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ORIGINAL ARTICLE

RISK-ADJUSTED GENERAL SURGICAL AUDIT IN OCTOGENARIANS

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Background: Surgical admissions in patients more than the age of 80 years are increasing. Age-related comorbidities place this group at particular risk of complications and death. The aim of this study was to specifically document our current outcomes in patients more than 80 years old admitted to a surgical unit, in particular, to assess the risk-adjusted scoring tool used to predict outcomes in this patient population for operative and non-operative patients.

Methods: A prospective audit of all patients older than 80 years admitted to the general surgical unit between the 1 January and 30 November 2006 was carried out. Morbidity and mortality data were collected on standardized pro forma.

Results: There were 243 consecutive admissions in 223 surgical patients (readmission 8.2%, *n* = 20) comprising 70 emergency admissions (28.8%), 82 elective admissions (33.8%) and 91 non-operative admissions (37.5%). Complications occurred in 47.1% of emergency admissions, 18.3% of elective admissions and 23.3% of non-operative admissions. Thirty-day mortality was 15.7% (*n* = 11) for emergency admissions, 0% for elective admissions and 17.4% (*n* = 16) for non-operative admissions. Emergency laparotomy 30-day mortality was 31.6% (*n* = 6). There was no evidence of lack of fit when using the risk-adjusted scoring tool to compare observed with predicted deaths in all patient groups.

Conclusion: In all patients more than the age of 80 years admitted to General Surgery, Taranaki Base Hospital, morbidity and mortality results were acceptable when compared with published work. Risk-adjusted prediction of mortality compared favourably with observed outcomes, but more data are required to validate this tool in elective patients.

Key words: aged 80 and over, audit, logistic model, mortality, surgery.

Abbreviations: BHOM, Biochemistry and Haematology Outcome Model; BUPA, British United Provident Association; ICU, intensive care unit; IQ, interquartile; P-POSSUM, Portsmouth Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity; SRS, surgical risk score.

INTRODUCTION

Life expectancy has increased significantly in the second half of this century with the ages of the male and female sexes in 2051 expected to be 84 and 88 years, respectively. Currently, the elderly comprise 12% of New Zealand's population; predictions state that this will increase to 25% in 2030.[1] There are few studies that have investigated this significant, older proportion of our surgical workload and the outcomes associated with carrying out surgery on these patients.

Surgical audit is an annual requirement for continuing certification by the Board of Continuing Professional Development and Standards.[2] It is important that reported mortality figures in this high-risk group of patients accurately reflect surgical performance. Crude, unadjusted mortality rates do not adjust for different casemixes in the surgical population and are not good indicators of surgical performance.

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The Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity (POSSUM),[3–5] Portsmouth-POSSUM (P-POSSUM)[6,7] and Surgical Risk Score (SRS) can be used to predict 30-day mortality after adjusting for casemix.[8] POSSUM requires collection of 12 physiological variables and 6 operative variables, which is difficult and time-consuming to implement into regular audit practice,[9] with only 30% being fully completed in one study.[9] POSSUM, P-POSSUM and SRS are models that require operative data and are not suitable for non-operative patients[10] although they constitute a substantial part of the surgical workload.[9] POSSUM has also been shown to overpredict mortality in low-risk patients and underestimate mortality in elderly and emergency patients. The SRS discriminates well for low-risk procedures, but requires further validation for high-risk procedures.[11]

A model will be more useful if it applies to all surgical admissions, both operative and non-operative, as well as high-risk and low-risk procedures. Most surgeons accept that the mode of presentation, physiological condition of the patient and surgical procedure carried out, are predictors of patient outcome.[11,12] The Biochemistry and Haematology Outcome Model (BHOM) has been proposed by Prytherch *et al.* 2003, which includes age, sex, type of admission, physiological parameters and operative severity score.[10] Predicted mortalities are calculated using a derived logistic regression equation. The BHOM uses information, which is easily obtainable from most hospital information systems.

The aim of this study was to document our current outcomes in patients older than 80 years admitted to a surgical unit. In particular, to assess the risk-adjusted scoring tool used to predict outcomes in operative and non-operative patients developed by Prytherch *et al.*

METHODS

A prospective audit was conducted of all consecutive octogenarian General Surgical admissions from 1 January to 30 November 2006 excluding day case admissions. All four general surgeons participated in the audit.

