Risk adjusted auditing of postop complications in gastric cancer patients by POSSUM

Birendra Kumar Sah, Chen Ming Min, Wang Xiao Yan, Yang Qiu Meng, Li Chen, Xiang Ming, Chen Jun, Yan Min, Zhu Zheng Gang

Department of General Surgery, Rui Jin Hospital, Shanghai Jiao Tong University, School of Medicine, Shanghai Institute of Digestive Surgery, Shanghai, China

ABSTRACT

POSSUM (Physiological and Operative Severity Score for the enUmeration of Morbidity and mortality) has been proposed as a promising system for risk adjusted audit in surgical practice. However it has not been generalized in gastric cancer surgery. Present study evaluates the POSSUM on malignant gastric cases in Chinese hospital where patient population or healthcare system might be different than United Kingdom (UK) where the formula was devised.

Total of 389 patients who underwent surgical intervention for gastric cancer and malignant gastric lymphomas during the year 2006 were included in the study. Median age was 58 years, with male:female ratio of 7:3. POSSUM data were collected according to standard criteria described by the original authors. Exponential analysis method was used for morbidity predictions.

POSSUM predicted satisfactorily for morbidity, observed morbidity was not significantly different than estimated morbidity ($p=0.962$). Overall, 176 cases were observed to have postoperative complications (including death). The observed to expect ratio (O:E) was 0.99. There was no significant increase in complication rate with increasing age ($\chi^2=3.75$, 4 d.f., $p=0.44$). Overall 176 cases were observed to have postop complications (including death).

Age was not a risk factor for early postoperative complication. POSSUM predicted well in this study, which means it is a valid system for gastric cancer surgery. However, overall complication rate considered being higher if it is recorded according to POSSUM criteria. Modification in POSSUM equation with revised morbidity definition may be more feasible for major operations.

© 2008 Surgical Associates Ltd. Published by Elsevier Ltd. All rights reserved.

1. Background

Postoperative complications after gastrectomy is still a major challenge to surgical practice, which demands further researches to optimize surgical extent to the least, while obtaining optimum result in gastric cancer patients. In this era of evidence-based medicine, it is time to standardize surgical practice too. And for this purpose, a standard auditing system is necessary to compare surgical outcome of different types of surgery and exploring optimal surgical treatment.
1.1. Importance of risk adjusted auditing

Surgical outcome possesses important role in practice of surgery. However 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 has a major effect on the ultimate outcome. Simple collection of numbers alone is not sufficient to reflect treatment quality as, to compare morbidity and mortality data directly, the original populations must be identical. Surgeons treating a predominantly young population would be expected to achieve lower morbidity and mortality rates than others serving areas with an elderly population. The unit that selects only low-risk cases achieves a low complication rate and therefore attracts more patients, whereas the unit that cannot select only low-risk cases are left with a worsening case mix. Monitoring crude death rates can mask the effects of case mix; surgeons who work in impoverished inner-city hospitals or tertiary referral centers may feel disadvantaged compared with their colleagues who elect to treat fit patients or work in affluent area.

1.2. Why POSSUM?

POSSUM has been proposed as a method for standardizing patient data, so that direct comparisons of patient outcomes can be made. There are many scoring systems, but to the date POSSUM is the most reliable system, which has been extensively used in various surgical specialties. POSSUM system offers two important applications; it provides information regarding operative risk, which can be used to give preoperative information to the patient about the risks of intervention during consent and also to aid clinicians in the management of patients. The second application is in auditing surgical practice and comparing between centers. Therefore we applied this auditing tool to evaluate its predictability of morbidity on gastric cancer patients in Chinese hospital where the health care system, patient population might be different than UK where the formula is devised first. If the POSSUM system is applicable in Chinese patients, it can be a basic system for risk adjusted auditing which may assists further researches to compare outcomes of different units and surgical modalities for gastric cancer in future.

2. Patients and methods

All the data were collected directly by comprehensive review of patient records. Patients who underwent surgical intervention for gastric cancer and malignant gastric lymphomas during the year 2006 were included. Gastrectomies for benign cases were excluded. There were 397 patients who underwent surgery for gastric cancer, data of eight cases were missing, thus excluded. However, there was no death in excluded cases as information provided by hospital database. All together 396 operations (including seven relaparotomy for complications) were performed on 389 patients. Two cases of relaparotomy were excluded for the evaluation of POSSUM scoring system due to preoperative data missing, but their complications were recorded for auditing purpose. Finally, 394 operations on 389 patients were included for the evaluation of POSSUM system. Median age was 58 years, with lowest 22 years and highest 88 years old (Table 1). We observed significant differences in incidence of gastric cancer in male and female, which was approx. 7:3. All operations were performed in eight departments including five general surgery departments, two laparoscopic surgery departments and one cardio-thoracic department of a well-known referral hospital of China. All the patients with early and resectable advanced gastric cancer (without significant distant metastases) were performed gastrectomy with D2 lymphadenectomy. Rare patients of vague diagnosis or early gastric cancer performed D1 lymphadenectomy. Patients of malignant gastric lymphoma were generally performed gastrectomy. Majority of operative surgeons were consultants, very few of them were vice consultants. The only endpoint studied was in-patient morbidity or mortality.

