Evaluation of POSSUM scoring system in the treatment of osteoporotic fracture of the hip in elder patients

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Objective: To evaluate the applicability of the modified physiological and operative severity score for enumeration of mortality and morbidity (POSSUM) scoring system in predicting mortality in the patients undergoing hip joint arthroplasty.

Methods: A total of 295 patients with hip fractures were analyzed using the modified POSSUM surgical scoring system. The mean ages of the patients were 66.59 years in the complicative group, 62.28 years in noncomplicative group, 77.89 years in the death group and 63.25 years in the living group, respectively. The comparisons between the observed and predicted morbidity, between the observed and predicted mortality were made within 30 days after operation.

Results: The average physiological scores and operative severity scores was 18.96 ± 4.83 and 13.47 ± 2.01 in complicative group, while 15.65 ± 3.66 and 11.74 ± 2.26 in noncomplicative group (P<0.05). The average physiological scores and operative severity scores was 25.56 ± 3.78 and 14.22 ± 0.67 in death group, while 16.46 ± 4.09 and 12.25 ± 2.33 in living group (P<0.05). Though POSSUM scoring system over-predicted the overall risk of death, its estimate was very close in the high risk groups (>10%). There was perfect consistence between the observed and the predicted morbidity as calculated by published predictor equation for morbidity, and consistence for mortality in the high risk band.

Conclusions: Modified POSSUM scoring system may be used to predict the morbidity in patients with hip fracture. Furthermore, POSSUM scoring system overpredicts the overall risk of death, but its estimate is close to the actual data in the high risk band (>10%).

Key words: ***Hip fractures; Mortality; Morbidity***

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It is important to evaluate the risk level of surgical operation for clinicians. The assessment mainly depends on patient's symptoms, signs, physiological scores and operative severity scores. As early as 1 750 BC, King Hammurabi in Babylon issued that if a surgeon operated on a free man, resulting in the patient's blindness or death, the surgeon should be punished cruelly. This raw and simple method,which was only based on "death" and "deformity", continued to be used for thousands of years. From then on, many people have been attempting to devise more reliable and robust methods to assess the outcome of surgical intervention.[1-3]

In order to create an ideal risk scoring system, Copeland et al[2] spent 2 years in multivariate analysis to develop the physiological and operative severity score for the enumeration of mortality and morbidity, which could predict mortality and morbidity, be quickly easily used in all general surgical procedures, applicable to any hospital and integrated easily into pre-existing audit program with minimal disruption.

In general surgery, the POSSUM and P-POSSUM systems have been proved to be the most reliable and widely applicable scoring methods until now,[2,4] which have been applied in subspecialities, including vascular surgery, surgical gastroenterology and urology, and are used by many health-care organizations.[5-7] With some modifications, Copeland et al[8] found that the orthopedic POSSUM system (contamination replaces peritoneal soiling in operative severity score, definitions of operative complexity are given) which they had developed gave predictions of mortality and morbidity, which correlated well with the observed rates in the sample of 2 326 orthopedic patients receiving operations over a period of 12 months.

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Hip fractures are common orthopedic traumas mostly occurring in old patients and the risk increases with age. The old patients often had problems in heart, liver and kidney before the trauma, therefore the mortality and the morbidity are higher than other fractures. With the improvement of living standard and elongation of mean longevity, the occurrence of fractures have the trend of increasing. Aimed at the diseases with higher risk such as hip fracture, we need a scoring system which can exactly estimate operative mortality and morbidity for the assessment of clinical outcome after operation.

To assess the modified POSSUM scoring system in patients with hip fractures in China, we use the methods similar to Copeland's description in the development of the POSSUM system (the dissimilarity lies that mean analysis replaces exponential analysis) to analyze 295 patients with hip fractures.

METHODS

From January 1995 to December 2002, 295 patients (over 18 years old) with hip fractures in the orthopaedics department of the First Hospital of Jilin University were assessed by the modified POSSUM system retrospectively. Among those patients, 36 patients underwent emergent operation within 48 hours after admission, but 256 patients required elective operation. All 295 patients had blood samples taken for the measurement of hemoglobin concentration and white cell count, and they had electrocardiography and chest radiograph. The majority of patients took the determination of urea and electrolyte levels, when a figure was missing, a score of 1 was allocated.

The scores include two parts: the physical assessment including 13 variables (Table 1) and the operative severity assessment including 6 variables. Each part is divided into four grades, with an exponentially increasing value (Table 2).

