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Evaluation of P-Possum in Elective and Emergency Surgeries

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Abstract: *Portsmouth modification of Physiological and Operative Severity Score for Enumeration of Mortality, popularly known as P-POSSUM score, is a surgical scoring system used to assess mortality in exclusively surgical patients. The study is aimed at studying the accuracy of P-POSSUM mortality predictor equation in predicting in-patient mortality in both elective and emergency surgeries separately. These results are compared with raw mortality.*

P-POSSUM is used as a tool in surgical audit. This score, devised in UK, has been used widely but its application outside UK is limited. So this studyis aimed at validating its application in surgical practice in developing countries like India with a different population and different level of resources. It may be useful to evaluate and monitor healthcare delivery and outcomes. It can also be used for research purpose and in clinical management as a prognostic indicator.

Methods: *All consecutive inpatients admitted and operated from August 2013 to August 2015 in surgical unit VIII of Upgraded Department of Surgery at Osmania General Hospital, a teaching hospital cum tertiary referral centre, affiliated to Osmania Medical College, Hyderabad, India were included in the study. All necessary data was collected both retrospectively and prospectively.*

All patients who underwent surgery under general or regional anaesthesia were included. Patients who had day-care surgery and / or surgery under local anaesthesia were excluded from the study as complications and mortality rates were extremely low and follow up was incomplete owing to social and geographical constraints. Only general surgical cases were included. Vascular, neurosurgery and urology cases were not included.

The physiological data were entered in proforma sheet at admission in emergency cases and a day before in elective cases or when the results of the tests were available. Necessary investigations were done for all patients. The operative data was obtained from the records and by personal communication with the surgeon, when required. The scoring system used to classify patients was similar to that of Copeland et al [24]

Results: *A total of 242 patients underwent emergency surgeries in the above mentioned period. Number of predicted deaths by P-POSSUM when done by linear analysis was 18.97 while the number of observed deaths was 21. The O;E ratio was 1.11 and the Hosmer-Lemeshow Goodness-of-fit shows that the fitness of P-POSSUM is good in emergency surgeries and the difference between the predicted and the actual mortality rates is not statistically significant (Chi – square 0.26; 3 df; p –value =0.967687). The predicted and observed mortality rates are close though the actual mortality rate is marginally higher then the predicted mortality rate.*

A total of 398 patients underwent elective surgeries in the above mentioned period. Number of predicted deaths by P-POSSUM when done by linear analysis was 3.74 while the number of observed deaths was 8. The O:E ratio was 2.14 and The Hosmer-Lemeshow Goodness-of fit shows that the fitness of P-POSSUM does not hold good in elective surgeries and the difference between the predicted and the actual mortality rates is statistically significant (Chi-square 10.08; 3 df; p-value =0.017884). The predicted and observed mortality rates has no coincidence and the actual mortality rate is significantly higher than the predicted mortality rate.

Conclusion: *There have been several attempts at creating a scoring system to predict mortality risk after surgery. Of the few surgical scoring systems available P-POSSUM appears to be the most appropriate. This equation is claimed to produce a closer fit with the observed patient mortality rate. It requires collection of simple physiological and operative scores within the scope of basic surgical care. The linear comparison analysis using the P-POSSUM equation is straightforward and easy to apply, which is relevant in developing countries with limited resources.*

This validation study opens up simple opportunities for the application of P-POSSUM scoring system as a comparative audit tool to allow assessment of the quality of care in a developing country like India with limited resources. It could also theoretically assist in direction of resuscitative efforts both pre and postoperatively.

I. Introduction

History Of Surgical Audit

Surgical audit is not a new phenomenon. As early as 1750 BC, king Hammurabi of Babylon[2] issued decrees for the punishment of negligent physicians, particularly surgeons. In such a decree discovered at Susa in Iran and inscribed on a 2-m-high black diorite stone, Hammurabi states that:

" If a doctor inflicts a serious wound with his operation knife on a free man's slave and kills him ,the doctor must replace the slave with another. If a doctor has treated a free man but caused a serious injury from which the man dies, the man is to cut off his hands."