POSSUM data were collected on a standard sheet and calculated as described by its original authors. A comprehensive explanatory sheet was prepared to ease any confusion in defining POSSUM variables. For multiple operations on one patient due to complication, data was collected on separate datasheet for each operation and new PS (physiological score) or OSS (operative severity score) was awarded for it. Similarly, complication for each operation was recorded separately (from a previous operation to just before the next operation) in patients with multiple operations. Morbidity was documented on the basis of definition by Copeland et al. with some added morbidity definition in our department (Appendix). Our added definition of morbidity was applied for internal audit and it did not increase the number of morbidity significantly, as most of cases have accompanied by other complications as defined by POSSUM.

2.1. Statistical analysis

All the data were recorded on Microsoft Access 2000 (Microsoft, Redmond, WA). The entire database underwent an extensive process of data editing to check for missing or out-of-range values and inconsistencies between data fields. After verification, error-free data were entered into a master file. SPSS 13.0 (SPSS Inc., Chicago, IL) statistics tool was used for statistic purpose.

POSSUM uses exponential analysis method for morbidity analysis. Linear analysis of data yields over prediction of morbidity. This was previously reported by Wijesinghe et al. However exponential analysis is unwieldy because it has to be stopped and restarted at a new level if the predicted number of morbidity falls below that calculated at a higher cut-off. In our study, the calculation for the bands below this point did not predict well by exponential method, therefore we used linear analysis for this, the number of patients falling into morbidity group was multiplied by the mean risk of morbidity to give the predicted number of morbidity in that group. The remaining bands were analyzed by exponential method. The ratio observed to expected morbidity (O:E ratio) was calculated for each band. A χ² test was used to detect any differences between predicted and observed rates of morbidity, \( p < 0.050 \) was accepted as significant.
3. Results

Majority of patients were above 50 years of age, however there was no significant \( \chi^2 = 3.75, 4 \text{ d.f}, p = 0.44 \) increase in complication rate with increasing age (Fig. 1). Overall 176 cases were observed to have postop complications (including death). There were six deaths and one patient discharged at end stage before clinical death. Owing to lack of universally accepted definition for complications, here we just listed pronounced complications in our study (Table 2). Number of complication is not equal to number of patient. Multiple complications may be possible in one case.

POSSUM predicted morbidity well and observed morbidity were not different than estimated morbidity by POSSUM \( (p = 0.962) \), the ratio of observed to expected morbidity was 0.99 (Table 3).

To give more objective view, all complications were stratified (Fig. 2A) according to RJH (Rui Jin Hospital) classification of complications (Table 4). To give indirect estimation about severity of complications. We also stratified all complications according to postop length (Fig. 2B).

4. Discussion

4.1. Correct analysis of POSSUM

POSSUM has been criticized in past for its overprediction, specially in predicting mortality, besides many authors reluctant to use POSSUM to predict morbidities, due to lack of universally accepted definition for morbidity and trouble in collecting data. And there have been many researches to explore new POSSUM system for mortality. One of the generally accepted modifications is P-POSSUM, which claims to predict mortality better than POSSUM.2,7 However, overprediction by POSSUM and better prediction by P-POSSUM may be the results of inadequate apply of analysis method.6 POSSUM seems to predict well by exponential method, though it is criticized

---

**Table 1 – Demographic data of the patients included for evaluation of POSSUM**

<table>
<thead>
<tr>
<th>Details</th>
<th>No.</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>273</td>
<td>70.2</td>
</tr>
<tr>
<td>Female</td>
<td>116</td>
<td>29.8</td>
</tr>
<tr>
<td>Operation type (total 396)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial gastrectomy</td>
<td>269</td>
<td>68.3</td>
</tr>
<tr>
<td>Total gastrectomy</td>
<td>77</td>
<td>19.5</td>
</tr>
<tr>
<td>Palliative</td>
<td>19</td>
<td>4.8</td>
</tr>
<tr>
<td>gastrojejunostomya</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laparotomya</td>
<td>23</td>
<td>5.8</td>
</tr>
<tr>
<td>Relaparotymb</td>
<td>7</td>
<td>1.3</td>
</tr>
<tr>
<td>Repair of perforated gastric cancer</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Mode of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>387</td>
<td>98.2</td>
</tr>
<tr>
<td>Emergency</td>
<td>7</td>
<td>1.78</td>
</tr>
<tr>
<td>Pathology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary gastric cancer</td>
<td>369</td>
<td>93.7</td>
</tr>
<tr>
<td>Gastric stump cancerd</td>
<td>13</td>
<td>3.3</td>
</tr>
<tr>
<td>Malignant gastric lymphoma</td>
<td>7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

a Tumor not resected.

b Laparotomy for complication.

c Including three relaparotomy.

d Including relapsing gastric cancer.

