted at Security forces Hospital, Riyadh, Kingdom of Saudi Arabia between July 2019 to November 2019. We included patients undergoing non-elective surgical procedures at Security Forces Hospital, Riyadh. We calculated P-POSSUM score for all included patients. We then collected the data for 30 days mortality for all patients having non-elective surgical procedures. We calculated observed to expected mortality ratio. P-value less than 0.05 was considered significant.

Results: Mean P-POSSUM mortality risk score (%) for whole sample was 5.56. Expected number of mortalities was 19.85 while observed mortalities were 9, yielding an O/E ratio of 0.45 (p-value .005). With respect to ASA class, we did not find a significant difference between expected and observed mortality except for ASA class 4 where expected number was higher than observed (p-value .005).

Conclusion: P-POSSUM score can reliably predict 30 days mortality in postoperative period although it overestimates risk in high risk patients (more than 20 % P-POSSUM mortality or ASA 4 patients).

Keywords: Risk stratification; P-Possum; Non-elective surgery; Mortality.

Introduction

Clinical judgement alone is not a reliable predictor of adverse outcome after surgery.[1] There have been many preoperative risk [2] assessment tools developed to help in identifiying high risk patients that complement investigations like cardiopulmonary exercise testing [3,4] and biomarker assays.[5] Exercise testing facilities are not available routinely [6] and are also inappropriate in urgent or emergency surgical patients. Some of these risk assessment tools or scoring systems include the

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Surgical Apgar Score,[7] APACHE II,[8] ASA,[9] POSSUM[10] and P-POSSUM.[11] The POSSUM [10] and P-POSSUM [11] scores remain the most studied and most validated across specialities and patient populations. The main goal of these scoring systems is to classify the patient's risk before the surgery and decide the best treatment option for a specific patient. [10-12]

POSSUM score was used in studies by Whiteley and colleagues [13] and Copeland and colleagues [11] to predict mortality and morbidity. However, Prytherch and colleagues [12] reported over-prediction of mortality by POSSUM more than twofold. Even though, both POSSUM and P-POSSUM scores are based on objective criteria, they vary across populations and healthcare systems and therefore can not be immediately valid across the countries. Variations in mortality scores have been demonstrated by comparative studies in different geographical regions. [14,15] In fact, Guerrero and colleagues [16] demonstrated a fourfold difference in mortality in major surgical procedures in UK and US patients. In another study conducted in Malayasia, P-POSSUM scoring was found applicable for risk adjusted patients. [14] The aim of this study is to find out whether there is any difference between predicted mortality from P-POSSUM score and actual observed mortality in Saudi population undergoing non-elective surgery.

Methods

Institutional ethical review committee approval (Registration number: H-01-R-069) was taken for this prospective observational study. Patient consent was not required for this study. Firstly, we collected data for patients undergoing non-elective surgery over a period between July 2019 to November 2019 at Security Forces Hospital, Riyadh, Kingdom of Saudi Arabia. Paediatric (aged under 18 years) patients were excluded from this study. P-POSSUM was calculated for all eligible patients. POSSUM scoring system incorporates a physiological score (PS) with 12 preoperative variables ranging score from 12 to 88 and an operative score (OS) that includes 6 variables ranging score between 6 and 48 [10]. POSSUM score resulted in over-prediction of mortality by factor more than 2. Therefore, a modified version was designed which is called Portsmouth POSSUM (P-POSSUM). This modification used methods to obtain logistic regression equation for predicting mortality.[11,12] All the preoperative and operative variables which were required to calculate P-POSSUM score were entered into P-POSSUM online calculator and the predicted mortality was documented in anaesthesia chart of individual patient.

Actual mortality data was collected from hospital monthly mortality reports. Patients outcome was also followed using our online patient database system. If the patient progress and outcome could not be accessed by online system, we contacted patients/relatives via telephone provided in medical record.

Data was entered in Microsoft Excel and analyzed using SPSS version 21.0. Descriptive analysis was carried out. Mean with standard deviations and frequencies were calculated for continuous and categorical variables respectively.