The verb 'to audit' dates back to sixteenth century when it meant 'to make an official systematic examination of accounts'. If the words 'of accounts' are omitted, it is what clinical audit means.[3] The Royal College of Surgeons of England has defined audit as the 'systemic appraisal of the implementation and outcome of any process in the context of prescribed targets and standards.'[1]

Audit has three components- structure, process and outcome. In 1982, Sheldon defined clinical audit as ' A study of outcome of the structures, process and outcome of medical care carried out by those personally engaged in the activity concerned, to measure whether set objectives have been attained and thus assess the quality of care delivered'. The audit of structure is essentially administrative. The audit of process is that, if correct steps are taken in correct order, the outcome measured in goods or services will be satisfactory and the audit of outcome is self explanatory. [4]

Why Develop A Scoring System?

Why develop such a system when individual surgeon judgment of risk- their gut feeling about the risk of postoperative morbidity – is a reliable method of patient evaluation? [5] . Formal systems predict the likely incidence of specific or collective complications in large groups of patients, enable stratification of patient groups according to risk. And, ideally, also identify risk levels for individual patients . It can supplement physician judgement and potentially enhance p0atient selection, informed consent, choice of procedures and predict complications.

Stratification of risk using scoring systems is vital in performing internal audits of surgeon and institutional performance over time. Evaluating outcomes without correcting for relative risk, limits conclusions that can be drawn from such analyses. Risks change as patient selection criteria, surgeon experience, operative techniques, and institutional expertise evolve over time, making complications more or less likely and perhaps changing the types of complications that are observed. Without use of scoring systems for assessing relative risk, identifying which of these factors contribute to changes in outcomes is impossible. Stratification of risk using a scoring system enables appropriate assigning resources for patient care. Finally , scoring systems may be used to stratify populations for clinical research.

Raw mortality and morbidity rates do little to expound these differences, and that the use of such statistics is at best inaccurate and at worst dangerous. The unit that selects only low- risk cases achieves a low mortality rate and therefore attracts more patients, perhaps undeservedly, whereas the unit that cannot select only low-risk cases is left with a worsening case mix, and their performance as judged by mortality rate will appear to deteriorate still further over a time.

The outcome of surgical intervention is not solely dependent on the abilities of the surgeon in isolation. The patient's physiological status, the disease that requires surgical correction, the nature of the operation, and the preoperative and postoperative support services have a major effect on the ultimate outcome.

What Is A Scoring System?

There are a wide variety of methods for assigning level of risk to a population or an individual. The simplest method categories patients based on a single factor related to their current status, medical history, or planned intervention. The American Society of Anaesthesiologists classification is one such system [6] . More complex risk assessments, such as the Apgar and Glasgow scales, require evaluation of more than one relevant paremeter.[7,8]

In successful scoring systems the lements of clinical systems must be routinely available, usually for both retrospective and prospective scoring purposes. Scores need to accurately indicate an incremental level of risk. The system must be able to be generalized in its application beyond the pool of patients used to develop the system.

Ideally, scores accurately reflect risk in both low-risk categories of patients, rather than merely achieving the goal of identifying high-risk patients. The importance of correctly assigning patients to a low-risk category permits appropriate assignment of resources to the bulk of patients undergoing a procedure.

II. Limitations

It is appropriate for any surgeon who is considering using a scoring system to ask a series of questions that will help determine the utility of that system for the desired application:

1. Is the population on which system was derived similar to my own population>
2. Is the model current, or is it obsolete because of the passage of time or the development of new technology or new medical therapies.
3. Is there a potential for misclassification of my patients such that I will apply the system algorithm incorrectly?
4. Is there a potential for systematic errors in my data collection, based on, eg, differences in laboratory units or training of data personnel, which could lead to inapplicability of the scoring system?

In addition to these considerations, surgeons should keep in mind the caveat that current risk scoring systems are best used to stratify risk in patient populations and have not reached the level of development at which they are good for individual patients. It certainly would be inappropriate to use currently available systems to prognosticate futility for an individual patient . The key word is guidance. Decisions should never be based solely on a score, instead, careful clinical judgment must be exercised based on the individual patient and circumstances as well as on the experience of the surgeon.