---

**Table 2 – List of objective complications**

<table>
<thead>
<tr>
<th>Surgical</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaparotomya</td>
<td>7</td>
</tr>
<tr>
<td>Intraabdominal hemorrhage</td>
<td>2</td>
</tr>
<tr>
<td>Anastomotic leak (13), hemorrhage (1)</td>
<td>14</td>
</tr>
<tr>
<td>Leak: Pancreatic (4), biliary (1), lymphatic (1)</td>
<td>6</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>6</td>
</tr>
<tr>
<td>Ileus (3), enteroplegia? (16)</td>
<td>19</td>
</tr>
<tr>
<td>Systemic</td>
<td></td>
</tr>
<tr>
<td>Cerebrovascular complication</td>
<td>2</td>
</tr>
<tr>
<td>MODS</td>
<td>7</td>
</tr>
<tr>
<td>Death (6), discharged at end stage (1)</td>
<td>7</td>
</tr>
</tbody>
</table>

Infection:

- Pulmonary: 50
- Urinary: 17
- Intraabdominal: 13
- Wound: 4

---

**Table 3 – Exponential analysis**

<table>
<thead>
<tr>
<th>Morbidity group (%)</th>
<th>No. of patients</th>
<th>No. of morbidity O:E</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>30</td>
<td>9</td>
</tr>
<tr>
<td>30–39</td>
<td>72</td>
<td>25</td>
</tr>
<tr>
<td>40–49</td>
<td>60</td>
<td>23</td>
</tr>
<tr>
<td>50–100</td>
<td>232</td>
<td>119</td>
</tr>
<tr>
<td>60–100</td>
<td>154</td>
<td>92</td>
</tr>
<tr>
<td>70–100</td>
<td>88</td>
<td>59</td>
</tr>
<tr>
<td>80–100</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>90–100</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>0–100</td>
<td>394</td>
<td>176</td>
</tr>
</tbody>
</table>

a Rounded to the nearest whole no. \( \chi^2 = 0.605, 4 \text{ d.f}, p = 0.962 \).
by some authors that it is not standard analysis method. But it was later defended by its original authors.1 There were reports of spurious result if linear analysis method used for POSSUM and exponential analysis used for P-POSSUM. Both systems predicts well by correct analysis.6,8

4.2. Application of POSSUM and its modifications

POSSUM has been applied in various sub-specialty of general surgery, including vascular surgery,6,9 colorectal surgery,10–12 hepato biliary and pancreatic surgery,13–16 laparoscopic surgery17,18 thoracic surgery.19,20 There were also reports of many modified POSSUM to fit different sub-specialty, like V-POSSUM, R-AAA POSSUM (in vascular surgery)21 Cr-POSSUM (for colorectal surgery).10 Orthopedic POSSUM was developed to fit the orthopedic cases.22 However, there have been relatively less reports on upper gastrointestinal surgery especially in gastric surgery. And in some reports, possum overpredicted morbidity and mortality. Tekkis et al. developed O-POSSUM specific for upper gastrointestinal surgery, which was reported to predict mortality more accurate.23 In a study, authors applied POSSUM on the patients who underwent gastrectomy with D2 lymphadenectomy but the result was discouraging.24 May be this was also the result of wrong analysis, as authors used linear analysis method in this study. Most of modified POSSUM were devised to predict mortality, which is more objective and easier to collect data. But, in clinical practice morbidity is more important than mortality. Early trend analysis for morbidity can identify early downturns in performance before this is replaced with mortality. Sudden death after surgery is a rare event, and death usually follows a series of antecedent complications.1

4.3. Interpretation of POSSUM variables

Variables of possum are relatively objective to collect but there are still some variables, which are hard to interpret. The electrocardiogram (ECG) seems to cause the most confusion. Recent myocardial infarction or evidence of myocardial ischemia scores 8, the highest value. However, the highest score category also includes miscellaneous items. Confusion can occur easily if minor, non-specific ECG changes are scored in this miscellaneous category.3 The operative score has an element of subjective assessment. The exact volume of blood

![Fig. 2](image-url)
loss may not be easy to determine. Data collection is a problem if more than one operation is performed due to complication. For example if there has been performed three operations on a patient, and the patient dies after 2nd or 3rd operation then how to audit their complication, original authors of these scoring systems have not explained clearly about this problem. However, all of these problems could be eased by the creation of a standard comprehensive explanatory sheet for surgeons using POSSUM scoring.  