Table 1. Physical severity data in modified POSSUM system

Physical score	1	2	4	8
Age (year)	<60	61-70	>71	
Cardiac signs	Normal	Cardiac drugs or steroid	Edema Warfarin	Raised JVP
Chest radiography	Normal		Borderline cardiomegaly	Cardiomegaly
Respiration signs	Normal	SOB* exertion	SOB* stairs	SOB* rest
Systolic BP (mm Hg)	110-130	131-170 or 100-109	≥ 171 or 90-99	≤ 89
Pulse (per min)	50-80	81-100 or 40-49	101-120	≤ 39 or ≥ 121
Glasgow coma score	15	12-14	9-11	≤ 8
Hb (g/L)	13-16	11.5-12.9 or 16.1-17.0	10.0-11.4 or 17.1-18.0	≥ 18.1 or ≤ 9.9
White cell count ($\times 10^3$/L)	4-10	10.1-20.0 or 3.1-4.0	≤ 3.0 or ≥ 30.1	
Blood urea (mmol/L)	≤ 7.5	7.6-10.0	10.1-15.0	≥ 15.1
Blood Na^+ (mmol/L)	≤ 136	131-135	126-130	≥ 125
Blood K^+ (mmol/L)	3.5-5.0	3.2-3.4 or 5.1-5.3	2.9-3.1 or 5.4-5.9	≤ 2.8 or ≥ 6.0
ECG	Normal		(60-90)	Any other change

*SOB: shortness of breath.

Table 2. Operative severity data in modified POSSUM system

Operative score	1	2	4	8
Magnitude	Minor	Intermediate	Major	Major+
Number of operative variables within 30 day	1		2	≥ 2
Total blood loss (ml)	≤ 100	101-500	501-999	≥ 1000
Contamination	None	Incised wound or stab	Minor contamination or necrotic tissue	Cross contamination or necrotic tissue
Presence of malignancy	None	Primary only	Node metastasis	Distant metastasis
Timing of operation	Elective		Emergency Resuscitation <48 h	Emergency <6 h

Thereafter they entered the following logistic equations and the patient's mortality was predicted. Every patient was scored carefully according to POSSUM scoring system. Missing data may be treated as normal values without influencing outcomes. Predictions of mortality and morbidity were estimated using the following equations (R1 relates to mortality and R2 to morbidity).

The operative outcome in 30 days was assessed as morbidity and mortality. Comparing the predictive and observed outcomes (dead/alive or complication/uncomplication in 30 days), we can assess the modified POSSUM scoring system in patients with hip fractures. The difference between observed and predicted outcomes were assessed using $\div^2$.

The mortality and morbidity for individual patients were estimated using the following equations (R1 relates to mortality and R2 to morbidity).

LogeR1/(1-R1)=-7.04+(0.13×physiological score) +(0.16×operative severity score)

LogeR2/(1-R2)=-5.91+(0.16×physiological score) +(0.19×operative severity score)

RESULTS

In the complicative group and noncomplicative group, the mean age of the patients were 66.59 and 62.28, respectively. In the complicative group, both physiological scores and operative severity scores of POSSUM scoring system were significantly higher than that of non-complicative group ((18.96 ± 4.83) *vs* (15.65 ± 3.66)) in physiological score and ((13.47± 2.01) *vs* (11.74 ± 2.26)) in operative severity score. Based on predictor equation of Copeland, the predicted and observed number of noncomplicative patients are 94 and 95. There was no statistical difference between them (P>0.05). The mean age of patients were 77.89 in the death group and 63.25 in living group, respectively. Both physiological scores and operative severity scores of POSSUM scoring system in death group were (25.56 ± 3.78) and (14.22 ± 0.67), significantly higher than (16.46 ± 4.09) and (12.25 ± 2.33) in living group.

The death cases we observed in 30 days after operation are shown in Table 3 and the complications that we observed in 30 days after operation are shown in Table 4.

The use of the POSSUM logistic regression equations yields an overall predicted mortality of 21 patients (observed: 9) and a predicted morbidity in 94 patients (observed: 9). The risk spectra for both mortality and morbidity are shown in Table 5 and Table 6.

Though POSSUM scoring system overpredicts the overall risk of death, it is very close to the observed data in the high risk band (>10%). There was good consistence between the observed and the predicted morbidity as calculated by published predictor equation for morbidity, and consistence for mortality in the high risk band.