III. Objectives Of The Study

1. The study is aimed at validating P-POSSUM score application in surgical practice in a tertiary centre in India
2. To evaluate and monitor healthcare delivery and outcomes
3. To use for research purpose and in clinical management as prognostic indicator.

IV. Materials And Methods

All consecutive inpatients admitted and operated from August 2013 to August 2015 in surgical unit VIII of Upgraded Department of Surgery at Osmania General Hospital, a teaching hospital cum tertiary referral centre, affiliated to Osmania Medical College, Hyderabad, India were included in the study. All necessary data was collected both retrospectively and prospectively.

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The physiological data were entered in proforma sheet at admission in emergency cases and a day before in elective cases or when the results of the tests were available. Necessary investigations were done for all patients. The operative data was obtained from the records and by personal communication with the surgeon, when required. The scoring system used to classify patients was similar to that of Copeland et al [24]

The data was entered in Microsoft Excel and analysed using P –POSSUM formula for mortality by linear analysis. The linear method of analysis was used rather than exponential analysis because it was more straightforward and simpler.

P –POSSUM equation [26] applied for mortality as follows:

In log (R/I-R)= -9.37 + (0.19 X physiological score) + 0.15 X operative severity score)

For a given range of risk, the number of operations within that range was given together with the mean risk for the operators and the predicted number of deaths was calculated i.e. number of operations x mean risk. This was compared with the observed number of deaths using the linear method of analysis. The ratio of observed to predicted death (O:E) was calculated for each analysis and frequency tables were compared for statistical significance by means of the Hosmer – Lemeshow goodness -of-it test and P value was derived.

Observed: Expected Ratio

After dividing the predicted mortality rates into different groups of risk factors, the actual and predicted mortality rates for each population group are calculated , as well as the ratio of actual mortality rate to predicted mortality rate. The observed expected (O:E) value is the ratio of the actual mortality to the predicted mortality. When the O:E value is 1 , the predictive ability of the scoring system is good. When the O:E value is greater than 1, the predictive value of the scoring system is low, and when the O:E value is less than 1, the predictive value is high.

Test For Goodness – Of – Fit

The model`s calibration or goodness-of-fit to assign the correct probability of outcome to individual patients. The Hosmer - Lemeshow statistic [61] was used to assess model calibration. To obtain this statistic, the estimated probability of death based on the model was calculated for each patient. Patients were ranked into equal groups of ascending surgical mortality rate, and the expected and obseved numbers of patients in each group were evaluated statistically. Similar values represent better model calibration.

Testing for goodness of fit with the data, to which it is being applied, is a must for any prognostic scoring system. Geographical variation in the different patient subsets makes such testing and validation mandatory. Since each hospital serves a different ensure that the model is applicable for the patient material involve, before the scoring system is accepted as quality standard.

V. Result And Analysis

A total of 242 patients underwent emergency surgeries in the above mentioned period. Number of predicted deaths by P-POSSUM when done by linear analysis was 18.97 while the number of observed deaths was 21. The O;E ratio was 1.11 and the Hosmer-Lemeshow Goodness-of-fit shows that the fitness of P-POSSUM is good in emergency surgeries and the difference between the predicted and the actual mortality rates is not statistically significant (Chi – square 0.26; 3 df; p –value =0.967687). The predicted and observed mortality rates are close though the actual mortality rate is marginally higher then the predicted mortality rate.