Pro forma – agreed by all surgeons contained the minimum clinical dataset – haemoglobin, white cell count, sodium, potassium, urea, age on admission, sex, British United Provident Association (BUPA) operative severity score (completed on discharge for operative admissions), mode of admission and 30-day mortality as described by Prytherch *et al.*[10,13] BUPA operative severity score is widely used in the private medical sector in the UK. This has been shown to be a useful measure of surgical workload and complexity of operation.[14]

The main end-points for this study included the complications for each patient, 30-day mortality, discharge destinations and calculation of the BHOM for operative and non-operative patients.

Data were collected by the general surgical house officers. Each week the pro forma was collated, cross-referenced against daily in-patient lists and discharge database. The data were entered into an Excel database by a single registrar.

The Excel database was used to collate data and calculate predicted mortality using the logistic regression equation. There are three separate models: elective admission, emergency admission and emergency admission that did not undergo an operation referred to as non-operative admission.

The logistic regression equation for predicting mortality is as follows:

$$
\begin{aligned}
L\eta\left\{\frac{R}{1-R}\right\} = {} & \text{constant} \\
& + (\beta 1 \times \text{sex}) + (\beta 2 \times \text{age on admission}) \\
& + (\beta 3 \times \text{urea}) + (\beta 4 \times \text{sodium}) \\
& + (\beta 5 \times \text{potassium}) + (\beta 6 \times \text{haemoglobin}) \\
& + (\beta 7 \times \text{white cell count}) \\
& + \beta \text{operative severity score}
\end{aligned}
$$

where R is the risk of death, β is the coefficient value given in Table 1 corresponding to patient type and βoperative severity score is the appropriate coefficient for the operative severity (if applicable) from Table 1. The constants and coefficients are given in Table 1.

Predicted mortality

The logistic regression equation is applied to the minimum clinical dataset. Using the predicted risk of death, the episodes were grouped into risk ranges chosen from the non-operative patients to give (as close as possible) similar predicted deaths in each range then carried these over to emergency and elective admissions. The number of episodes within each risk band is given together with the mean risk (%). The predicted number of deaths is then calculated by the number of episodes multiplied by the mean risk (%). This is compared with the actual number of deaths. Goodness of fit is assessed using the χ^2-test with 4 degrees of freedom (d.f.). This is a null hypothesis test – models with P-values greater than 0.05 are considered to show no evidence of lack of fit. Cochrane's rules for χ^2 require at least five predicted events in 80% of risk ranges of strata.

Table 1. Constants and coefficients for risk models

	Non-operative	Emergency operation	Elective operation
Constant	−6.9247	−5.1412	−15.4194
Sex (M = 1), (F = 0)	0.2203	−0.1734	0.3290
Age	0.0765	0.0496	0.1145
Urea	0.0971	0.0782	0.1110
Sodium	−0.0133	−0.0067	−0.0047
Potassium	−0.0487	−0.2744	0.2846
Haemoglobin	−0.0897	−0.0730	−0.0383
White cell count	0.0584	0.0424	0.0048
BUPA operative severity score			
1	—	0	0
2	—	0.1485	−0.2611
3	—	0.9012	1.0052
4	—	1.6405	2.0910
5	—	1.6501	3.3117
6	—	1.5592	3.1713
7	—	3.0636	4.4598
8	—	−2.8362	0

BUPA, British United Provident Association; —, no coefficient (value 0).

RESULTS

Patient characteristics

Overall there were 243 admission episodes from 223 surgical patients with 20 readmissions (8.2%) constituting 13% of all surgical admissions. The male : female ratio was 2:3. The median age of patients was 84 (interquartile (IQ) range 82–87 years). There were 70 emergency admissions (28.8%), 82 elective admissions (33.8%) and 91 non-operative admissions (37.5%). There was one elective admission that did not undergo an operation and is included in the non-operative patient group. For BHOM analysis, this patient is excluded, as only acute non-operative admissions can be included in this modelling.

The overall length of stay (LOS) (median and IQ range) was 4 days (3–8 days). Emergency admissions stayed 7.5 days (4–12 days), which was longer than elective admissions (LOS 3 days, IQ range, 2–7 days) and non-operative admission (LOS 4 days, IQ range 3–5.5 days).