P-POSSUM score for mortality of all the participants was calculated using the scoring system. Expected number of mortalities was calculated by multiplying mean risk score of each group with number of patients in that group. Observed to expected number of mortalities ratio was calculated. Binomial test was applied to assess the difference between expected and observed number of mortalities. P-value less than 0.05 was considered significant.

Results

A total of 357 patients who underwent emergency surgical procedures were included in the study. Mean age of the participants was 42.0 ±19.0 years and 69.5% (248) were male. The majority of the patients were ASA class II (51.8%), followed by class I (22.7%). Class III and IV were 17.9% and 7.6% respectively. Most of the patients were recruited from general surgery (41.5%) followed by urology (20.4%) and orthopedics (16.2%). Other specialties were vascular surgery (7.0%), gynecology (4.8%), plastic surgery (4.2%), neurosurgery (3.9%) and otolaryngology (2.0%).

Mean P-POSSUM mortality risk score for whole sample was 5.56%. Expected number of mortalities was 19.85 while observed mortalities were 9, yielding an O/E ratio of 0.45 (p=0.005). There were no significant differences in the expected and observed mortalities in P-POSSOM categories I-III; however expected mortalities were significantly higher than observed mortalities in risk category IV (Table 1).

With respect to ASA class, we did not find significant differences between expected and observed mortalities except for ASA class 4 where expected number was higher than observed number of mortalities (p=0.005). There was a significantly higher number of expected mortalities than observed mortalities in surgeries of more than one hour duration. For laparotomy, there was no significant difference in the expected and observed number of mortalities (Table 2). However, P-POSSUM overestimated the expected mortalities as indicated by O/E ratio 0.45 (Table 2).

The predictability of P-POSSUM mortality scores with respect to surgical specialties were evaluated and indicated no significances difference in the observed and expected number of mortalities (Table 3).

Discussion

The perfect risk scoring system needs to be simple, reporducible, objective and applicable to all

Table 1

Risk category specific comparison of expected and observed mortality by P-POSSUM

Risk category of P-POSSUM score	Number of patients	Mean Risk score±SD	Mean Risk score (%)	Expected number of mortalities	Observed number of mortalities	O/E ratio	p-value
I: Up to 5 %	312	0.009 ± 0.007	0.92	2.87	1	0.35	0.218
II: 5.1-10.0 %	8	0.075± 0.01	7.54	0.60	0	0	0.534
III: 10.1 – 20.0 %	6	0.130.032±	13.20	0.79	1	1.26	0.572
IV: More than 20 %	31	0.50± 0.23	50.30	15.59	7	0.45	<0.001
Overall	357	0.0550.15±	5.56	19.85	9	0.45	0.005

Table 2

Comparison of expected and observed mortalities with respect to ASA class, duration of surgery and laparotomy

ASA class	Number of patients	Mean Risk score±SD	Mean Risk score (%)	Expected number of mortalities	Observed number of mortalities	O/E ratio	p-value
1	81	0.007±۰,۰۰٥	0.79	0.64	0	0	0.526
2	185	0.01±.۰۲۲	1.00	1.85	0	0	0.831
3	64	0.067±۰,۱۱	6.7	4.29	3	0.70	0.371
4	27	0.483±۰,۲۸۲	48.39	13.06	6	0.46	0.005
	Duration of surgery						
Up to 1 hour	194	0.034±۰,۱۱٤	3.48	6.75	3	0.44	0.092
More than 1 hour	163	0.08±۰,۱۸۹	8.05	13.12	6	0.46	0.020
	Laparotomy						
	13	0.34±.٤۰	34.17	4.44	2	0.45	0.070