Table 3. Comparison of predicted and observed mortality rates by P-POSSUM using in emergency surgeries

PREDICTED MORTALITY RISK	MEAN OF PREDICTED MORTALITY	NUMBER OF PATIENTS	PREDICTED DEATHS	OBSERVED	O:E RATIO
0-5%	1.71	169	2.88	3	1.04
5-10%	9	32	2.89	3	1.04
10-20%	18.77	18	3.39	4	1.18
20-100%	42.74	23	9.83	11	1.11
0-100%	7.84	242	18.97	21	1.12

Chi-square = 0.26, df=3, p-value =0.967687

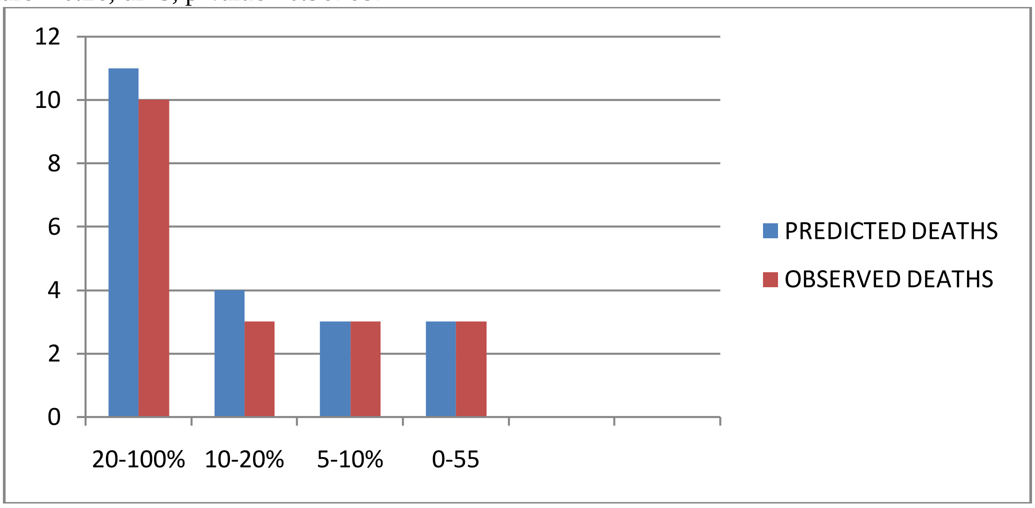


Figure 1 Distribution of patients undergoing emergency surgery

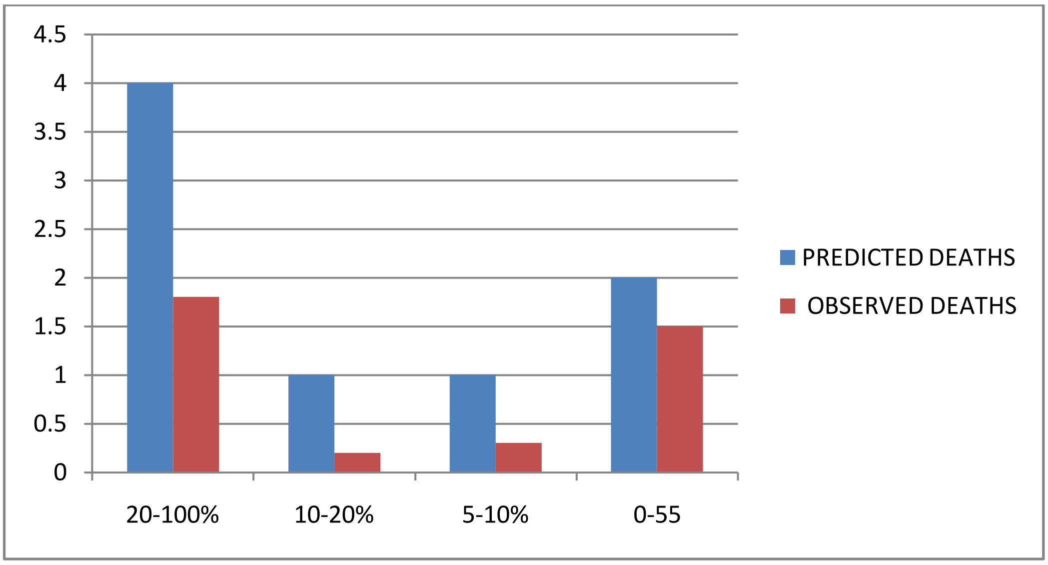


Figure 2 Distribution of patients undergoing elective surgery

A total OF 398 patients underwent elective surgeries in the above mentioned period. Number of predicted deaths by P-POSSUM when done by linear analysis was 3.74 while the number of observed deaths was 8. The O:E ratio was 2.14 and The Hosmer-Lemeshow Goodness-of fit shows that the fitness of P-POSSUM does not hold good in elective surgeries and the difference between the predicted and the actual mortality rates is statistically significant (Chi-square 10.08; 3 df; p-value =0.017884). The predicted and observed mortality rates has no coincidence and the actual mortality rate is significantly higher than the predicted mortality rate.