Table 3. The characteristics of patients who died after operation

No.	Trauma	Age (year)	Operation	Death cause	Death time (day)	Predicted mortality (R1)
1	Femoral neck fracture	74	Femoral head replacement	Respiratory failure	11	0.421
2	Femoral neck fracture	85	Femoral head replacement	Cerebrovascular infarction	12	0.195
3	Femoral neck fracture	68	Total hip replacement	Respiratory failure	During operation	0.141
4	Femoral neck fracture	90	Femoral head replacement	Myocardial infarction	20	0.263
5	Femoral neck fracture	77	Total hip replacement	Cerebrovascular infarction	18	0.263
6	Femoral neck fracture	81	Femoral head replacement	Respiratory failure	5	0.141
7	Intertrochanteric fracture	76	L-trapezoid Plate	Respiratory failure	3	0.100
8	Femoral neck fracture	79	Femoral head replacement	Cerebrovascular infarction	25	0.157
9	Femoral neck fracture	72	Total hip replacement	Cerebral hemorrhage	9	0.157

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Table 4. Patients with complications after operation

Complications	Cases
Cardiovascular diseases (hypertension, cardiac failure, myocardial infarction, arrhythmia, angina)	19
Respiratory diseases (pulmonary infection, respiratory failure)	21
Thrombosis (deep-venous thrombosis, pulmonary embolus, cerebrovascular infarction, limb occlusion, etc.)	43
Urinary diseases (urinary infection, urinary retention)	11
Gastrointestinal diseases (stress ulcer, gastric hemorrhage, hepatic failure)	9
Wound infection	1
Cerebral hemorrhage	1
Total	105

Table 5. Risk spectra for predicted mortality and observed mortality

Risk band (%)	Number of death		O:E ratio
	Evaluated	Observed	
<10	11	0	
10-19	7	6	0.86
20-29	2	2	1.00
30-39	0	0	
40-49	1	1	1.00
0-100	21	9	0.43

Table 6. Risk spectra for predicted morbidity and observed morbidity

Risk band (%)	Number of complications		O:E ratio
	Evaluated	Observed	
<10	0	0	
10-19	15	14	0.93
20-29	12	13	1.08
30-39	18	19	1.06
40-49	17	17	1.00
50-59	13	14	1.08
60-69	12	12	1.00
70-79	3	3	1.00
80-89	2	3	1.50
>90	2	2	1.00
0-100	94	97	1.03

DISCUSSION

To find out why the POSSUM scoring system is not suitable for the lower risk band analysis, we suppose that a healthy young man undergoing uncomplicated hernia repairs, has the lowest physiological and operative scores (12 and 6 respectively), which gives a minimum risk of mortality of 1.1% when applied to the POSSUM mortality predictor equation. This is far too high, given that it represents the fittest individual undergoing the most minor surgery. POSSUM scoring system itself has a tendency to overpredict mortality in lower risk band.[8]

In 1996, a research by Whiteley et al[9] showed how the original POSSUM overpredicted mortality in a cohort of 1 485 patients, particularly those with low risk. POSSUM data can be used, but a different regression equation was needed. This regression equation became known as the Portsmouth predictor equation, or P-POSSUM, in which R1 relates to the mortality. The P-POSSUM equation is LogeR1/(1-R1)=-9.065+(0.1692×physiological score)+(0.1550×operative severity score. Midwinter and Ashley[10] found that the P-POSSUM more accurately predicted the outcome in their patients, most of whom had vascular procedures. Though P-POSSUM had attempted to correct some problems by changing regression equation, there is no published papers comparing with POSSUM in orthopedics.

POSSUM physiological score may change with time. For example, an elderly patient admitted with septicaemia from a diverticular abscess, who is aggressively resuscitated before operation, should have an improving physiologic score. So surgeons can improve outcome after operation by preoperative resuscitation. Mellroy[11] reported that preoperative resuscitation could improve physiological scores and then outcomes were poor in patients who failed to respond to resuscitation.

POSSUM scoring system can be used to compare the performance of individual surgeon with risk-adjusted outcomes (calculated from POSSUM observed: expected ratio). In a study of 3 006 general surgical episodes by five surgeons from a single

hospital, crude mortality were compared with risk-adjusted outcomes (calculated from POSSUM observed: expected ratio). Individual surgeons had mortality that varied fivefold, from 1.0% to 4.9%. However, once adjusted, there was no significant difference in the ratios of observed: expected mortality, ranging from 0.86 to 1.06.[12] POSSUM scoring system has also been used to compare surgical patients treated in different countries and appears to be valid in continents with healthcare systems, different from that of the UK.[13,14] Even if the resources, facilities and prehospital care are different, POSSUM scoring system can still predict outcome.

Using physiological score as the *x* axis and operative severity score as the *y* axis, it is possible to generate graphically zone of increasing mortality and morbidity by POSSUM regression equations. Using the increasing zones of mortality and morbidity rates, surgeons can get the predicted operative risk ranges of patients, then comparing with the mortality and morbidity of conservative therapy, surgeons can make decision which design is chosen to cure patients.

In conclusion, modified POSSUM scoring system may be appropriately used to predict the morbidity in patients with hip fracture in China. Furthermore, POSSUM scoring system overpredict the overall risk of death, but its estimate is very close to the observed data in the high risk band (> 10%).

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