Table 3

Comparison of expected and observed mortalities with respect to type of surgery

Specialty	Number of patients	Mean Risk score (%)	Expected number of mortalities	Observed number of mortalities	O/E ratio	p-value
Spinal surgery	14	11.23	1.57	0	0	0.189
ENT	7	30.77	2.15	1	0.46	0.313
GS	148	5.15	7.62	5	0.66	0.221
VS	25	19.28	4.82	2	0.42	0.114
Urology	73	1.60	1.17	0	0	0.308
Gynecology	17	1.27	0.22	0	0	0.805
Orthopedics	58	3.81	2.21	1	0.45	0.346
PS	15	0.70	0.10	0	0	0.900
ENT: Ear, nose and throat, GS: General surgery, VS: Vascular surgery, PS: Plastic surgery						

surgical patients. ASA scoring system is the most widely used preoperative assessment tool because of simplicity and easy applicability.[9] However, it does not account for peripoperative adverse events or complications and anesthesia or surgical management of patients. ASA score has usually been questioned due to its subjectivity and inability to accurately predict mortality on individual basis.[17] Allan and colleagues [18] in their study demostrated that ASA score of 3 or more significantly predicted mortality which is in accordance with a study by Chu and colleagues.[19] Although overall mortality appears to be higher than observed for major surgeries.[20]

P-POSSUM and POSSUM scoring systems use similar physiological and operative variables but POSSUM uses exponential analysis while P-POSSUM uses linear analysis.[11] Khan and colleagues [21] reported an observed mortality of 4 % versus a predicted POSSUM mortality of 26 % and P-POSSUM mortality of 6 % in patients undergoing pancreatoduodenectomy. Tamijmarane and colleagues [22] reported in patients undergoing pancreatoduodenectomy that overall observed mortality were 8 % which was higher than predicted by P-POSSUM score.

Mohil and colleagues [23] demonstrated that P-POSSUM predicted mortality well in patients who underwent emergency laparotomy. In our study, the overall observed to expected mortality ratio was 0.45 and it was found to be statistically significant despite that the overall P-POSSUM mean overall did not reliably predict mortality. Although, the number of emergency laparotomy cases were lower in our study but P-POSSUM predicted mortality was 4.44 against observed 2 deaths and hence it reliably predicted mortality. In another study, POSSUM and P-POSSUM over-predicted mortality in the younger age group (50 years) while under-predicted it in older age group (80 years) among colorectal surgical patients.[24] In our study, P-POSSUM mortality was found to be better predictive for ASA 1-3 group of patients but it overestimated the risk in ASA 4 patients or patients having higher risk scores (P-POSSUM score more than 20 %).

P-POSSUM have been tested and validated in developed world and also in some developing countries. In Saudi arabia, Isbister and colleagues [25] did a study in 2002 comparing the observed mortality with predicted mortality by POSSUM and P-POSSUM scores. They demonstrated that POSSUM failed to predict outcomes accurately in patients undergoing surgery for rectal cancer. P-POSSUM also overpredicted mortality but to a lesser extent which is not consistent with our results. This could be due to the fact that their study was done for rectal cancer patients only. The authors also mentioned that their patients undergoing resections were younger than patients in the West. Yadav and colleagues [26] showed that P-POSSUM slightly over-predicted mortality in very low risk patients but it was more accurate for high risk patients in indian population as was the case in our study. Although in our study, P-POSSUM slightly under predicted mortality for patients having P-POSSUM mortality between 10-20 % (O/E ratio 1.26) while it over predicted mortality in patients having P-POSSUM mortality score more than 20 % (O/E ratio 0.45). Allan and colleagues [18] demonstrated in their study on Zimbabwean patients that observed to expected mortality ratio was 1.06 which means near accurate mortality prediction by P-POSSUM. In another study done on Malayasian population,[27] P-POSSUM was found to be over-predictive for mortality with observed to predicted mortality ratio 0.721. In our study, although overall P-POSSUM score did not reliably predict mortality, but the results for individual specialities indicated that P-POSSUM reliably predict mortality in General surgery, Urology and Orthopaedics surgeries. It is difficult to comment about other specialities as the number of cases were smaller. Although, our sample size included variety of surgical specialities which provide good representation of our practice. Another limitation of the study is small number of observed deaths which may affect the power of study.

Conclusion

P-POSSUM score can reliably predict mortality in ASA 1-3 group of patients but it overestimated risk in ASA 4 patients or patients having higher P-POSSUM score >20 % in Saudi population. It also reliably predicts mortality in emergency laparotomy patients.