Table 4. Comparison of predicted and observed mortality rates by P-POSSUM in elective surgeries

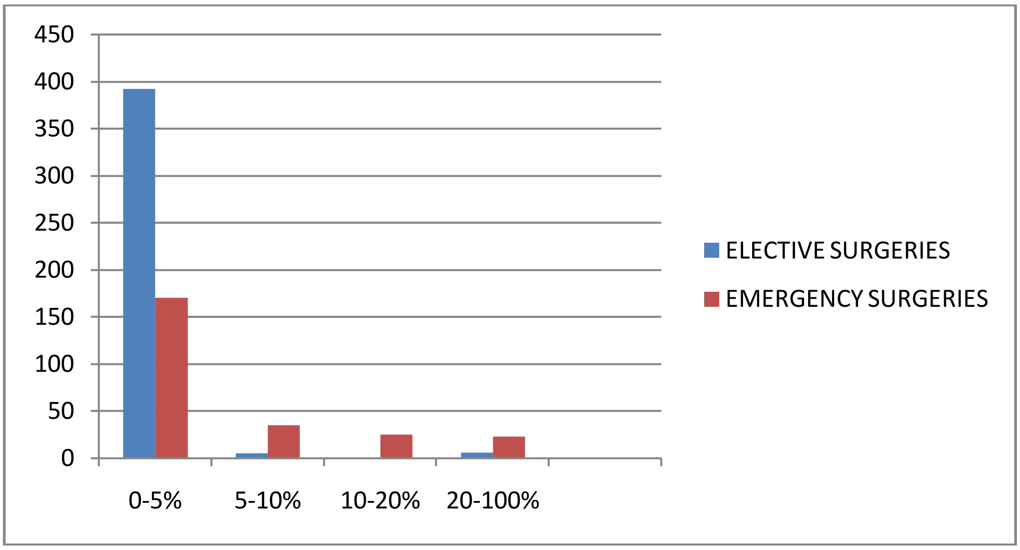
PREDICTED MORTALITY RISK	MEAN OF PREDICTED MORTALITY	NUMBER OF PATIENTS	PREDICTED DEATHS	OBSERVED	O:E RATIO
0-5%	0.39	389	1.52	2	1.31
5-10%	7.66	3	0.23	1	4.34
10-20%	15	1	0.15	1	6.66
20-100%	36.8	5	1.84	4	2.17
0-100%	0.94	398	3.74	8	2.14

Chi-square= 10.08, df=3, p-value =0.017884

VI. Discussion

Audit is much more than only data collection, it is complementary to research education, a commitment of improvement in care by stimulating further analysis, ensuring that practice is recorded, reviewed and made accountable, there by resulting in improved practice habits. Surgical audit has increased in importance over the past few years, both as an educational process and as a means of assessing and improving the quality of surgical care. Recognising patients who are at risk of developing complication will contribute substantially to the better management of the patients and resource utilization. A scoring system would seem to be the best method available for assessing the risk of mortality and morbidity. In the past, various scoring systems such as ASA and APACHE II have been used to predict both mortality and morbidity in surgical patients. These existing scoring systems are either too simple or too complex and do not completely meet the expectations as being readily applicable to audit. POSSUM and P-POSSUM scoring systems have been proven useful for comparative audit and have been validated in numerous studies.

Perioperative mortality is an important objective index that is used to evaluate the medical quality of surgical institutions. The inpatient mortality rate and 30 day mortality rate is used for this evaluation. POSSUM generally overpredicts mortality particularly in lower risk groups and overprediction results in most surgeons appearing to perform favourably. In addition to POSSUM giving the impression of favourable performance, it may also fail to identify poor performance. P-POSSUM was developed to avoid this overprediction in low risk groups and it proved to be a better prediction in low risk groups and it proved to be a better predictor of mortality than POSSUM.