The overall classification of admissions included colorectal 37.6% (n = 89), vascular 17.6% (n = 43), hepatobilary 9.1% (n = 22), upper gastrointestinal 8.2% (n = 20), cellulitis 6.2% (n = 15), trauma 4.9% (n = 12), hernia 4.9% (n = 12), skin 4.9% (n = 12), general 3.7% (n = 9), head and neck 2.1% (n = 5), breast 1.2% (n = 3) and thoracic 0.05% (n = 1). The level of complexity according to BUPA operative severity score for elective admissions were 15 minor, 31 intermediate, 15 major, 9 major+, 2 CMO1, 2 CMO2, 8 CMO3 and emergency admissions they were 25 minor, 17 intermediate, 16 major, 2 CMO1 and no CMO2/3 scores. There were no CMO4 scores.

Complications

Blood transfusions were required in 20% ($n = 14$) emergency patients, 8.5% ($n = 7$) elective patients and 9% ($n = 8$) non-operative patients. Complications outlined in Table 2 occurred in 33 emergency patients (47.1%), 15 elective patients (18.3%) and 22 non-operative patients (23.3%). Five patients required return to theatre (3.3%), four emergency patients and one elective patient. Thirty-day mortality rates were 15.7% ($n = 11$) for emergency admission and 17.4% ($n = 16$) for non-operative admissions. There were no elective deaths. There were 19 emergency laparotomies carried out with 6 deaths (31.6%).

Intensive care unit (ICU) admissions: there were six emergency patients in ICU with a total stay of 24 days and five elective patients with a total stay of 9 days. High-dependency unit admissions: there were 17 emergency patients with a total stay of 57 days, 3 elective patients with a total stay of 9 days and 3 non-operative patients totalling 6 days.

Transfers during admission to another medical team was required for 9% ($n = 6$) emergency patients, 5% ($n = 4$) elective patients and 9% ($n = 8$) non-operative patients. Rehabilitation was necessary for 14% ($n = 10$) of emergency patients and 10% ($n = 9$) of non-operative patients with no elective patients needing rehabilitation services. Discharge destinations showed most of patients in all groups returned home or to previous rest-home placement: 79% ($n = 55$) emergency patients, 98% ($n = 80$) elective patients and 77% ($n = 70$) non-operative patients. New rest-home referrals were generated for 13% ($n = 9$) emergency patients, 2% ($n = 2$) elective patients and 15% ($n = 14$) non-operative patients. Hospice and death in emergency patients was 1% ($n = 1$) and 7% ($n = 5$), respectively, and in the non-operative patients 2% ($n = 2$) and 6% ($n = 5$), respectively.

Predicted mortality

The logistic regression equation was applied to the minimum clinical dataset. Risk stratification is shown in Tables 3–5. Emergency, elective and non-operative admission patient groups show no evidence for lack of fit. Cochrane's rules for χ^2 require at least five predicted events in 80% of risk ranges of strata therefore at present there are inadequate numbers to prove in this audit; however, these results are promising.

Table 2. Complications

	Emergency, $n = 33$	Elective, $n = 15$	Non-operative, $n = 22$
Cardiac	17	8	5
Respiratory	14	3	7
Renal	13	10	15
Thrombosis/bleeding	3	2	1
Wound	7	2	0
Systemic/other	2	1	3
Total	55	24	31

DISCUSSION

Elderly patients are higher-risk patients with longer LOS and higher rates of complications. There are limited studies describing complication and mortality rates for this population, especially non-operative patients admitted under surgical care. Our results confirm higher rates of complications particularly in emergency patients.

Mortality rates were also high in the emergency and non-operative groups at 15.7 and 17.8%, respectively. This is similar to other reports of emergency mortality rates between 11.1 and 29%.[15–17,19,20] In addition, emergency laparotomy mortality was found to be 31.6%, which was comparable to a similar study, which reported 60% mortality.[18] The variability of mortality rates reflects the limited and small studies investigating mortality in this patient population. The high non-operative mortality rate is a figure frequently not reported, as most papers focus on surgical operative deaths. This is a neglected group of patients, which require more attention in future surgical audit.