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Conflicts of interest: None.

References

1. Liao L, Mark DB. Clinical prediction models: are we building better mousetraps? J Am Coll Cardiol 2003; 42:851-3. doi: 10.1016/s0735-1097(03)00836-2. PMID: 12957431.
2. Adams ST, Leveson SH. Clinical prediction rules. BMJ 2012; 344:d8312. doi: 10.1136/bmj.d8312. PMID: 22250218.
3. Goodyear SJ, Yow H, Saedon M, Shakespeare J, Hill CE, Watson D et al. Risk stratification by pre-operative cardiopulmonary exercise testing improves outcomes following elective abdominal aortic aneurysm surgery: a cohort study. Perioper Med (Lond) 2013; 2:10. doi: 10.1186/2047-0525-2-10. PMID: 24472159; PMCID: PMC3964330.
4. Hennis PJ, Meale PM, Grocott MP. Cardiopulmonary exercise testing for the evaluation of perioperative risk in non-cardiopulmonary surgery. Postgrad Med J 2011; 87:550-7. doi: 10.1136/pgmj.2010.107185. Epub 2011 Jun 21. PMID: 21693573.
5. Edwards M, Whittle J, Ackland GL. Biomarkers to guide perioperative management. Postgrad Med J 2011; 87:542-9. doi: 10.1136/pgmj.2010.107177. Epub 2011 Jan 17. PMID: 21242576.
6. Findlay GP, Goodwin APL, Protopapa KL, Smith NCE, Mason M. Knowing the Risk: a Review of the Peri-Operative Care of Surgical Patients. London: National Confidential Enquiry into Patient Outcome and Death 2011. Available from https://www.ncepod.org.uk/2011poc.html. Accessed on November 2020.
7. Regenbogen SE, Ehrenfeld JM, Lipsitz SR, Greenberg CC, Hutter MM, Gawande AA. Utility of the surgical apgar score: validation in 4119 patients. Arch Surg 2009; 144:30-6. doi: 10.1001/archsurg.2008.504. PMID: 19153322.
8. Tsai CL, Chu H, Peng GS, Ma HI, Cheng CA, Hueng DY. Preoperative APACHE II and GCS scores as predictors of outcomes in patients with malignant MCA infarction after decompressive hemicraniectomy. Neurol India 2012; 60:608-12. doi: 10.4103/0028-3886.105195. PMID: 23287323
9. Chandra A, Mangam S, Marzouk D. A review of risk scoring systems utilised in patients undergoing gastrointestinal surgery. J Gastrointest Surg 2009;13:1529-38. doi: 10.1007/s11605-009-0857-z. Epub 2009 Mar 25. PMID: 19319612.
10. Barnett S, Moonesinghe SR. Clinical risk scores to guide perioperative management. Postgrad Med J 2011; 87:535-41. doi: 10.1136/pgmj.2010.107169. Epub 2011 Jan 21. PMID: 21257993.
11. Copeland GP, Jones D, Walters M. POSSUM: a scoring system for surgical audit. Br J Surg 1991; 78:355-60. doi: 10.1002/bjs.1800780327. PMID: 2021856.
12. Prytherch DR, Whiteley MS, Higgins B, Weaver PC, Prout WG, Powell SJ. POSSUM and Portsmouth POSSUM for predicting mortality. Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity. Br J Surg 1998; 85:1217-20. doi: 10.1046/j.1365-2168.1998.00840.x. PMID: 9752863.
13. Whiteley MS, Prytherch DR, Higgins B, Weaver PC, Prout WG. An evaluation of the POSSUM surgical scoring system. Br J Surg 1996; 83: 812-5. doi: 10.1002/bjs.1800830628. PMID: 8696749.
14. Yii MK, Ng KJ. Risk-adjusted surgical audit with the POSSUM scoring system in a developing country. Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity. Br J Surg 2002; 89: 110-3. doi: 10.1046/j.0007-1323.2001.01979.x. PMID: 11851674.