In developing countries like India these risk-adjusted evaluations have not been done ,perhaps, because of difficulty in the collection or accurate data, difference in patient presentation, follow-up difficulties and limited financial resources. Testing of goodness of fit with the data, to which it is being applied, is must for any prognostic scoring system. Geographical variations in the different patient subsets make such testing validation mandatory. Since each hospital/institution may serve a different population, each scoring system must be calibrated in the individual hospital to ensure that the model is applicable for the patient material involved and the patient presentation (either for elective or emergency), before the scoring system is accepted as quality standard. This prompted to attempt the prospective validation of P-POSSUM in a tertiary referral hospital like Osmania General Hospital in both elective and emergency surgeries.

In this present study, it is observed that P-POSSUM equation demonstrated better prediction with linear method of analysis in emergency surgeries. Of 242 patients there were 18.97 predicted deaths while observed deaths were 19. But it significantly under predicted in elective surgeries especially in the high risk groups. Of 398 patients there were 3.74 predicted deaths while observed deaths were 8.

Though the numbers of patients included in elective surgeries were 398 only 9 patients had p-POSSUM predicted mortality risk of >5%. Out of these 9 there were 6 deaths which has grossly altered the O:E ratio, the resulted p-value <0.05 which is statistically significant and thus altered the conclusion of the study with regard to evaluation of P-POSSUM for elective surgeries. So presence of more number in low risk group which composed of fit patients undergoing minor surgery has significantly altered the case mix and as a result, the conclusion of the study with regard to the elective surgeries.

So inclusion of more number of high risk cases is needed for a broad case mix to validate the P-POSSUM equation surgeries which was lacking in this study. These high risk cases also need to be given proper postoperative intensive and intermediate care with the help of an efficient anaesthetic unit which is also lacking in this study. High risk cases from a physiological point of view or operative point of view may require elective post operative ventilation. The type of ventilation required and the duration may also vary and be individualized. This is best done in an intensive care unit managed by an efficient anaesthetic/surgeon team complimented by efficient physiotherapist to prevent certain complications associated with such high risk cases.

So the inclusion of less number of high risk cases, the lack of proper postoperative intensive care which is beyond the preview of the surgeon etc may be responsible for the underprediction of the deaths in elective_surgeries. A proper study may further be required with a proper case mix as was in emergency surgeries in this study to evaluate P-POSSUM in elective surgeries or probably one will have to analyse methods of treatment and change or modify them. A modification of the formula may also be required in elective surgeries.

Limitations of this study is that it does not take into consideration certain factors that may have impact on surgical care and outcome such as surgical expertise and seniority, anaesthesitic expertise, duration of operation, organ system being operated on and the duration of stay after operation which may indicate the morbidity associated with the complications of such surgery. Importance was also not given to some prognostic factors which have an impact on the outcome of surgery like jaundice, diabetes mellitus etc.

There were many studies done to evaluate P-POSSUM equation for predicting mortality , as a tool of surgical audit and it effectiveness in various geographical locations. Some of the important studies are quoted below.

M.K.Yii and K.J.Ng evaluated application of POSSUM and P-POSSUM in surgical practice with a different population and level of resources in centres outside UK. All general surgical patients operated as inpatients over a 4 month period at Sarawak General Hospital in Malaysia in 1999 were entered into the study. A total of 605 patients were evaluated with theses equations using linear anaylsis. POSSUM overestimates the mortality by a factor of 9.3. In contrast, the observed and predicted mortality rates were comparable when P-POSSUM equation was used. The study concluded that p-possum was applicable in Malaysia for risk-adjusted surgical audit and thus may serve as a useful comparative audit tool for surgical practice in many geographical locations.[35]

Mahesh G et al [62] evaluated P-POSSUM mortality predictor equation and its use as a tool in surgical audit. A total of493 patients admitted in Kasturba Medical College, Manipal, India in over 6 units. They were operated occurred. He concluded that P-POSSUM mortality predictor equation predicts death accurately in general surgical patients. The present study results are also comparable to the study done by Mohil et al [63] in a referral hospital in a developing country in patients undergoing emergency laparotimies.