4.4. Morbidity definition

In present study, POSSUM predicted satisfactorily with its recommended analysis method, which means POSSUM is a valid system for gastric cancer surgery. However, most of complications in our study, were minor or moderate and only documented here to comply with morbidity definition of POSSUM. And in general, most of these complications considered having no clinical importance. As POSSUM was originally devised to fit all general surgery cases, including minor surgery, therefore it accounts for very minor complications too, e.g. PUO, but for major operations many of these complications are negligible and if we account for these all complications, definitely morbidities will be higher which is probably not acceptable for operative surgeons.

To stand as universally acceptable auditing tool, POSSUM may need some modifications, a new equation with revised definition of morbidity may be suitable for major surgical interventions. If not, care should be taken while interpreting complication rate recorded by POSSUM criteria, however, this is not a problem as long as standardized documentaiton is practiced for POSSUM system and the result can be taken as reference to improve patient care even though it seems to be higher. And for more feasible comparison, there should be further classification for complications, as we stratified all morbidities into minor, moderate and severe complications.

5. Conclusion

Traditional concept that higher age may lead to poor surgical outcome, may not be true in all aspects as we found there was no significant increase in complication with increasing age. It is time to change the traditional concept of crude auditing of postoperative complications and more reliable risk adjusted auditing is need of new era. POSSUM can be used for risk adjusted auditing in gastric cancer surgery, which may facilitate other researches to optimize surgical outcome.

Conflicts of interest
None declared.

Funding
Institute of Digestive Surgery.

Ethical approval
Approval was given by director of Institute of Digestive Surgery who is also the corresponding author of this manuscript.

Acknowledgement

The authors thank Shanghai Institute of Digestive Surgery for funding this research, Dr Miao Qiong, for her assistance in designing of data collection charts, computer engineer Mr. Dipendra Kumar Sah for designing a special POSSUM calculator and database program, the statistic bureau of Rui Jin hospital for providing records of patients, Mr. Sun Jing Jian, officer of patient record, for his enthusiasm and support.

Appendix

Definitions of morbidity by Copeland et al.

2. Chest infection: production of purulent sputum with positive bacteriological cultures, with or without chest radiography changes or pyrexia, or consolidation seen on chest radiograph.
3. Wound infection: wound cellulitis or the discharge of purulent exudates.
4. Urinary infection: the presence of >10⁵ bacteria/ml with the presence of white cells in the urine, in previously clear urine.
5. Deep infection: the presence of an intraabdominal collection confirmed clinically or radiologically.
7. Pyrexia of unknown origin: any temperature above 37 °C for more than 24 h occurring after the original pyrexia following surgery (if present) had settled, for which no obvious cause could be found.
8. Wound dehiscence: superficial or deep wound breakdown.
9. Deep venous thrombosis and pulmonary embolus: when suspected, confirmed radiologically by venography or ventilation/perfusion scanning or diagnosed at post mortem.
10. Cardiac failure: symptoms or signs of left ventricular or congestive cardiac failure, which required an alteration from preoperative therapeutic measures.
11. Impaired renal function: arbitrarily defined as an increase in blood urea of >5 mmol/l from preoperative levels.
12. Hypotension: a fall in systolic blood pressure below 90 mmHg for more than 2 H as determined by sphygmomanometer or arterial pressure transducer measurement.
13. Respiratory failure: respiratory difficulty requiring emergency ventilation.
14. Anastomotic failure: pyrexia of unknown origin, which follows just after feeding (PO) and settles after NPO, or any suspicious leak on radiological examination.

Added morbidity definition in our study

1. Suspicious or sub-clinical anastomotic leak: pyrexia of unknown origin, which follows just after feeding (PO) and settles after NPO, or any suspicious leak on radiological examination.
2. Others:
   I) Ileus: radiological confirmation or diagnosed on laparotomy.
   II) Pleural effusion: radiological or ultrasound confirmation.
   III) Gastro or enteroplegia: empirical diagnosis on the basis of length of gastric tube drainage.
   IV) Extended drainage of unknown reason: >10 days.
   V) Continuous or relapsing pyrexia of unknown origin: continuous fever after surgery (T > 37.5).
   VI) Pancreatitis: elevation of serum, urine amylase or radiological diagnosis. Diagnosis on laparotomy.
   VII) Seroperitoneum (including pelvic cavity effusion): radiological or ultrasound confirmation.
   VIII) Other pulmonary complication: e.g. shortness of breath relapsing asthma.

REFERENCES