15. Parihar V, Sharma D, Kohli R, Sharma DB. Risk adjustment for audit of low risk general surgical patients by Jabalpur-POSSUM score. Ind J Surg. 2005;67:38–42.
16. Bennett-Guerrero E, Hyam JA, Shaefi S, Prytherch DR, Sutton GL, Weaver PC et al. Comparison of P-POSSUM risk-adjusted mortality rates after surgery between patients in the USA and the UK. Br J Surg 2003; 90: 1593-8. doi: 10.1002/bjs.4347. PMID: 14648741.
17. Moonesinghe SR, Mythen MG, Das P, Rowan KM, Grocott MP. Risk stratification tools for predicting morbidity and mortality in adult patients undergoing major surgery: qualitative systematic review. Anesthesiology 2013; 119:959-81. doi: 10.1097/ALN.0b013e3182a4e94d. PMID: 24195875.
18. Ngulube A, Muguti GI, Muguti EG. Validation of POSSUM, P-POSSUM and the surgical risk scale in major general surgical operations in Harare: A prospective observational study. Ann Med Surg (Lond) 2019; 41: 33-39. doi: 10.1016/j.amsu.2019.03.007. PMID: 31016016; PMCID: PMC6475666.
19. Chu KM, Ford N, Trelles M. Operative mortality in resource-limited settings: the experience of Medecins Sans Frontieres in 13 countries. Arch Surg 2010; 145: 721-5. doi: 10.1001/archsurg.2010.137. PMID: 20713922.
20. Tyagi A, Nagpal N, Sidhu DS, Singh A, Tyagi A. Portsmouth physiological and operative severity score for the Enumeration of Mortality and morbidity scoring system in general surgical practice and identifying risk factors for poor outcome. J Nat Sci Biol Med 2017; 8: 22-25. doi: 10.4103/0976-9668.198342. PMID: 28250670; PMCID: PMC5320818.
21. Khan AW, Shah SR, Agarwal AK, Davidson BR. Evaluation of the POSSUM scoring system for comparative audit in pancreatic surgery. Dig Surg 2003; 20: 539-45. doi: 10.1159/000073701. Epub 2003 Sep 24. PMID: 14534377.
22. Tamijmarane A, Bhati CS, Mirza DF, Bramhall SR, Mayer DA, Wigmore SJ et al. Application of Portsmouth modification of physiological and operative severity scoring system for enumeration of morbidity and mortality (P-POSSUM) in pancreatic surgery. World J Surg Oncol 2008; 6:39. doi: 10.1186/1477-7819-6-39. PMID: 18400108; PMCID: PMC2346467.
23. Mohil RS, Bhatnagar D, Bahadur L, Rajneesh, Dev DK, Magan M. POSSUM and P-POSSUM for risk-adjusted audit of patients undergoing emergency laparotomy. Br J Surg 2004; 91: 500-3. doi: 10.1002/bjs.4465. PMID: 15048756.
24. Tekkis PP, Kessaris N, Kocher HM, Poloniecki JD, Lyttle J, Windsor AC. Evaluation of POSSUM and P-POSSUM scoring systems in patients undergoing colorectal surgery. Br J Surg 2003; 90: 340-5. doi: 10.1002/bjs.4037. PMID: 12594670.
25. Isbister WH, Al-Sanea N. POSSUM: a re-evaluation in patients undergoing surgery for rectal cancer. The Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity. ANZ J Surg 2002; 72: 421-5. doi: 10.1046/j.1445-2197.2002.02436.x. PMID: 12121162.
26. Yadav K, Singh M, Griwan M, Mishra Ts, Kumar N, Kumar H. Evaluation of POSSUM and P-POSSUM as a tool for prediction of surgical outcomes in the Indian population. Australas Med J 2011; 4: 366-73. doi: 10.4066/AMJ.2011558. Epub 2011 Jul 31. PMID: 23393521; PMCID: PMC3562937.
27. Chieng TH, Roslan AC, Chuah JA. Risk-adjusted analysis of patients undergoing laparotomy using POSSUM and P-POSSUM score in Queen Elizabeth Hospital, Sabah. Med J Malaysia 2010; 65: 286-90. PMID: 21901947.