Ramesh VJ et al evaluated the usefulness of POSSUM and P-POSSUM scoring systems in elective neurosurgical patients in predicting in hospital mortality.[64]A total of 285 patients were studied from april 2005 to feb 2006. Overall observed mortality was nine patients (3.16%). The mortality predicted by the P-POSSUM model was also nine patients (3.16%). Mortality predicted by POSSUM was poor with predicted deaths in 31 patients (11%). The difference between observed and predicted deaths at different risk levels was not significant with P-POSSUM ($p = 0.424$) and was significantly different with POSSUM score ($p < 0.001$). P-POSSUM scoring system was highly accurate in predicting the overall mortality in neurosurgical patients. In contrast, POSSUM score was not useful for prediction of mortality.
The results of the present study concur with the above observations.

The evaluation of P-POSSUM in emergency surgeries as in this study is also comparable in the study done by Pavan kumar and Gabriel Sunil Rodrigues in comparision of POSSUM and P-POSSUM in patients undergoing emergency laparotomy[65] . 82 patients were included in the study of which 8 deaths occurred. POSSUM predicted 17 and 12 deaths by linear and exponential analysis respectively. But P-POSSUM predicted 11 and 9 deaths by linear and exponential analysis respectively.

In 2005 Parihar Vijay et al used linear analysis and POSSUM overpredicted the mortality as compared to observed mortality; while using exponential analysis, the predicted and observed mortality rates were similar. The mortality rate predicted by P-POSSUM, using linear analysis was as expected but when exponential analysis was used it was significantly higher than observed mortality. Hence the authors developed the Jabalpur POSSUM score (J-POSSUM)[30] for low-risk general surgical patients as under:

J-POSSUM = POSSUM X correction Factor for mortality if risk <10%.
J-POSSUM = POSSUM X correction Factor for morbidity if risk <40%.

Although P-POSSUM may not be able to replace highly specific scoring systems for individual disease or the intensive care patient, it does appear to provide an efficient indicator of the risk of mortality in the general surgical patients. P-POSSUM is to be used as a tool for surgical audit and should never be intended to affect the decision to operate, a decision that must always remain clinical. Scoring will never replace clinical judgement. If a prediction of 75% mortality after surgery is made by a score, the decision of whether to operate or not is left to the surgeon`s wisdom.

VII. Conclusions

There have been several attempts at creating a scoring system to predict mortality risk after surgery. Some scoring systems provide a prediction that approximates the observed mortality rate for a cohort, but none is sufficiently accurate when considering an individual patient. Of the few surgical scoring systems available P-POSSUM appears to be the most appropriate. This equation is claimed to produce a closer fit with the observed patient mortality rate. It requires collection of simple physiological and operative scores within the scope of basic surgical care. The linear comparison analysis using the P-POSSUM equation is straightforward and easy to apply, which is relevant in developing countries with limited resources.

P-POSSUM have been extensively used in UK and the present study has confirmed that it can be used in patients attending tertiary referral hospitals in a developing country like India for emergency surgeries. Further studies are required to evaluate P-POSSUM in elective surgeries with a broad case mix and proper postoperative intensive care for high risk cases by judicious utilization of the resources available.

This validation study opens up simple opportunities for the application of P-POSSUM scoring system as a comparative audit tool to allow assessment of the quality of care in a developing country like India with limited resources. It could also theoretically assist in direction of resuscitative efforts both pre and postoperatively.

VIII. Future Scoring Systems- Genetic Profiling?

In the future, clinical scoring systems likely will be supplemented or supplanted by other means of profiling patient risk. One such method has been recently detailed by Shaw and others[9], who explored the genotypes of inflammatory genes in patients undergoing lung resection. They identified specific alleles of interleukin 6 (IL-6) and tumor necrosis factor (TNF) that, when present , conferred an increased risk of pulmonary complications.

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