There were no elective surgical deaths in octogenarians and an 18% complication rate. These figures compare well with published reports of elective operative mortality rates of 7.5% and morbidity rates of 33%.[15–17]

Interestingly, discharge destinations were similar for emergency and non-operative patients with 79 and 77% returning home or previous rest-home residence. All elective patients returned to their previous residence, be that home or rest home. New rest-home referrals were required for 13% of emergency patients and 15% of non-operative patients. Other research has found that 70% of general surgical patients were discharged home and 16% discharged to rest home, which correlated to our results.[20]

The BHOM, which was used to analyse our patient data, has been proposed by Prytherch *et al.*[10] as an alternative to POSSUM,[3–5] P-POSSUM[6,7] and SRS, which can be used to similarly predict 30-day mortality.[8] Criticism of these current models is, most notably, the difficulty in collecting the physiological and operative variables required to incorporate these tools into regular clinical practice.[9]

The formula for POSSUM and P-POSSUM is complex and performance depends on the method of analysis and also requires manipulation for different subspecialties within surgery. POSSUM has been shown to overpredict mortality in low-risk patients and underestimate in elderly and emergency patients.

Table 3. Minimum clinical dataset applied to emergency admissions

Risk band (%)	No. episodes	Mean risk (%)	Predicted deaths	Observed deaths	χ^2
0–14	46	6.86	3	4	0.24
15–22	8	17.93	1	3	2.08
23–38	11	27.14	3	3	0.00
38–100	5	52.09	3	1	2.06
0–100	70	14.54	10	11	4.39

$\chi^2 = 4.39$, 4 d.f., $P = 0.357$. No evidence of lack of fit.

Table 4. Minimum clinical dataset applied to elective admissions

Risk band (%)	No. episodes	Mean risk (%)	Predicted deaths	Observed deaths	χ^2
0–14	68	2.52	2	0	1.76
15–22	4	17.51	1	0	0.85
23–38	6	25.41	2	0	2.04
38–100	4	49.18	2	0	3.87
0–100	82	7.2	6	0	8.52

$\chi 2 = 8.52$, 4 d.f., $P = 0.074$. No evidence of lack of fit.

Table 5. Minimum clinical dataset applied to non-operative admissions

Risk band (%)	No. episodes	Mean risk (%)	Predicted deaths	Observed deaths	χ^2
0–14	48	8.9	4	2	1.33
15–22	20	17.63	4	5	0.75
23–38	13	30.45	4	3	0.33
38–100	9	50.28	5	6	0.97
0–100	90	18.09	16	16	3.37

$\chi 2 = 3.37$, 4 d.f., $P = 0.498$. No evidence of lack of fit.

Surgical Risk Scores in comparison to POSSUM is based on the Confidental Enquiry into PeriOperative Deaths grade, American Society of Anesthesiologists grade and the BUPA operative grade[8] and performs well in low-risk procedures. SRS performs well in low-risk procedures, as the lowest predicted risk is 0.07%. The absolute minimum risk of mortality for POSSUM is 1.08% and 0.2% for P-POSSUM, which is too high for these procedures.[8] An imoportant limitation is that only operative patients can be assessed, as none of these tools is suitable for non-operative patients.

Overall, a risk assessment scoring system should have few variables, be easy to collect and implemented into daily practice, be available for every patient and have limited potential observer bias. BHOM uses clinical data, which is easily available from a single venesection. It is logically feasible to collect this for all patients as part of routine care. The data are objective and cannot be manipulated by observer bias.

The BHOM risk-adjusted tool for predicting mortality in emergency, elective and non-operative admission patient groups shows no evidence for lack of fit when applied to our audit data. Unfortunately, Cochrane's rule for χ^2 require at least five predicted events in at least 80% of strata therefore at present there are inadequate numbers to prove in this audit; however, these results are promising. The main difficulty would be in proving elective operations, as we had no patient deaths in this category. Prytherch *et al.* in the original paper, found similar problems with insufficient numbers, which prevented stratification into more than five bands. Large patient numbers would be required, which is not easily obtainable in a small peripheral hospital. The BHOM appears, albeit with insufficient numbers, appropriate for our population and adequately predicted mortality. Further studies will be required to ascertain if this is the case for Australasian population, preferably in a larger centre to gain the numbers required.

CONCLUSION

In conclusion, this general surgical audit confirms the outcomes in the more-than-eighties were acceptable when compared with other studies. The minimum clinical dataset is a promising tool for risk-adjusted evaluation of surgical mortality, which can be applied easily in a provincial setting and deserves wider attention.

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